James Emerson Elliot

3 N. Bridge Street

d

1922.

15/- net

A SYSTEM

OF

DENTAL SURGERY

A SYSTEM

OF

DENTAL SURGERY

BY THE LATE

SIR JOHN TOMES, F.R.S.

CORRESPONDING MEMBER OF THE PHILADELPHIA ACADEMY OF NATURAL SCIENCES; LATE DENTAL SURGEON TO THE MIDDLESEX AND DENTAL HOSPITALS

FIFTH EDITION

REVISED AND ENLARGED
BY

CHARLES S. TOMES, M.A., F.R.S.

LATE LECTURER ON DENTAL ANATOMY AND PHYSIOLOGY TO THE ROYAL DENTAL HOSPITAL OF LONDON

AND

WALTER S. NOWELL, M.A. Oxon.

ASSISTANT DENTAL SURGEON MIDDLESEX HOSPITAL; LATE ASSISTANT DENTAL SURGEON AND MEDICAL TUTOR ROYAL DENTAL HOSPITAL OF LONDON

WITH 318 ILLUSTRATIONS

LONDON

J. & A. CHURCHILL

7 GREAT MARLBOROUGH STREET

1906

BRADBURY, AGNEW, & CO. LD., PRINTERS,
LONDON AND TONBRIDGE.

PREFACE

TO THE FIFTH EDITION.

To retain the initial character of a work written nearly fifty years ago, whilst endeavouring to bring it up to date in successive editions, is no easy task. The difficulties are enhanced when, as in this case, the original treatise contained many new investigations on points at that time unknown in the development and eruption of the teeth; the views advanced have, however, since obtained such general acceptance that it has appeared unnecessary to retain the evidence upon which they were based, except in so far as is essential to a proper understanding of the origin and treatment of irregularities of the teeth.

The personal pronoun "I" was frequently made use of by Sir John Tomes, and was for the most part left unaltered in subsequent editions, but the editor, through inadvertence, occasionally himself made use of the same pronoun, thereby causing possible ambiguity as to the responsibility for particular opinions. In the present edition this has been, partly at all events, remedied, and the first person singular may be taken generally to refer to the opinions of the original author, and the present editors have used the expression "we" when endorsing original statements or commenting on new theories. The text has been completely revised and additions made, though without materially increasing the size of the volume, whilst for facility of reference heavy type headings have been freely used.

Such convenient and generally accepted terms as "bicuspid" and "Pyorrhea" have been for the most part retained even though open to exception from the standpoint of strict scientific nomenclature. In those portions of the work which treat of manipulative processes, little more has been attempted than to offer such details as may serve to illustrate general principles of procedure, as it is fully recognised that not much can be gained by the verbal description of mechanical operations within the space available. The chapter on Bacteriology has been entirely revised and largely rewritten by Mr. J. Howard Mummery, who has also revised the references made to micro-organisms in the section relating to dental caries; to him the authors tender their warmest thanks for the manner in which he has carried out this portion of the work.

In the revision of the rest of the work no definite division of labour has been adopted, but the editor of the previous editions having relinquished active practice it was obviously desirable that there should be associated with him someone still in touch with present methods, upon whom in fact the burden of the work has chiefly fallen.

September, 1906.

PREFACE

TO THE FIRST EDITION.

In the following pages an attempt has been made to produce within the limits of a manual a strictly practical work on Dental Surgery. In order to fulfil this object, it became necessary to enter upon the structure and development of the teeth and jaws in a limited degree only, and to leave untouched any historical account of the writings of those who have from time to time contributed to our knowledge in this branch of surgery. The diseases of the teeth, and of the parts subservient to them, together with the coincident maladies, have been treated of, so far as may be, in the natural order of their occurrence, and the structure and development of the tissues involved have been to some extent described before entering upon the diseases to which they are respectively liable.

In a work devoted to the description of practical details, the modes of procedure in the treatment of diseases, whether by operations or otherwise, must necessarily be those practised by the Author. The methods adopted by others are known only through published descriptions, the mere reprint of which would be but a work of supererogation. On this account, together with the want of space, the quotations from other writers have been but limited. I must, however, express my obligation to many of those who have written upon dental surgery; and I cannot leave unmentioned the names of

Mr. Bell, Mr. Spence Bate, Mr. Samuel Cartwright, Mr. Chapin Harris, and Mr. Arthur. Reference is not unfrequently made to a series of lectures published in 1848. Many subjects but imperfectly touched upon in these pages are more fully treated in that work, and many specimens are there figured which illustrate subjects discussed in this volume.

The demands of an active practice leave but little leisure for writing, and that little has been seriously interrupted by engagements consequent upon the gradual organization which the dental profession has recently undergone. From these, and from causes less controllable, the present work has passed very slowly through the press, many of the earlier sheets having been in print upwards of eighteen months.

To Mr. Bagg I am greatly indebted for the highly artistic illustrations which he has produced from specimens in my own collection, and from others which have been liberally contributed by my professional friends.

JOHN TOMES.

37, Cavendish Square,
February 28th, 1859.

CONTENTS.

A

SYSTEM OF DENTAL SURGERY.

TEETHING AND NORMAL SECOND DENTITION.

The term teething might be understood as embracing the development of the teeth from the commencement of their formation to the completion of their eruption, but custom has limited its use to a single phase of the process—that is, to the eruption or cutting of the temporary teeth. Yet if observation were restricted to the eruption of the teeth without instituting an inquiry into the preceding conditions, our knowledge of the subject would be very imperfect. It is desirable, therefore, to describe the conditions of the teeth and jaws at the time of birth and to trace the changes onwards until the temporary teeth are in functional use.

At the time when Sir John Tomes undertook to write the first edition of this work, the museums in which an extended series of young skulls would be likely to be found were visited, but without success. So far as could be learned, no such series existed; it therefore became necessary for him to make a collection, taking care that the age of each specimen should, if possible, be ascertained. This was done, and the preparations comprised in his collection, which are now for the most part in the museum of the Odontological Society, were sufficiently numerous to allow of deductions being made from the characters they presented. Indeed, little or no literature bearing upon the subject, with the exception of John Hunter's writings, existed, and hence the earlier chapters of the book embodied not only the conclusions arrived at respecting the growth and development of the jaws and teeth, but also many details of the data upon which they were based. But now that the deductions drawn from the large, and at that time unique, collection of young skulls of known ages have obtained general acceptance, and that other works treating of special dental anatomy are in existence, such full detail is no longer necessary, and the original chapter upon teething has been greatly abridged.

If two perfectly healthy children of the same age be examined, we shall rarely find that they present precisely similar conditions as regards the stage of teething; yet there will probably be no great disparity in the conditions found.

There is, however, another source of fallacy to be guarded against. The specimens obtained are necessarily taken from individuals who have been the subjects of disease; and, supposing the fatal illness to have been of long standing, the jaws may have been modified. That this has occurred to some members of the series is sufficiently obvious, but the diseased action appears to have influenced the growth of the jaws themselves rather than the rate of development of the teeth. And it is a remarkable fact that there is more fixity about the teeth than about the jawbones under the influence of inherited or of pathological variations; thus in short-muzzled dogs the teeth do not diminish in size proportionately with the shortening of the face, so that they come to be crowded, and the same thing is every day observed in the human subject, even in cases of rickets. Hence even these specimens may sometimes serve to confirm the results obtained from an examination of healthy jaws, so far as the teeth themselves are concerned.

The fact that the development of the hard tissues of a tooth is preceded by the formation of soft tissues, or tooth-pulps of size and form equal to the future tooth, must at all times be kept in view. The entire pulp does not assume at once the dimensions of a perfected tooth before its conversion into the hard tissue commences, but each individual part of the developing tooth is first formed in pulp tissue of its full size and then calcifies. In dentine, which forms the great bulk of each tooth, we have no such thing as outward growth; no addition to the external surface of the formed tissue ever takes place, except by the superposition of the enamel, and of the cementum, which respectively coat the crown and the root of the tooth; but these add comparatively little to the size of the organ. Hence it follows that both the forms and dimensions of the crowns of the teeth are unalterably fixed long before the jaws are sufficiently enlarged to admit of their ultimate normal arrangement, so that the forming teeth and their crypts have to be packed by overlapping one another; this also applies in even greater degree to the second dentition.

At the period of birth the articular process of the lower jaw is scarcely raised above the level of the alveolar edge, while the angle is projected downwards a little below the general level of the inferior margin of the jaw. The coronoid process rises at an angle of forty-five degrees from the alveolar edge, its ascent commencing at the anterior boundary of the socket of the first permanent molar. In the upper jaw the zygomatic process proceeds outwards from the anterior margin of the large open socket of the second temporary molar. These conditions are shown in Figs. 1 and 2.

The temporary teeth in a nine-months fœtus are partly formed. The central incisors are calcified through most of the length of the crown; but the lateral incisors are less advanced. The terminal points only of the canines are calcified, while the masticating surfaces of the first temporary molars are completed, except as to the enamel, which at this stage has not attained to more than half its thickness, a condition which is common also to the more anterior teeth. The second temporary molar is represented by calcified cusps, which are united in a ring, the central part of the crown being as yet uncalcified. If examined in the recent condition, it will be seen that in the front teeth calcification has advanced nearly to the base of the tooth pulp, which ends in a broad flat surface; while in the canines and molars the pulp extends a short distance below the terminal line of calcification.

As the growth of the lower jaw goes on especially rapidly in the ramus the angle becomes less obtuse, and the articular process rises more abruptly above the alveolar border. A general increase in depth takes place by additions to the free edge of the alveoli, and growth also takes place at the suture connecting the two halves, both in upper and lower jaws, in the fibro-cellular tissue which connects them. Increase of bone in the median line would necessarily lead to separation of the central incisors ; this is, however, met by the teeth on either side inclining towards the centre, and the sockets partake in a similar change of direction, their free edges being closely approximated, while the deeper parts are separated from each other.

By the age of **eight months**, the alveoli of the front part of the mouth, which have hitherto grown more rapidly than those

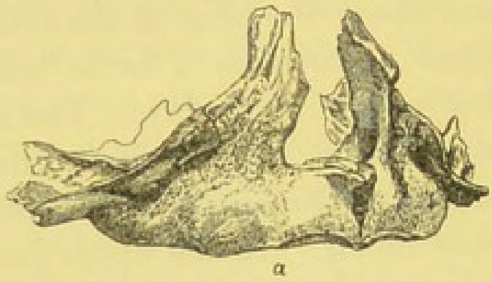


FIG. 1.—The upper jaw of a nine-months fœtus, the soft parts having been removed, showing the outer surface of the alveolar process. *a*, the depressed portion corresponding to the position of the lateral incisor.

situated further back, now become the seat of absorption : while the more posterior ones assume a greater activity of growth. The central incisors of the upper jaw, although they do not descend below the general level of the alveolar ridge, have become exposed on their anterior surfaces by the absorption

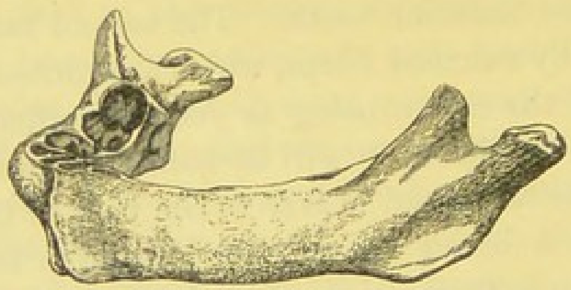


FIG. 2.—The lower jaw of a nine-months fœtus, showing the relative size and position of the several parts of the bone at this age.

of a great part of the outer wall of the sockets, and at the same time the teeth have moved bodily a little forward. The distal edges of the central incisors are in front of the lateral incisors, the latter being still placed in a line internal to the canines, so that if the teeth were cut in their present positions, the arrangement would be extremely irregular. These facts, which apply equally to the permanent dentition, should be steadily kept in mind when estimating the degree of irregularity of newly-cut teeth.

The sockets of the upper molar teeth, which formerly extended up to the floor of the orbit, are now separated from it by the antrum, which at this time is represented by a deep depression, extending under the orbit to the extent of its inner two-thirds.

In the lower jaw the changes from the earlier conditions are more striking. The two halves, which in the upper are still easily separable, are in the inferior maxilla becoming united, and no longer part after maceration. The symphysis and mental prominence are strongly marked, the bone behind the front teeth is thickened and turned forwards at the alveolar margin, making a curved surface with the convexity directed towards the tongue—a form altogether different from that of the corresponding part in the mature fœtus, where the posterior surface of the symphysis is straight. It was shown that in the fœtal jaw the point of the inferior border corresponding to the position of the first and second temporary molars descends to a lower level than the parts anterior or posterior to it. In the nine-months jaw, the relative depths of the three parts indicated are changed, the middle portion now being the highest. The removal of the anterior wall of the alveoli of the central incisors, and partly also of that of the lateral incisors, has been effected in the lower as well as in the upper jaw.

Taking the jaw figured as a fair standard of the conditions peculiar to this age, it will be seen, on comparison with the preceding figures, that the bone has undergone great change, not only in size but also in form, and that the changes in form are more remarkable in some parts of the jaw than in others.

If we draw a horizontal line through the level of the upper pair of spinæ mentales in an adult jaw we shall about equally divide it; but the life history of that part which lies above the line and that which lies below it is widely different. The lower portion is the jaw that supports muscles of deglutition, of mastication, and the like structures essential to the well-being of the animal, and is progressively developed from the earliest time of ossification until it has attained its full size without intermission; not so, however, the portion of bone above our imaginary line. This is subservient to two purposes only: that of supporting the teeth when perfected, and that of protecting them whilst developing. And so far from being itself

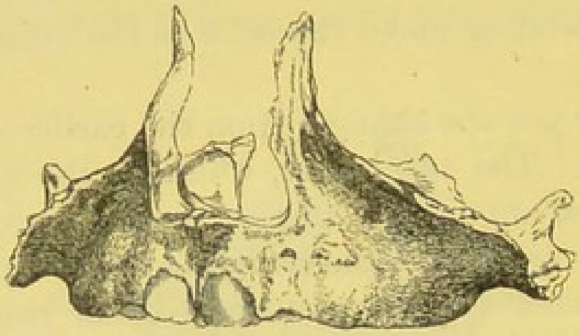


FIG. 3.—The upper jaw of a male nine months old, showing absorption of the anterior walls of the sockets of the central incisors preparatory to the escape of the crowns of the teeth from their alveoli.

gradually elaborated and developed without a check, it was built up around the calcifying temporary teeth, and then in part removed to allow of their eruption; built up again around their roots, and yet once more absorbed to give exit to the

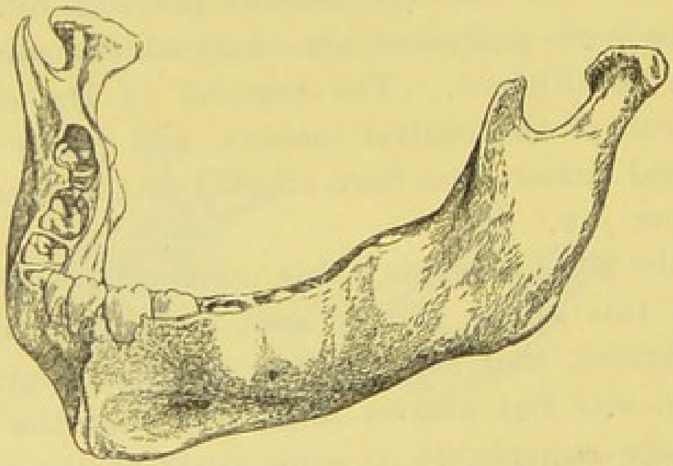


FIG. 4.—The lower jaw of a male nine months old, showing absorption of the outer walls of the sockets of the incisors preparatory to the eruption of those teeth. Two-thirds life-size.

permanent teeth; then developed afresh around the roots of the permanent set of the teeth, so that in the socket of the permanent teeth probably not one fragment of the original alveolar portion of the jaw remains. And when the teeth are shed in old age the alveolar portion of the jaw is again removed. Relatively, then, to the changeable alveolar portion we may regard the body of the ramus as fixed and immutable, and we shall not be led into any error of consequence by taking muscular processes or foramina as points of measurement from which to estimate the relative proportions of these two parts of the horizontal ramus at various ages.

The foramen mentale and the geniohyoid and geniohyoglossus tubercles are convenient points whence to take measurements, and from a study of such measurements the features of the growth of the jaws, which were set forth at greater length in the earlier editions of this book, were deduced.

Three years after the publication of the preceding statements in the first edition of this work, the late Sir G. Humphry read a paper before the Cambridge Philosophical Society, in which a similar conclusion was arrived at as to the growth of the jaw by inferences drawn from a series of experiments performed by inserting wires into the jaws of growing animals. During growth of the jaws in various other dimensions it was found that the inner alveolar plate is comparatively stationary, while the outer alveolar plate and teeth were moved forward, allowing the jaw to increase in thickness, and to afford space for the pulps of the anterior permanent teeth.

The following diagram may serve to render some of the chief points clear; in it a jaw from a nine-months fœtus is placed over an adult jaw, the limits of which are marked by dotted lines.

It will be seen that the arch of the jaw in the fœtus is as wide and as large as in the adult; the difference between them in this part being simply due to additions to its thickness, to a slight extent on the inside, but very much more on the outside of the jaw. It will also be seen that the increase in size in the adult jaw is gained exclusively by its prolongation backwards, and not by anything like interstitial growth. As expressed by Sir G. Humphry, "Although the bones of the alveolar arch are lengthened, and the arch is rendered more elliptical, it is not widened. The widening of the jaw, in correspondence with the increasing width of the base of the skull, takes place behind the alveolar arch in the ascending portion, and is effected by the progression of absorption on the inner and addition to the outer surface of this part." But even without the aid of this modelling process, the mere prolongation backwards of the horns would give a considerable increase in width.

The growth of the anterior part of the jaw by addition of bone prior to union at the symphysis, may be computed by relative measurements of the fœtal and nine-months jaws. An increase of distance between the symphysis and mental foramen, amounting to the eighth of an inch in favour of the older jaw, is shown. This increase will be found to correspond in amount with the greater thickness in the antero-posterior direction near the symphysis of the nine-months jaw over that of the fœtal organ. The foregoing facts show sufficiently clearly that the

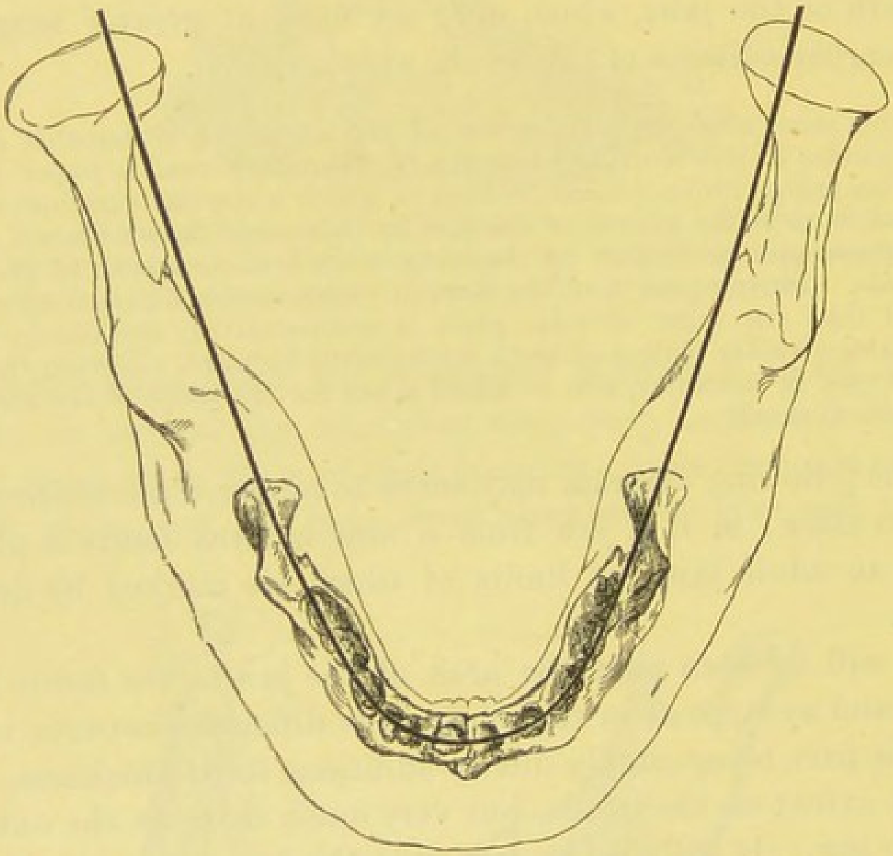


FIG. 5.—Lower jaw of a nine-months fœtus superimposed upon an adult jaw.

growth of the anterior parts of the lower jaw is produced by addition of bone to the anterior surface, rather than by any material increase by the development of bone in the fibro-cellular tissue which, up to this period, unites the two halves. Development in the latter position appears to have its period of activity limited to intra-uterine life. After birth, the process of growth in this direction is all but suspended until the period arrives for the osseous union of the two halves of the jaw, when the fibro-cellular tissue is replaced by bone, and all further increase at this point is then at an end. Still keeping the mental foramen as the point from which to make the computations of relative growth in different directions, it will be found, by examining the series of jaws, that additions have been made to the lower border of the jaws, but that there has been relatively a much greater activity shown in the alveoli, which at the age of nine months have acquired their maximum height in the front part of the jaw. The length of the jaw behind the mental foramen has steadily increased with the increasing age of the subject, the direction of the growth being indicated by a series of minute grooves which mark the bone at and near the angle of the jaw. Between these grooves the bone rises into minute ridges, many of which are continued to the posterior border of the ramus, and there terminate in short slender spiculæ, giving to the border a rough surface which, although well marked in many dry specimens, is much more strongly pronounced before the bone is allowed to dry, and the partly-calcified spiculæ to become contracted by the loss of moisture. If these grooves are traced through a series of specimens of progressive ages, commencing with the fœtal jaw, it will be seen that those about the coronoid process indicate the path in which that part has travelled; a line which, as will subsequently be shown, is permanently marked in the adult jaw by the external *oblique line*. Then, again, a similar line of grooves indicates the course which has been taken by the articular process in its progressive growth upwards and backwards. Indeed this line is also indicated by the surface being slightly raised, there being a distinct rounded eminence along the outer surface of the jaw, ending in the condyle, which becomes less marked in the adult. Below, and a little posterior to this line, we have the angle of the jaw, the increase in which has been already noted.

Prof. Kölliker has shown that the articular cartilage is of unusual thickness for cartilage so placed; and that, in addition to the usual functions of articular cartilage, it is here subservient to the purposes of development, its office in one respect being similar to the cartilage which in childhood is placed between the epiphysis and shaft of a long bone. Thus in whatever direction the jaw has increased, the increase has been produced by additions to the external surface. There are no indications of interstitial growth within and throughout the whole substance of the bone. It is not unusual to find increased size of a bone described as expansion, but the term is not applicable. We may have great increase in the size of the medullary cavity and of the circumference of a long bone, as

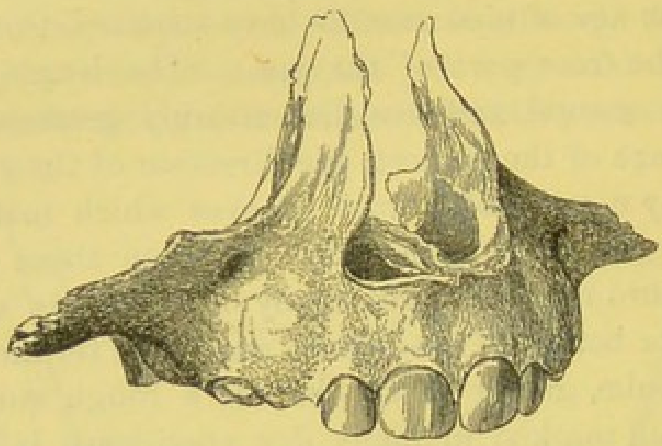


FIG. 6.—Upper jaw of a male thirteen months old, showing the incisors, with the crowns escaped from the alveoli, and the emargination of the socket of the first temporary molar.

is seen in diseased limbs; but in such cases the enlargement of the cavity is produced by progressive absorption of its parietes and the enlargement of the outer dimensions by development of bone upon the surface.

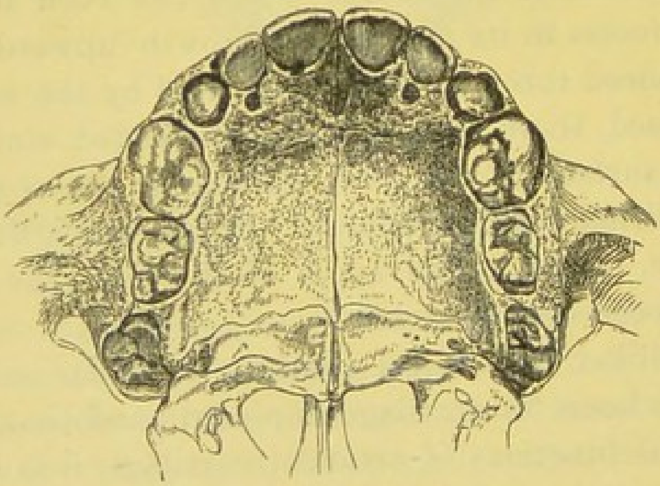
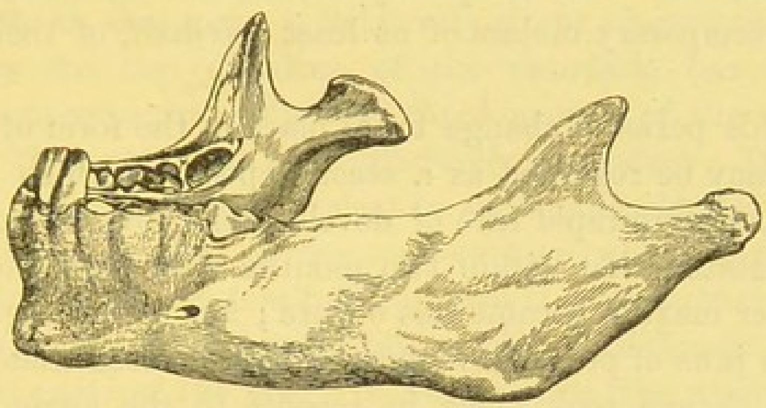
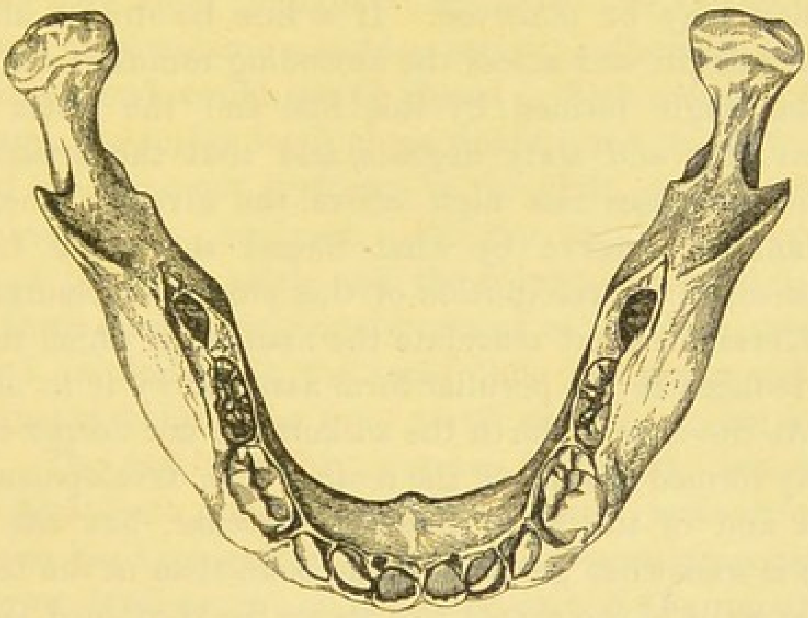


FIG. 7.—The palatal surface and the alveolar margins of the same specimen.

If the teeth of a child aged nine months be removed from their sockets and examined separately, it will be seen that the crowns of the central incisors are perfected so far as their exteriors are concerned, and that the production of the necks of the teeth has commenced. The enamel of these teeth presents the character which marks the completion of its development—namely, the smooth and polished surface which succeeds to the dull, opaque, and almost chalk-like character maintained so long as the tissue is incomplete.





FIGS. 8 AND 9.—The condition of the lower jaw and teeth of a thirteen-months male subject. In this example, the first temporary molars of the upper do not appear more advanced than the corresponding teeth of the lower jaw—a condition which is rather unusual.

Passing from the nine to the **twelve-months** subject, further changes in the dental apparatus will be observed, indicating that during the intervening three months the process of teething, as the term is commonly understood, has fairly set in, and at the latter age is in full activity.

If we now consider a subject **forty months** old, it will be seen that the whole of the temporary teeth have taken their normal position in the jaws, and appear complete; but if the roots are examined, the inaccuracy of this conclusion will be discovered. The incisors are the only teeth in which the roots are completely formed. The canines are destitute of about one-third, the first temporary molars of one-fifth, and the second temporary molars of at least one-half, of their normal length.

At this period a change takes place in the form of the jaw, and it may be regarded as a second epoch, at which this bone takes on a more rapid rate of development towards adult form. It was stated that within two months after birth the angle of the lower maxilla became less obtuse; and in tracing the same point in jaws of progressive ages, it may be seen that but little further change took place in respect to the angle until the subject arrived at the third year. But at this age a manifest alteration may be observed. If a line be drawn along the alveolar margin, and across the ascending ramus, it will be seen that the angle formed by this line and the latter part is between fifty and sixty degrees, and that the articular and coronoid processes rise high above the alveolar line. It is important to observe by what means the angle has been diminished, as the recognition of this process of change will to a considerable extent elucidate the manner in which the adult jaw is reduced to the peculiar form assumed by it in advanced age. At the time of birth the sockets are not deeper than the partially formed crowns of the teeth. The development of the sockets and of the teeth proceed together, but the rate of growth is somewhat greater in the bone than in the teeth; so that the walls of the crypts rise above the contained teeth, and eventually arch over and protect them. When the crowns of the teeth are completed, the inverted edges of the sockets are absorbed, and reduced in height until they are lower than the teeth. The crowns of the latter gradually pass through the widened apertures of their respective sockets. When the portions of the teeth which are invested with enamel have passed the edges of the bone, development of the latter is resumed, and keeps pace with the increasing length of the teeth. Now, if attention be directed to the mental foramen at the several ages which have been noticed, it will be seen that from first to last this aperture is in close connection with the apex of the root of the first temporary molar, indicating that the gradually increased depth of the jaw has been obtained by additions above it to the alveolar edge of the bone. If equal additions had been made to the lower border, the relations between the body and the rami would have been maintained. But growth at that part is relatively slight; hence the angle formed by the two divisions of the mandible has become changed contemporaneously with rapid growth of the alveolar margin. The rami have been gradually elongated. The rate of growth is not, however, subject to sudden acceleration, as in the case of the alveolar border; a condition which is compensated by the increased depth of the alveoli, still further by the protrusion of the several teeth taking place at different periods in different parts of the jaw. If, for instance, the whole of the temporary teeth were cut at the same time, and the growth of the alveoli were equal throughout the whole line, the elongation of the rami must assume a sudden activity, otherwise the front part of the mouth could not be closed. With deficient length of the rami, the molar teeth alone would come in contact—an abnormal condition not very rare in the adult, and to which we shall subsequently readvert. In the child, however, the eruption of the front teeth, and the subsequent rapid development of their alveoli, produce depression of the chin even when the mouth is closed; at the same time the upper and lower gums, situated behind the front teeth, no longer come in close contact. The rami steadily increase in length, and after a time the back teeth appear through the gums, and occupy the space which has been gained, first by the separation occasioned by the prior development at the front part of the mouth, and afterwards increased by the lengthening of the rami.

By the uninterrupted but comparatively slow elongation of the rami, and the rapid but successive growth of the front and back parts of the jaws, a relation of parts is brought about by which the whole series of teeth are allowed to be brought in contact simultaneously. If it were necessary to find a reason why the rami should not be subject to irregular rates of growth, similar to, and in accordance with, such as are seen to occur in the alveolar portions of the jaws, a sufficient reason might be found in the fact that bone which is developed in temporary cartilage under ordinary circumstances increases steadily, and that the articular processes of the lower maxilla are increased in length by development in cartilage situated beneath the surface of the articular cartilage; the development in this situation offering no exception to what appears to be a general law in relation to the development of bone in temporary cartilage. On the other hand, bone may be formed with comparative rapidity upon a free surface of pre-existing bone.

The smaller angle formed by the alveolar margin and the ascending rami in the jaw of the forty-months subject, as compared with younger subjects, has been already mentioned. But if the line formed by the lower border of the body of the jaw be examined in relation to that bounding the posterior portions of the rami, it will be found that the angles formed are here more obtuse, hence preserving at these points a greater similarity to the younger jaws; and the condition is maintained so long as the jaw continues to increase in length. If, therefore, the lines last referred to were rectangular, as is the case in some finely-developed adult jaws, we might have a further increase in the length of the ascending rami, and in the depth of the jaws; but it would be difficult to see how the length could be increased in the horizontal direction.

In jaws from a specimen, aged **four years,** the incisor teeth are the only ones which are really perfected. The roots of the others are slightly deficient in length, and are open at their extremities. Four or five additional months would probably have served for their completion. At the commencement of the **sixth year** the temporary teeth are all fully formed, a condition which is most likely attained six months prior to this period.

Such are, in brief, the facts in the development of the teeth and jaws which have a practical bearing upon the work of the dental surgeon, and which it is quite necessary for him to keep in mind if he is to treat irregularities in an intelligent manner.

The period at which the **eruption of the temporary teeth** takes place varies much in different animals. The reptile has to seek his living for himself from the moment he leaves the egg, but the presence in mammalia of the store of food provided by the mammary glands of the mother enables the use of teeth to be postponed for a material length of time.

In the human subject, at an age varying from six to nine months, the lower central incisors appear, their eruption being rapid, and being completed in from three to ten days; then comes a period of rest of two or three months, at the end of which the four upper incisors come down into place. Then, again, after the lapse of some months, the lower lateral incisors and the four first molars are cut, their eruption being followed by a considerable lapse of time, amounting often to four or five months, when the four canines commence to come through. The eruption of the canine teeth covers a very long period, taking perhaps two or three months for its completion, and it is during the eruption of these teeth (according to Trousseau) that a child suffers most severely, though a different opinion has been expressed by the late Dr. West,[1] who considers that the four first molars cause the greatest amount of constitutional disturbance during their progress from the alveoli. The greater time taken by the canine teeth, and the severer symptoms occasioned by them, are accounted for by Trousseau by the fact that they are the only members of the temporary series which come into place between two other previously erupted teeth, so that they are likely to meet with greater resistance in their transit. But he appears to have in some degree misapprehended the conditions under which the eruption of teeth takes place when he mentions their length of root as being another difficulty in the way of their easy transit; for the root is not fully formed until the crown is well advanced in its movement towards its final position.

After the crown of a tooth has been formed, before it can be cut, the aperture of the socket must be enlarged, and the coat of the sac immediately above the crown of the tooth removed, together with the superimposed fibro-areolar tissue and epithelial layer. These parts—which stand in the way of the eruption of a tooth—may, however, be removed in such strict accordance with the rate of growth and outward progress of the tooth—growth and waste may be so nicely balanced—that the subject of these changes suffers no inconvenience. In some children

[1] "On some Nervous Disorders of Childhood," by Charles West, M.D.

tooth after tooth appears without any premonitory symptoms. The period of teething comes and goes, attracting attention only when a new tooth is discovered. Instances of teething such as the foregoing are comparatively rare, and can only occur in children who are and have been in all respects perfectly healthy, which involves a series of conditions which our artificial state of living does not tend to bring about, even if it can allow it.

Residence in crowded cities, even in members of the middle classes, seldom fails to produce some amount of injurious influence upon childhood; and among the working classes insufficient or improper food greatly tends to increase the evil which the want of a good atmosphere has been sufficient to create. Even among the agricultural population we often find great crowding in the individual dwellings, a scarcity of animal food, and, by way of making the matter worse, a perfect indifference to the condition of the precincts of the cottages. Hence we find that but few children pass through the period of teething without suffering. In some cases the attendant ailment is slight and unimportant; in others maladies arise which endanger life. The management of children during the eruption of the temporary teeth is seldom entrusted to those who confine their practice to dental surgery, and therefore their knowledge of the coincident disorders necessarily becomes limited, a condition which has arisen within the last seventy or eighty years. Many of the earlier writers upon dental surgery were evidently consulted in cases where disease was supposed, correctly or otherwise, to arise from obstruction to the eruption of the temporary teeth.

While the child starts life edentulous and gradually acquires teeth, other parts in the alimentary tract in the healthy subject undergo concordant changes. Dr. West, in his valuable work "On Diseases of Infancy and Childhood," has brought together many of the facts which bear upon this subject. In his words:—

"The shape of the human stomach in the first month of existence approaches that which it retains through life in the carnivora, in whom the process of digestion is more simple than in any other mammalia. It is long, but little curved, growing narrower toward either end, where it passes into the œsophagus on the one hand, and into the intestine on the other—characteristics which are all found in the stomach of carnivorous animals." "Compare with this the form of the stomach in the adult. It is altogether more rounded : the œsophagus no longer enters at its left extremity, but nearly midway between that point and the pylorus." "Besides this, too, the transition from the pylorus to the intestine is gradual in the child, while in the adult the demarcation between stomach and intestine is well marked. The result of all this is, that in the adult, who is an omnivorous animal, the stomach presents a form not unlike that which it has in some of the rodents—as the rat and the rabbit ; and that the food, in the course of digestion, undergoes somewhat of a churning motion, not the simple onward movement which is communicated to it in the stomach of the carnivora. The stomach of the adult, then, is framed to act upon substances which may require some time for their digestion, while that of the infant is ill suited to retain matters long within it, and its small size unfits it for receiving much at once. If, therefore, the food given to an infant be such as can be digested with facility, it soon passes out of the stomach, and the infant speedily seeks for more. Nor are these arrangements, calculated for the rapid digestion of easily-assimilated food, confined to the stomach of the infant, but the form and proportions of the intestines correspond thereto : the small intestine is relatively shorter than in the adult ; the large intestine of smaller calibre ; the cæcum less developed ; whilst the peristaltic action of the bowels is more rapid than in later life ; excrementitious matters are quickly expelled, and the healthy infant passes three or four evacuations in the twenty-four hours."

Thus it is shown that while the organs of mastication are coming forward for use, the alimentary canal is at the same time assuming a form suitable for the digestion of substances that require to be masticated before they are passed into the stomach.

Diseases arising during teething.—The older tables of mortality, under the head of death from teething, give over four per cent. of the whole number of deaths under the age of twelve months, and over seven per cent. between the latter age and three years. In these cases death is not, presumably, supposed to arise directly from disordered dentition, but from disease produced by teething. But before full credence is given to facts advanced in these returns, it should be shown that the disordered dentition was not itself a secondary affection, or that its cause was incapable of producing the fatal disease. There is a lack of records of careful post-mortem examinations of the teeth and jaws in cases of death attributed to abnormal dentition. There can be but little doubt that difficult dentition has been overrated as a cause of fatal disease occurring during the period of its presence. This has been strongly felt by Dr. West, who says :—

"The error which has been committed with reference to this matter, not merely by the vulgar, but by members of our own profession also, consists, not in overrating the hazards of the time when changes so important are being accomplished, but in regarding only one of the manifestations—though that, indeed, is the most striking one—of the many important ends which nature is then labouring to bring about. A child in perfect health usually cuts its teeth at a certain time and in a certain order, just as a girl at a certain age presents the various signs of approaching puberty, and at length begins to menstruate. In her case we do not fix our attention solely on the menstrual flux ; nor, if it fail to appear, do we have recourse to the empirical employment of emmenagogue medicines. We examine into the cause of its absence, try to ascertain whether it depends on the state of the health in general or of the uterine system in particular, and regulate accordingly our attempts at cure. The epoch of dentition is to be looked at just in the same way as that in which we regard the epoch of puberty. Constitutional disturbance is more common, and serious disease more frequent, at those times than at others ; but their causes lie deeper than the tooth which irritates the gum that it has not yet pierced in the one case, or than the womb which has not yielded the due discharge of blood in the other. You might produce hæmorrhage from the uterine vessels in the latter instance, or might cut through the gum which enclosed the teeth in the former, with no other effect than that of aggravating the condition of your patient."

Yet the phrase "Bel enfant jusqu'aux dents" gives expression to a belief very widely spread, and unfortunately too well grounded, that this is the period at which many a child becomes sickly, and perhaps never again recovers strength.

In describing the local symptoms, we must again borrow from Dr. West :—

"Though a perfectly natural process, dentition is yet almost always attended with some degree of suffering. Many of us, no doubt, can remember feeling much pain when we cut our wisdom teeth, and children probably experience the same kind of annoyance. This, however, is not always the case ; for sometimes we discover that an infant has cut a tooth, who had yet shown no sign of discomfort, nor any indication that dentition was commencing, with the exception of an increased flow of saliva. More frequently, indeed, the mouth becomes hot, and the gums look tumid, tense, and shining, while the exact position of each tooth is marked, for some time before its appearance, by the prominence of the gum ; or the eruption of the teeth is preceded or accompanied by somewhat different conditions of the mouth, in which there are much heat, an intense redness of the mucous membrane, an extremely copious flow of thin saliva, and a disposition to the formation of small aphthous ulcerations on the tongue, at the outer surface of the alveolæ or at the duplicature of the lip, though the gums themselves may not be particularly swollen or painful. Either of these states is usually attended with some degree of febrile disturbance, and apparently with considerable suffering to the infant, who is constantly fretful and peevish, or cries out occasionally as if in pain. A third morbid condition of the mouth is sometimes seen, which is usually ushered in or attended by very considerable fever and disorder of the chylopoietic viscera. The gums then become extremely hot and swollen, and unusually tender, especially over some tooth or other in particular, and in that situation we find the gum swollen up into a kind of little tumour. Small unhealthy ulcerations, with a sloughy appearance, often form upon the summit of the gum, and especially around any tooth which has partly pierced through it. To this affection, which is often very painful, and often difficult of cure, the name of *Odontitis Infantum* has been applied by some Continental writers."

One of the most common diseases incident to this period is diarrhœa, attacks of which will come on as each group of teeth comes to the surface, and pass away in the intervals; sometimes, however, from the long continuance of the diarrhœa, the child will pass into the condition of marasmus.

Many of these symptoms, according to Dr. Copland, frequently precede the appearance of the teeth by several weeks, but do not always maintain a uniform severity. Indeed, they may altogether subside and reappear before the teeth are cut. In such cases, the old nurses tell you that the teeth were breeding in the first attack, and in the second cutting the gums. A more probable explanation is, that in the one case they were passing through the alveolar opening—in the other, making their way through the gums. It has been pointed out by Trousseau [1] that teething is not a continuous process which, once begun, is carried on without interruption till its completion, but that it takes place in well-marked stages. The teeth are cut in groups, and when one group of teeth is fairly erupted there is a period of rest till it is time for the next group to appear. It will of course be understood by every one who is familiarised with the numerous irregularities arising in dentition, that this definite serial order will in some instances be departed from, though the statement is none the less very generally true.

Among the collection of infantile maxillæ which was made, there are several specimens of local disorder which may be noticed at this point of the inquiry. In one example, taken from a subject nearly nine months old, the teeth present no obvious peculiarity either as regards structure or forwardness. The jaws are, however, small, and the bone is unusually porous, the alveoli being at many points imperfect, leaving the forming teeth partly exposed on their anterior surfaces. In a second specimen, twenty-one months old, a similar condition of the maxillæ exists. The incisors and first temporary molars have been erupted, and appear tolerably well developed. Nothing

[1] Clinical Lectures, Trousseau, vol. iv. (Sydenham Society Edition)

is known of the history of these cases, but surely the unusual condition of the bone of the alveolar processes must have been attended with local indications of disorder. In a third specimen we have the enlarged cranium peculiar to chronic hydrocephalus, accompanied with an absence of the outer alveolar plate, so that the teeth are exposed over the whole of their anterior surfaces. The bone does not exhibit any unusual porosity, the defect being in quantity only—a peculiarity which is extended to the whole of the bones of the face. (Fig. 10.) In a patient who presented similar conditions, the anterior surfaces of the teeth could be felt through the gums. The child was under the

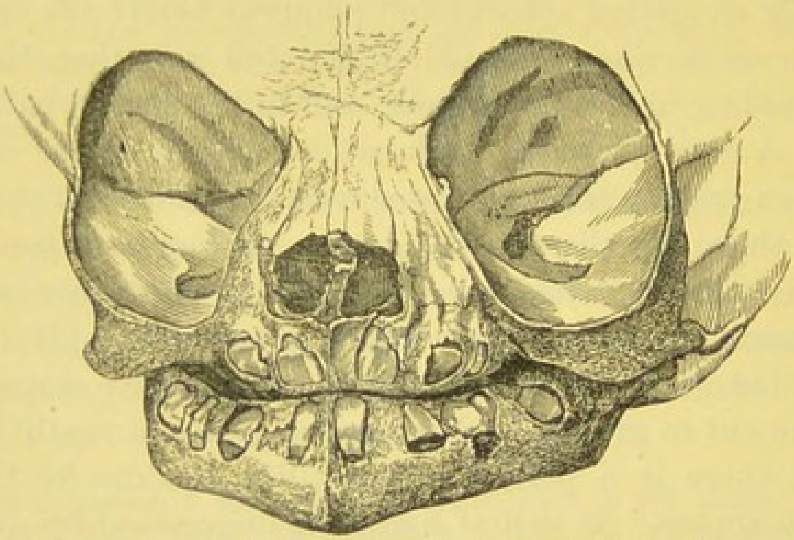


FIG. 10.—View of the facial portion of skull of child who had suffered from hydrocephalus, showing the developing temporary teeth, and the defective anterior walls of the sockets.

treatment of the late Dr. West, who had observed in cases of this kind that dentition is seldom attended with local irritation or any increase of the pre-existing constitutional disturbance. If this be a constant condition, it goes some way towards showing that the **local irritation** so commonly observed is consequent upon the obstruction offered to the eruption of the teeth by the margins of the sockets, rather than to that afforded by the gums. Further observation is required before the question can be set at rest. Indeed, this remark may be applied to the whole subject. Some practitioners attribute almost every ailment of infancy to dentition, without, however, attempting to explain how so much mischief is produced ; contenting themselves with the general statement, without telling us in what particulars the series of changes which accompany the eruption of the teeth were defective. Other medical men entertain the opinions so clearly set forth by Dr. West.

In addition to the various characters presented by the gums which have been already noticed, there is a condition which is more rare. The gum over the coming tooth is enlarged, but the enlargement is circumscribed, has a blue or purple colour, and yields to pressure. If an incision be made into it, a small quantity of transparent fluid will escape, and we shall find the tooth at the bottom of the emptied cyst. In these cases, the enlargement apparent on the surface of the gum was obviously produced by the secretion of fluid between the surface of the enamel and the superjacent soft tissue. But it is not certain whether the lining of the cyst was composed of the fibrous tissue of the tooth sac, or of structures external to it, though the former appears the more probable, as there appears to be no connection kept up between the enamel and the tooth sac when once the former is completed, and it is not improbable that a slight amount of fluid may be present as a normal condition. The inconvenience experienced by the patients appeared to be very slight, and the occurrence of effusion in the sac would merit little attention, but that it offers a probable explanation as to the source of cysts which sometimes arises in connection with the evolution of teeth—a subject which will be considered in a future page.

John Hunter, after stating that the teeth, in their advance towards the surface of the gum, exert pressure upon the superimposed parts, thereby causing inflammation and ulceration, goes on to say, "that ulceration which takes place in dentition is one of the species which seldom or never produces suppuration; however, in some few cases I have found the gums ulcerated, and the body of the tooth surrounded with matter; but I believe this seldom happens till the tooth is near cutting the skin of the gums." The condition here described is probably subsequent to the infiltration of serous fluid within the capsule investing the enamel.

The most common result of difficult dentition is a **general febrile condition.** Hunter says:

"The fever is sometimes slight, and sometimes violent. It is very remarkable both for its sudden rise and declension: so that in the first hour of this illness the child shall be perfectly cool; in the second, flushed and burning hot: and in a third, temperate again."

Disorders of the nervous system frequently arise at this epoch, varying in intensity from slight muscular twitching to violent **convulsions.** The following case occurred in the family of a medical man:—A child, playing round the dining-room table, suddenly fell down in a state of insensibility. The father at the time was absent, and a neighbouring practitioner was called in, who, on examining the mouth, found that the gum was raised, and in a state of tension over a temporary molar. An incision was made down to the tooth, the child immediately recovered its sensibility, and in a few hours was perfectly well. Now, as no medicine was given, and as the insensibility was continued until the gum was divided, it would be too much to assume that the operation and the recovery had no further relation than mere coincidence, especially when it is remembered that the majority of those engaged in extensive general practice could furnish cases more or less similar to this. On the other hand, we may have convulsions when teeth are about to be cut, and the gums may be lanced with no apparent advantage, the disease running its course towards recovery or death, uninfluenced by the dental operation.[1]

Instances of epileptiform convulsions dependent on the eruption of the temporary teeth are far from uncommon; and in some few cases where partially erupted temporary teeth have appeared to be sources of irritation, medical men,[2] all other remedies having failed, have in several instances extracted them with the effect of at once relieving the convulsions. Hunter, whose classical work on the teeth cannot be too often referred to by those engaged in the practice of dental surgery, or in the treatment of disorders coincident with an abnormal state of the dental apparatus, states: "The partial or local consequential symptoms are the most varied and

[1] Two equally striking cases of convulsions with considerable pyrexia at once relieved by lancing tumid reddened gums, were communicated by Mr. Stevenson Smith to the Edinburgh Obstetrical Society, and are quoted in the Dental Cosmos, vol. xii., p. 209.

[2] Portal, Observations sur l'Epilepsie, p. 333, and Dental Cosmos, vol. xii., p. 211, in which latter case the patient was in a state of collapse.

complicated; for the appearance they put on is in some degree determined by the nature of the parts they affect; wherefore they imitate various diseases of the human body. These symptoms we shall describe in the order of their most frequent occurrence: diarrhœa, costiveness, loss of appetite; eruptions on the skin, especially on the face and scalp; cough, shortness of breath, with a kind of convulsed respiration, similar to that observed in whooping-cough; spasms of particular parts, either by intervals or continued; an increased secretion of urine, and sometimes a diminution of that secretion; a discharge of matter from the penis, with a difficulty and pain in making water, imitating exactly a violent gonorrhœa."

A case is given in which this **disturbance of the urinary organs** was invariably coincident with cutting of teeth, the one as it were keeping time with the other. Hunter's own words are: "It was observed at last, that they (the urinary symptoms) returned only upon his cutting a new tooth; this happens so often, regularly, and constantly, that there was no reason to doubt but that it was owing to that cause."

Here, then, we have, on the highest authority, a long list of the many ailments that *may* be consequent upon disordered dentition; and it is for the practitioner to distinguish in individual cases whether the disease present during the time of teething is consequent upon some derangement of this process, or upon an abnormal condition of some other organ or organs, of which the dental difficulty is but itself a symptom. In forming this distinction, the state of the jaws must be the principal guide. If, in the presence of symptoms which might arise from teeth, we find that teeth are not pressing forward towards the surface of the gums, and that the latter maintain their normal appearance, it will be useless to have recourse to the gum lancet; yet, even in this case, the disorder may be due to, or much influenced by, the teeth. They may be confined by the sockets, a difficulty beyond the reach of mere division of the gum. It is not easy to see how wounding the superjacent soft tissues should promote absorption of the osseous margins of the sockets; yet there are those who, on all occasions, have recourse to this practice.

There are, however, cases in which this simple operation will at once either mitigate or entirely remove most alarming symptoms; but in such we shall find the gum prominent, and in a state of tension over the advancing tooth. Under these conditions the gum should be divided down to the surface of the tooth, and not at a point only, but across the whole breadth or length of the crown; in fact, the imprisoned organ should be entirely set free.

Then, again, there are cases in which the gums may be lanced with advantage, for the sake of local depletion, without reference to the liberation of the teeth. When we find the part inflamed and painful, this measure may be adopted, but the indiscriminate adoption of this treatment in all cases when the gums are turgid and inflamed will occasionally lead to mischievous results. In children who are enfeebled, either from disease or residence in a bad atmosphere, ulceration of the wounded parts may follow as a consequence of the operation, or in some instances severe hæmorrhage, which has been known to prove fatal.

Trousseau expresses a strong opinion adverse to scarification of the gum, which is, nevertheless, undoubtedly of great service in some cases, and it will be long before the practice is abandoned, if indeed it ever will be.

The local disturbances which may occur range from a simple inflammation of the parts concerned to actual ulceration—the so-called odontitis infantum: this readily yields to the administration of potassium chlorate.

Rickets unquestionably retards the eruption of the temporary teeth, whilst syphilis, and with less certainty struma, seem to tend to accelerate the process.

According to Mr. J. G. Turner,[1] the shedding of the temporary teeth and the eruption of the permanent teeth are both retarded in cretins, so that a child of ten years presented the stage of dentition proper to six years; one of twelve years that appropriate to seven years; and in adults of twenty-one, twenty-three, and even in one of thirty years, some temporary teeth were retained. A baby of one year five months was edentulous, and one of two years had only four deciduous molars. Thyroid gland treatment, whilst effecting general improvement, hurried on the eruption of the teeth. In

[1] Trans. Odont. Soc., 1901.

microcephaly the teeth are generally well formed, but are always under-sized; in one case, at ten years of age, only the permanent central incisors and first permanent molars were in place.

In scrofulous children a spongy, ulcerated condition of the gums is sometimes met with which does not appear to be closely connected with teething: this also is best treated with potassium chlorate, together with tonics, iron, cod liver oil, and such remedies.

As a result of exanthematous fevers, **necrosis** and exfoliation of the developing teeth sometimes takes place, and this may, and often does, involve the crypts containing the permanent teeth.

It has been pointed out that mechanical injury is frequently the starting-point of these destructive inflammations, the parts thereby becoming open to infection. The mechanical injury may easily take place in feeding an unconscious or refractory child, and it is by no means uncommon for a somewhat loose temporary tooth to be thus displaced, leaving a wounded surface.

The severe **gangrenous inflammation** which attacks the inside of the cheek, and is known as cancrum oris, also attacks ill-nourished children after exanthemata. It would not call for notice here but that in it bacteria are met with which bear a close resemblance to those found in the ulcerative stomatitis of calves. They form a leptothrix-like organism which grows into the tissues and rapidly destroys them in its progress.

Normal Second Dentition.

If we select for examination perfectly well-formed jaws from a subject in which the first permanent molars have not appeared through the gums, but in which the temporary teeth are all perfect, we shall find that each member of the latter set has become slightly separated from its fellow—a condition indicating that the growth of the jaws has been in all respects normal, and consequently that a good and well-arranged set of permanent teeth may reasonably be expected.

At **five-and-a-half years** the crowns of the permanent incisors, both of the upper and lower jaws, are perfected, excepting perhaps at that part where the enamel terminates. There the dull and chalk-like appearance which that tissue presents when the development is progressing may be observed. The canines are still less advanced, while the crowns of the first bicuspids have not attained to more than two-thirds, and those of the second bicuspid not more than a third, of their ultimate lengths. The crowns of the first permanent molars are, as respects their external surface, fully developed; and the septa of dentine which extend across the base of the pulps marking out the several roots yet to be developed are fully pronounced. The second permanent molars are at present represented by about two-thirds of their crowns, and invested with a thin layer of partially developed enamel. The position of the pulps of the wisdom-teeth is but faintly indicated by slight depressions in the bone posterior to the sockets which contain the forming second molars. These marks may, however, at this period, be altogether wanting.

The position of the temporary teeth in the jaws differs from that of the permanent set in being perfectly vertical. The crowns do not occupy a more forward position in the dental arch than their respective roots; the crown of each tooth is directly over or under (as the case may be) its own root, the latter standing immediately in front of one or other of the successional teeth.

On removal of the bone from the anterior surface of the maxilla, it will be seen that the permanent **central incisors** are placed nearly parallel with each other, the cutting edges in the upper teeth being inclined a little forwards, while the parts corresponding to the base of the crowns of the two teeth respectively are placed immediately below the floor of the nose, from which cavity they are separated by a thin layer of bone only. The teeth at this stage of growth completley fill the cells or crypts. The corresponding lower teeth hold a similar position in the lower jaw, but have a strictly vertical position, and show a slight advance in development as compared with the upper centrals.

The **lateral incisors** of the upper jaw have a slightly oblique direction, the cutting edges being more forward than the base of the crowns, which are nearly on a level with the corresponding parts of the central teeth. The cutting edge of each is often slightly turned, so that the mesial surface which lies against the central incisor is directed outwards, while the mesial angle of the tooth stands in front of, and a little over, the contiguous portion of the central incisor. The point at which the one tooth overlaps the other corresponds to the position of the root of the temporary lateral incisor. That side of the lateral, which in the perfected tooth lies against the canine, here rests against the cell which contains the first bicuspid ; while the developing canine is at this period above the latter tooth. In the lower jaw the lateral incisors are placed less regularly, holding a position slightly more backward than the centrals. The tooth on either side is turned from the median line, and lies obliquely over the canine, to

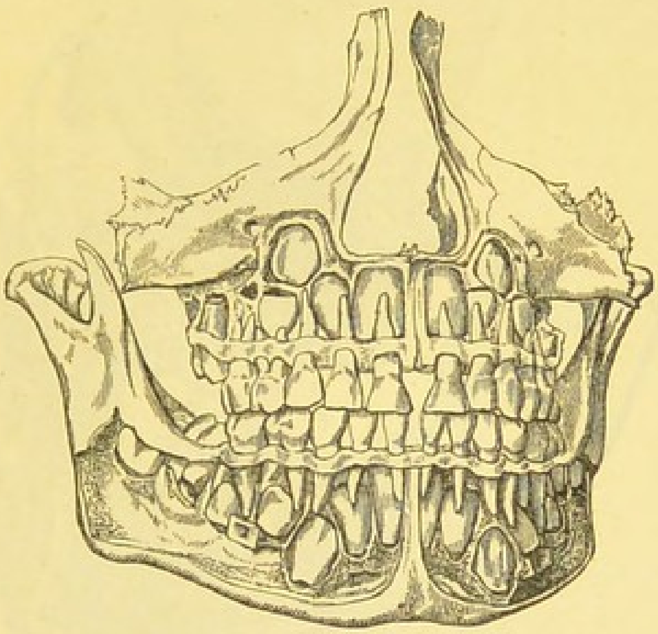


FIG. 11.—Shows the relations of the temporary and permanent teeth at the period when the former are perfectly formed, in well-formed maxillæ.

the extent of about half of that tooth. They do not, however, as in the upper jaw, come in contact with the cells that contain the first bicuspids. The eruption of the teeth without change from these positions is a common source of slight irregularity.

The **permanent canine teeth** at this stage of dentition are situated above the line of the other teeth in the upper, and below it in the inferior maxilla. Those of the upper jaw are directed slightly forwards and outwards, while in the lower jaw these teeth have a direction upwards and a little inwards. The bicuspids are placed in cells situated between the roots of the temporary molars.

In the specimen which has been chosen for description, and from which the illustration is taken, we have perfectly well-grown jaws, showing very completely the relations in position of the first to the second set of teeth, and the relative position of the several members of the latter to each other.

In another specimen (Fig. 12), the arrangement is almost normal, but differs in one respect from that which has been described. In this case the mesial sides of the upper lateral incisors are placed behind the distal sides of the central teeth. The degree of overlapping is perhaps rather in excess of what

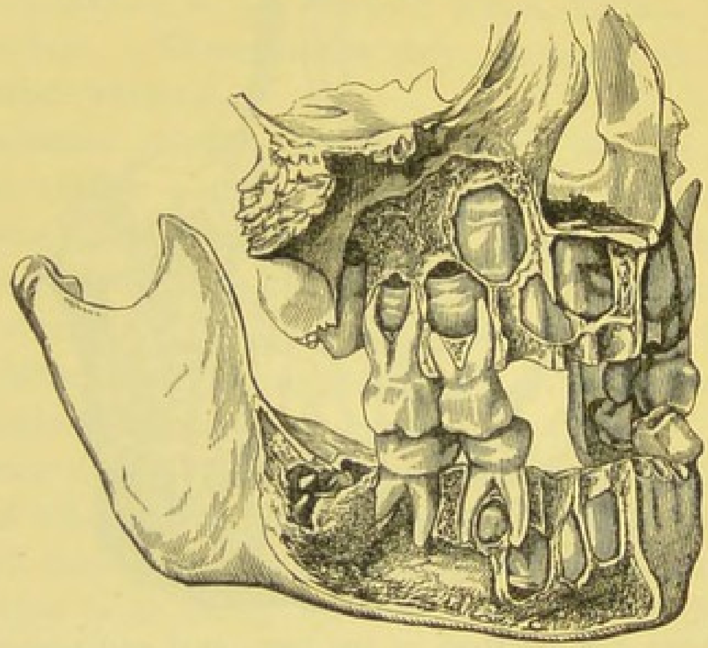


FIG. 12.—Showing the relative position of the two sets of teeth, with the upper lateral incisors descending lower than the central teeth, and the right lower lateral with its mesial edge turned outwards.

may be regarded as a perfect arrangement, and the lateral have descended nearer to the alveolar margin than the central incisors; but still the specimen will serve for illustrating the relative position of the several teeth alluded to, at the same time that it exhibits an irregularity in the position of the right lateral incisor in the lower jaw. This tooth has its mesial edge turned outwards towards the lips, and there is a diminished size of the anterior part of the jaw, as compared with many other jaws of similar age.

Attention may again be directed to the fact that the temporary teeth are placed vertically in the jaws, and that if their successors were similarly implanted there would not be room in the upper jaw for the canine teeth. But the upper incisors in the place of a vertical have an oblique direction forwards and outwards towards the lips, while the vertical line is at this age followed by the bicuspids. Now, if we produce an imaginary line through the axes of the upper incisors in their present state to the extent of perfected teeth, it will be seen that the difference in the direction of the line of growth between the incisors and the bicuspids will lead to a separation

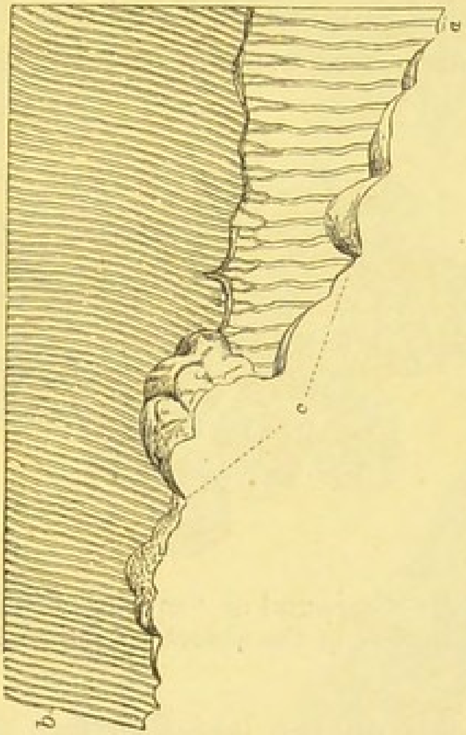


FIG. 13.—A section from a temporary tooth, in which the dentine (*a*) and the enamel (*b*) have been removed by absorption, leaving the festooned outline (*c*).

between these teeth sufficient to admit the canine into the dental line. In order that this result shall be attained, it is necessary that the relative rate of growth between the several teeth shall remain undisturbed. If, for instance, the canine advances too rapidly upon the lateral incisor, and makes its appearance through the gum before the lateral tooth has advanced sufficiently forwards and outwards, both teeth will be displaced : the lateral will be forced within the proper line, and the canine will occupy a place external to it.

Shedding of the temporary teeth.—No sooner is the temporary set of teeth fully formed, than a process is set up for the removal of some of its members. Within twelve or eighteen months of the completion of the roots of the second molars and canines, the roots of the incisors are attacked by absorption.

The destruction may commence on any part of the root, or at several spots simultaneously. Particle after particle is by degrees carried away, until nothing but the crown of the tooth is left, and even this is often so much hollowed out that little save the enamel remains, and sometimes not all of that.

Although among a number of temporary teeth we may find that absorption has commenced at several and distant points,

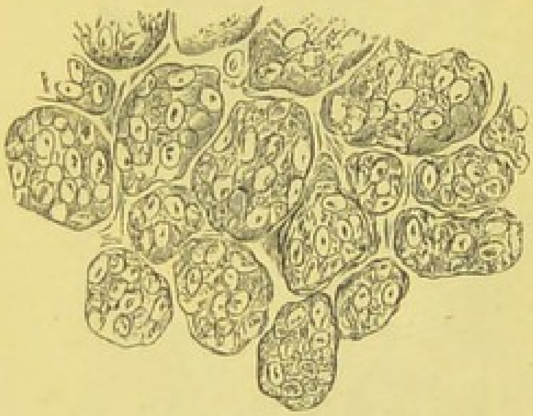


FIG. 14.—Shows the compound or "myeloid" cells which form the surface of the absorbent papilla.

and not uncommonly on the labial surface of the root, yet in the majority of cases that part which lies nearest to the growing tooth will be the first to show indications of wasting, and upon it the process will be the most active.

If a tooth which has lost its root be carefully removed, we shall find remaining in its place the growing papilla, corresponding exactly in size and form to the surface from which it has been separated; and this separation may often be effected with so little injury that no blood appears upon its surface after the operation, although the organ is highly vascular and readily torn.[1] The superficial extent of the papilla will be equal to that part of the tooth undergoing waste; but the

[1] Laforgue and Bourdet recognised the presence of the absorbent organ, but supposed it exhaled a fluid capable of dissolving the roots of the temporary tooth.

extent as regards depth is slight, for, as the root of the tooth disappears, the socket is contracted by the deposition of bone, which forms at the base of the absorbent organ as rapidly as the cellular surface encroaches upon the tooth. The cases in

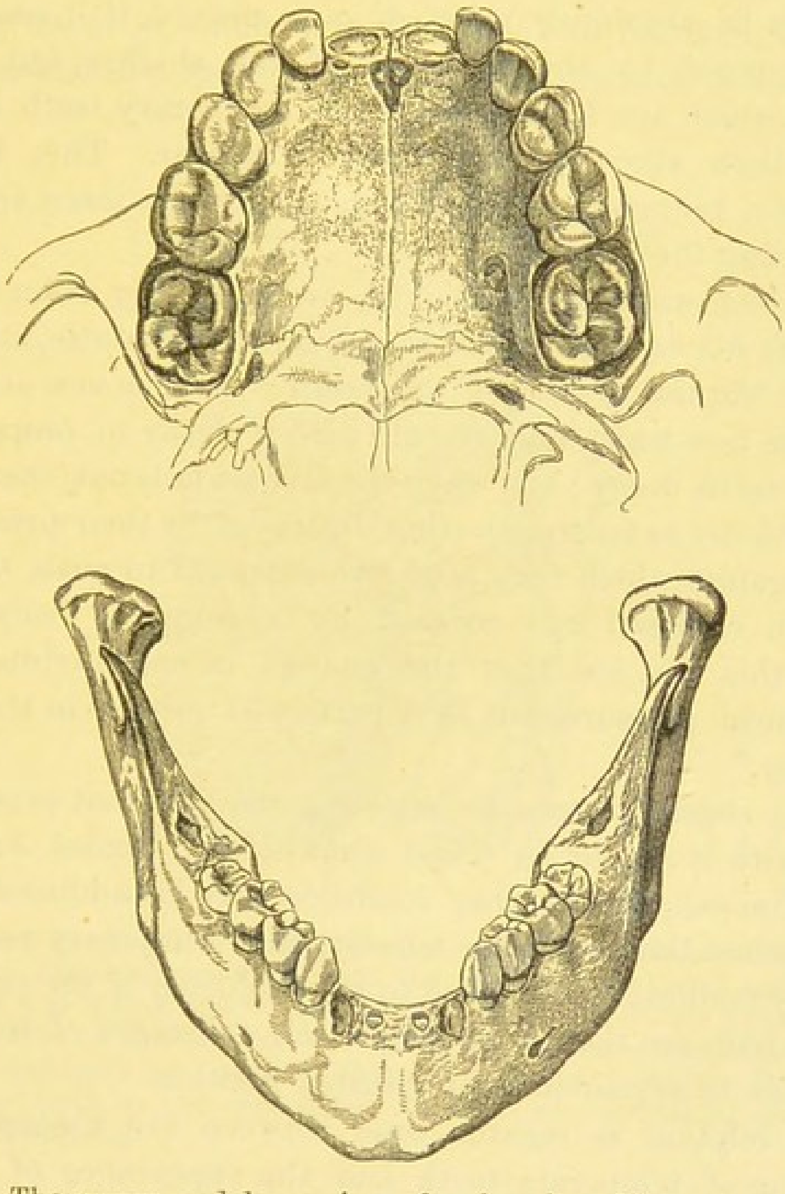


FIG. 15.—The upper and lower jaw of a female subject, six years and five months old, showing the layer of bone which forms the bottom of the socket of the temporary incisors after the roots have been absorbed.

which we find an exception to this condition are those in which the permanent has advanced close to the roots of the temporary tooth, when the crypt containing the one communicates with the socket of the other, indicating that the rate of growth of the permanent has been equal to if not greater than the absorption of the deciduous organ. But even in these cases we may occasionally observe some part in which the contraction of the socket has been coincident with the absorption of the occupant root.

The idea that mere pressure of the one tooth against the other has anything to do with the absorption of the first set must be absolutely rejected, as is proved, if it needed any further proof, by the existence of the shallow but perfect sockets which are formed when the temporary teeth are shed before their successors are ready to appear. This, however, must be a very common condition, as there are many specimens illustrating the point.

The fact was not overlooked, we think, by John Hunter, although his description is not very clear. He states, at page 99 in his "Natural History of the Teeth:"—"The new *alveoli* rise with the new teeth, and the old *alveoli* decay in proportion as the old teeth decay; and when the first set falls out, the succeeding teeth are so far from having destroyed by their pressure the parts against which they might be supposed to push, that they are still enclosed and covered by a complete bony socket. From this we see that the change is not produced by a mechanical pressure, but by a particular process in the animal economy."

Many cogent reasons for rejecting the idea that pressure has to do with it are to be found elsewhere ("Dental Anatomy," C. S. Tomes); but another condition may be adduced tending also against that opinion—namely, that temporary teeth occasionally maintain their place to the exclusion of the permanent ones, which are then kept within the substance of the jaw, or are made to appear in some unusual position.

The relation as regards time between the absorption and shedding of temporary teeth and the appearance of the succeeding permanent teeth, is by no means constant. In some cases the temporary teeth are thrown off two years before the corresponding permanent ones come through the gums. While in others, again, the new will replace the old ones in as many weeks or even days.

When the process of absorption has once commenced, it appears to have been assumed that the action would be continued, with more or less rapidity, until the tooth falls out. Such, however, is not constantly the case. Not only is the action of absorption suspended, but one of deposition takes its place. We find the excavated surface of the dentine, cementum, or enamel covered with a kind of cementum, which fills up the absorption excavations, and is closely united to them. (Fig. 16.) In cases where this development is going on, or in which the new tissue is retained, the teeth offer considerable resistance when their removal is attempted.

FIG. 16.—A section from the root of a tooth in which the dentine (*a*) has been removed, together with the cementum (*c*), and again made good by the deposition of cementum. The appearance presented at the junction of the dentine and cementum, where absorption has not encroached upon the tissues at that point, is shown at (*b*). The curved irregular lines in the cementum indicate alternations of absorption and re-deposition.

In those instances where the first teeth have remained, and tend to the displacement of their successors, this deposit of cementum will be found to exist in considerable quantity.

The development of bone upon the surface which had formerly been the seat of absorption, by no means indicates that the tooth will not again be subject to destructive action. On the contrary, specimens show that the bone deposited under the above circumstances may itself become the subject of absorption, that this process may be again suspended and deposition be renewed; in fact, that wasting and reparation may alternate until, by the preponderance of the former, the tooth is shed. In sections of teeth showing this peculiar condition of development, we may find upon the growing tissue numerous osteoblasts. A bone lacuna, situated within a semi-

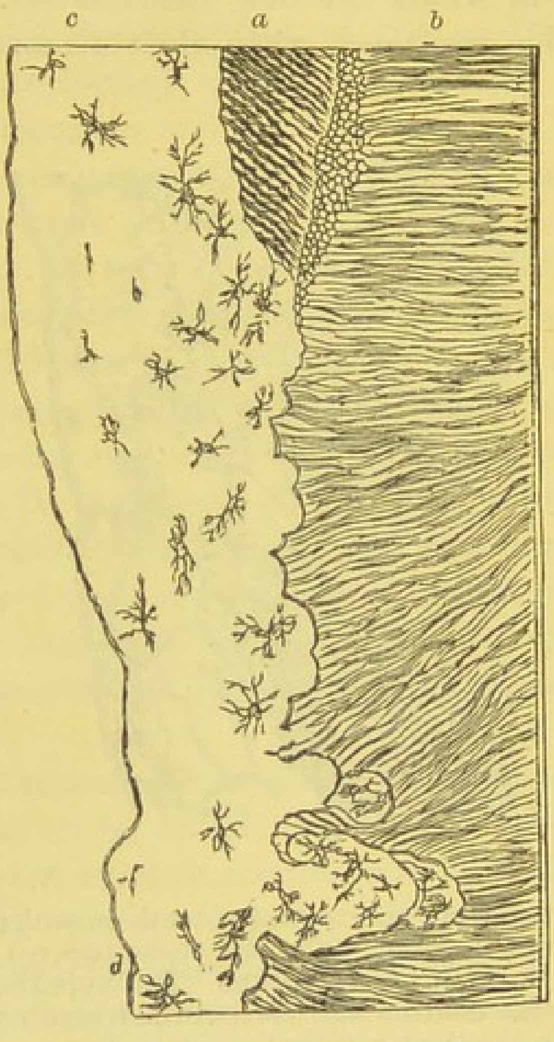


FIG. 17.—A section from a temporary tooth, the roots of which have been absorbed, and the crown hollowed out; the enamel having been partly removed, and both tissues coated over with new cementum. *a*, the dentine; *b*, the enamel; *c*, the cementum; *d*, the junction of the absorbed surface of the enamel and new cementum.

circular indentation in the dentine, gives the appearance of a lacunal cell, and a lacuna similarly situated in the cementum (a circumstance of common occurrence), has possibly been supposed by Mr. J. Salter to be what has been described in the paper referred to as a lacunal cell.[1]

The part of a tooth which has the greatest power of resisting

[1] Transactions of the Pathological Society, vol. vi., p. 169.

absorption is that in immediate contact with the pulp. We find examples in which a thin shell of dentine encircles that organ, while that around it has been in great part taken away. This is, however, eventually removed, and the pulp itself changes its character, and either itself becomes an absorbent organ, or makes way for that which is. In a fortunate section we may find in parts dentine which has been but recently formed; in others, absorption in active progress; and in others, the deposition of bone on the surface of the wasted dentine. In no instance, however, is new dentine deposited upon the surface of that which has been attacked by absorption.

It would appear that the dentinal pulp, although its function may be changed into that of absorption, or its place be taken by an absorbent organ, and this, again, changed to one for the development of bone, is incapable of resuming under any recognised circumstances its primary function of dentinal development. In other words, that a portion of dentine when removed by absorption cannot be replaced; while in bone, or cementum, the renewal of a lost portion is of frequent occurrence.

The normal shedding of one or more of the temporary teeth is, however, sometimes subject to interruption. The absorption of the roots is suspended, and the tooth holds its place, while its successor is matured within the jaw in some unusual position, or is altogether wanting. It is not uncommon to find the temporary incisors firmly implanted, with the permanent teeth appearing through the gum behind them. In instances of this kind it is difficult to determine whether or not the permanent teeth were developed in a perfectly normal position, and their position subsequently changed by the persistence of the milk teeth consequent on the arrest of absorption, or whether the relative position of the two sets has been from the first irregular; but original malposition of the developing permanent organs is the more probable. Many instances in which the second temporary molars have been retained until the middle period of life has passed, have come under notice. The second bicuspid has been wanting, and the temporary tooth has retained its original position.

Eruption of permanent teeth.—When the permanent tooth is ready to emerge from its bony cell, absorption is again set up, and in this case the bone which lies over the crown of the growing tooth is attacked. The coronal portion of the crypt is enlarged, and the outer alveolar plate emarginated in the manner which we have seen during the eruption of the temporary tooth. The aperture becomes enlarged until the crown of the tooth can readily pass through. The comparatively large size of the crown, as compared with the neck or the root of a tooth, necessitates a breadth of socket, during the period both of development and of eruption, far greater than is required for the implantation of the fully-emerged organ. Hence a tooth at this stage of its progress can be readily moved from side to side by moderate pressure, and very slight mechanical obstruction will turn it either into or out of its normal position. The presence even of a small portion of the root of a temporary tooth will be sufficient to change the direction; and, on the other hand, the action of the tongue or the lips will suffice to bring back the outgrowing organ into its natural position, if the impediment be removed during the period of active eruption. The condition to which we have alluded is shown in the enlarged alveolar apertures of the first permanent molar teeth in Fig. 15, and will be seen in connection with other permanent teeth forming the subject of subsequent illustrations.

The provision for a tooth to take its proper place, displayed in the greatly widened socket at the period of eruption, would however be insufficient if the whole of the front teeth advanced towards their ultimate position simultaneously. It has been shown that the crowns, while within the jaws, are necessarily placed in an uneven line, and this irregularity would become permanent if all were to make their appearance through the gums at the same time. But, although the jaws at the age of five or six years do not afford sufficient space for the uniform arrangement of the crowns of the developing teeth, yet there would be ample room for the roots of these teeth to be placed in an even line. It has been stated that the crowns of the forming teeth are inclined slightly outwards, and that the growth of the alveolar arch is principally confined to the free edges and the outer surface. Bone is added externally, while it is being removed from the inner surface of each crypt to allow space for the increasing tooth, at the same time that the tooth is moved bodily forward. If adult specimens in which the teeth and jaws are well formed be examined, it will be found that growth in the direction indicated has been continued until the parts have arrived at maturity. In the adult the crowns of the front teeth are placed in advance of the base of the nose; in the child they are in a line vertical to it; and if we measure the ellipse formed by the anterior surface of the upper jaw at this level as far back as the second bicuspids, and then apply the measure to the corresponding part in an adult, or in an edentulous old person, we shall find the result in each case very nearly similar. In tracing the course of teeth as they are respectively protruded and take their position in the dental arch, it is desirable to bear the foregoing points in mind. In certain cases we shall find mischief arising from want of growth in the facial bones at the earlier periods of life, but in many instances the deviations from the normal position of the teeth and alveoli are independent of insufficient size of the bodies of the maxillæ; or in other words, there are cases in which the basal bone has attained its usual extent, though the teeth are irregularly placed in an irregularly-formed arch.

It is therefore necessary to draw a distinction between the bodies of the maxillæ and the alveolar processes, as it will subsequently be shown that in cases of irregular dentition, the irregularity may depend upon a want of accordance between the general dimensions of the jaws and the predetermined size of the teeth; or the malarrangement may depend solely upon imperfect development, in respect to position, of the teeth and the alveoli.

In describing the eruption of the teeth individually, and the coincident conditions, the chronological order in which they usually appear will be followed.

The first permanent molar of the upper not uncommonly precedes by a few weeks the corresponding tooth of the lower jaw; but we do not know that, in respect to priority, any great uniformity prevails. The conditions presented by these teeth at the age of **six years and five months**, are shown in Fig. 15. In the upper jaw the bone which lay over and protected the tooth at an earlier age is entirely removed, not only from the coronal surface, but also to a great extent from the labial side of the crypt; and this has taken place prior to the tooth being raised above the general level of the alveolar margin. It is now, however, in a condition for rapid development of the roots, and two or three months would have served to bring it to the surface of the gums. On removing one of the teeth from the upper jaw, the roots, although very short and imperfect, are seen to have their respective positions defined, the neck of the tooth being perfected. The enamel has attained its maximum amount, and is deficient only in density. At the age under consideration, the first molars occupy the posterior part of the alveolar arch, the second molar in the upper being

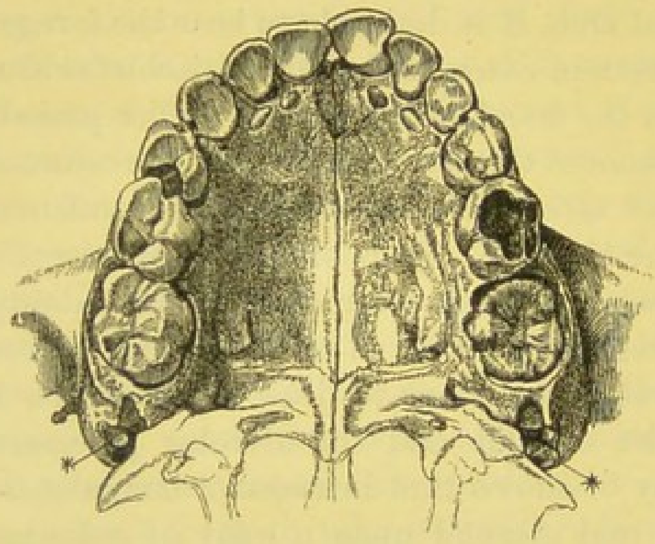


FIG. 18.—Showing the condition of the alveolus of the first permanent molar at the time the tooth is advancing to the surface of the gum. The tooth on the right side is a little in advance of that on the left side of the mouth. *The crypt of the second permanent molar. Age seven years.

confined to the back part of the tuberosity, and in the lower jaw to an excavation in the base of the coronoid process.

In the accompanying figure (Fig. 18), the molar of the right is in advance of the corresponding tooth of the opposite side of the jaw. On the one side the tooth had appeared through the gum, on the other the surface of the mucous membrane had not been pierced. The position of the second molars is indicated by the asterisks. In the specimen previously described, the first molars occupied the terminal portion of the alveolar arch; in the present case a small amount of space behind them has been gained, and the second molars, which were placed at the back part of the tuberosity and directed backwards, are now descending into the dental line, and are directed obliquely downwards and backwards.

In the specimens which have been described, the new teeth in their implanted portions are quite equal to the depth of the sockets, the bottoms of which reach in the upper jaw to the floor of the antrum, and in the lower maxilla to the inferior dental canal. This leaves no room for growth in the direction of the deeper parts. The increasing length of each tooth

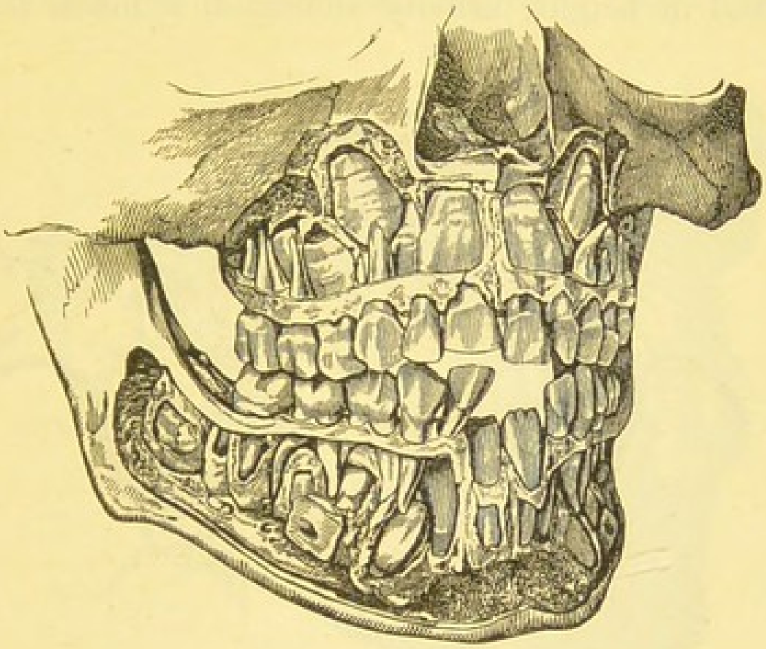


FIG. 19.—Shows the relative position of the two sets of teeth, and the absorption of the anterior plate of the alveoli of the lower central incisors antecedent to their emergence. In the upper jaw the roots of the temporary incisor have been removed, and absorption of the edge of the alveolus of the left central incisor has commenced. It will be seen that the depth of the alveoli at this point is equal to the length of the developing teeth.

must therefore be accompanied by an increased depth of socket produced by addition of bone to the free margin of the alveolus.

The development proceeds rapidly until the opposing teeth come in contact, when the antagonism becomes adjusted, a process which is rendered easy by the comparatively loose implantation of the teeth.

The teeth which usually succeed the first permanent molars in the order of emergence are the central incisors of the lower jaw. After the temporary central incisors have been shed, absorption of the corresponding edges of the alveoli commences, and commonly carries away the outer plate to a considerable depth. The condition is shown in Fig. 19; in this case the whole of the bone which lay in front of the crowns of the new teeth has been absorbed. In other instances the waste may be rather more limited, but in all cases the depth of the jaw becomes diminished at the points corresponding to the teeth, which are about to advance from their osseous crypts to the surface of the gums. The posterior alveolar plate, although diminished in height, usually suffers in a much less degree

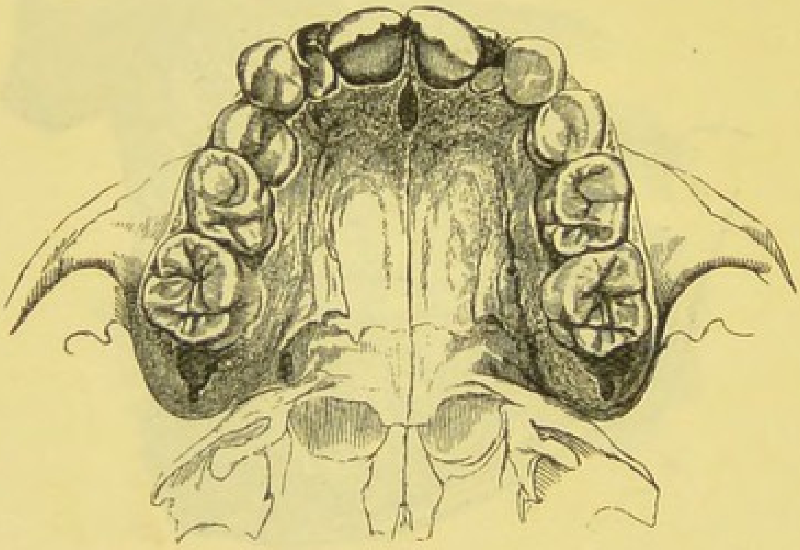


FIG. 20.—Upper jaw of a female subject seven years and eight months old, showing the central incisors taking their place in the alveolar arch. The right tooth is well placed, but the left is a little turned on its axis. The alveolus of each is larger than the contained tooth, affording space for the teeth to assume a normal position.

than the outer surface of the jaw, and consequently offers a less broken outline than that shown in the last figure. If the specimen under consideration be compared with an adult jaw from which the outer alveolar plate has been removed, it will be seen that the bases of the two advancing incisors hold the position which the ends of the roots of the fully formed corresponding teeth occupy.

The conditions which have been described as pertaining to the eruption of the lower central incisors will be found to accompany the eruption of the **upper central incisors**, the amount of bone removed by absorption varying with the position and size of the teeth. It is, however, by no means easy to obtain specimens of the age required to illustrate the changes attendant upon the eruption of the permanent teeth. The dealers do not appear to regard them as saleable, and they can be acquired from other sources only at uncertain intervals.

The subject (a female) from which the preceding figure has been taken, died at the age of seven years and eight months. The central incisors have emerged from the alveoli to the extent of about two-thirds of the length of their crowns, the

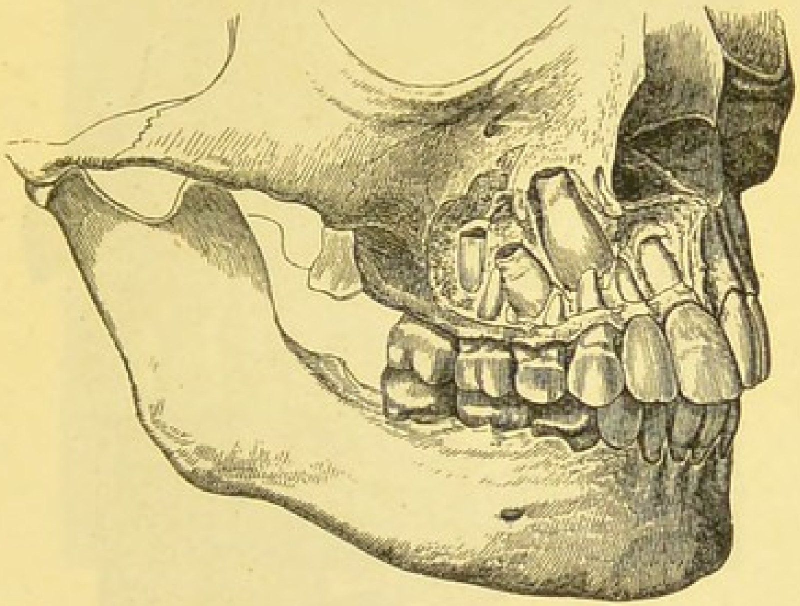


FIG. 21.—Showing the permanent central and lateral incisors in their normal position in the dental arch, with the canine and bicuspids within the jaw.

right being a little in advance of its fellow tooth. The respective alveolar apertures are greatly enlarged, allowing the teeth to be moved either outwards or inwards.

In this instance the jaw is rather contracted in size, and the new teeth, in the absence of the temporary laterals, have their distal sides situated but a short distance from the canines, leaving insufficient space for the permanent lateral teeth, supposing the present position of the centrals to be maintained. But the provision afforded for adjustment by the enlarged sockets will allow the crowns of the teeth to take a more forward position, and the space for the lateral incisors will be still further increased when the teeth have attained their full length. And thus the space, at present too limited for the normal arrangement of the neighbouring teeth, would probably eventually become sufficiently extended.

The phenomena which have been described as attending the eruption of the central incisor are repeated when the **lateral incisors** are protruded. These are, however, subject to an influence, as regards their position, from which the central incisors are exempt. The **canines** are at this period far

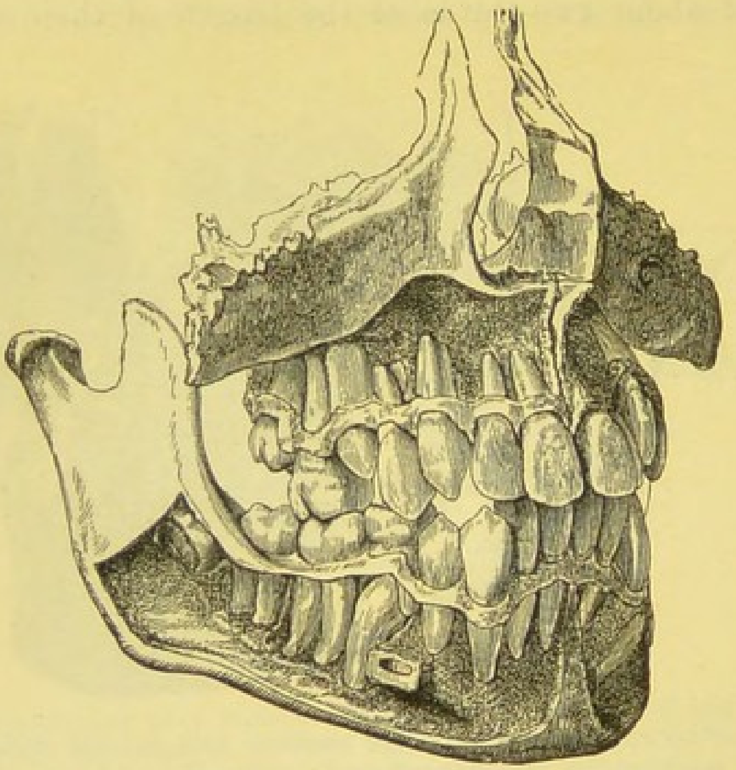


Fig. 22.—Showing the conditions of the permanent teeth after the eruption of the canines; in the upper jaw, the second bicuspid is in course of eruption.

advanced in development, and their large, rounded, mesial sides not unfrequently interfere with the roots of the lateral teeth, and thus tend to turn the crowns of the teeth out of their natural position—an evil which is usually remedied by the further descent of the canines towards the alveolar margin. The normal position of the incisors after falling into line, is shown in Fig. 22.

Taking what may be regarded as the normal order of eruption, the **first bicuspids** will succeed the lateral incisors. If Fig. 22 be examined, it may be seen that the convex distal side of the crown of the upper canine lies upon the mesial side of the neck of the first bicuspid, and necessitates the flattened or grooved surface which characterises that part of the tooth, while the distal side of the tooth is similarly influenced (although in a less degree) by the second bicuspid.

After the first bicuspid has taken its position, the canines are the next to appear in the line of the erupted teeth. The appearances presented by the teeth in a favourable specimen are shown in Fig. 22.

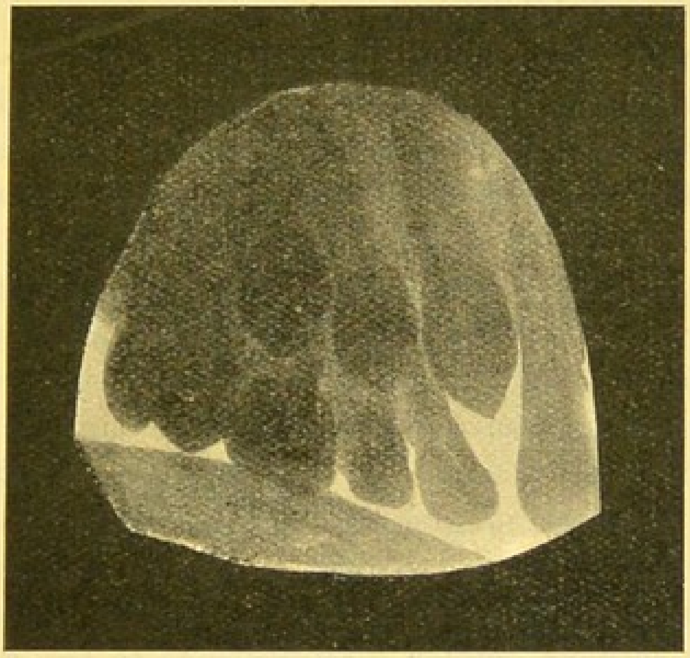


FIG. 23.—Skiagram of left maxilla of a girl aged nine and a half years, taken in order to ascertain the position of permanent canine. The central, lateral and first molar of the permanent series, and the temporary molars are in position. The lateral incisor was subsequently extracted, and two years later the canine filled the interval between the central incisor and first bicuspid teeth.

After the canines, the **second bicuspids** appear through the gums, and make up the full complement of those which have been preceded by temporary teeth. The preceding may be looked upon as the natural order in which the first permanent molars, and the teeth anterior to them, appear; but this order is frequently subverted, and in very many cases without entailing any evil consequences. It will, however, be convenient to consider all the deviations from that which is regarded as the normal order, under one general heading, after the evolution of the second permanent molar has been considered, and after the changes in the form and size of the jaws coincident with the eruption of the permanent teeth have been traced.

Between the age of twelve and thirteen years, the second permanent molars advance towards the surface of the gums, the alveolar changes being similar to those which have been described in connection with the emergence of other teeth. At this time the crypts for the third molars hold the positions which those for the second molars held when the first molars emerged from their bony cells, and occupied the terminal portion of the alveolar tract.

If the mouth be examined immediately after the eruption of the second molars, the dental arches will appear fully occupied. In the lower jaw, a tooth on either side will be placed close to the base of the coronoid processes, and in the upper maxilla at the extremities of the alveolar portion of the bone. But by the time the patient has reached the **sixteenth or twentieth year,** the jaws will have lengthened posteriorly, and to an extent sufficient for four new teeth to take their respective positions in the dental arches. Under favourable circumstances, the development and eruption of the **wisdom teeth** is but a repetition of those progressive changes which have already been described in respect to the first and second molars, and therefore need not be dwelt upon. No doubt these teeth are seldom cut without greater inconvenience to the patient than the anterior molars, and the period of emergence, too, is less defined; but we have hitherto considered the eruption of the permanent teeth when the process has been perfectly normal, and deviations from it have yet to be considered.

The periods of eruption of the permanent teeth have in the foregoing pages been traced from preparations. But the subject has been examined statistically.

In 1837 Sir Edwin Saunders published a monograph entitled, "The Teeth a Test of Age." About this time, the miseries entailed by employing young children in factories were, not for the first time, forced upon the attention of the Legislature. The necessity of restricting the hours of labour and of establishing laws for defining the period at which children should be allowed to enter upon factory labour, was admitted. But a difficulty arose as to the principles upon which this period should be fixed. It was contended by some that a certain state of physical development should be taken as the standard, while others thought that the age would form a better criterion of the capabilities of enduring labour without injury. The statements of parents as respects the ages of their children could not be depended upon; hence it became necessary that some means should be found whereby the age of a child could be determined independently of the representations of interested parties. With this view, Sir E. Saunders entered upon an inquiry respecting the relations of the eruption of the permanent teeth to the age of the individual. He visited many of the large metropolitan schools, and selected for examination those children who had reached the ninth and the thirteenth year, and published the results in a series of tables, of which the following are characteristic examples :—

	INCISORS.		CUSPID.	BICUSPID.		MOLARS.	
	Cent.	Lat.		Ant.	Post.	Ant.	Post.
Of 457 boys of nine years of age—							
20 had	4	4	...	...	...	4	...
77 had	4	3	...	...	...	4	...
91 had	4	2	...	...	...	4	...
5 had	4	1	...	...	...	4	...
34 had	4	...	...	...	...	4	...
20 had	3	3	...	...	...	4	...
10 had	3	...	...	...	...	4	...
Of 227 boys of thirteen years of age—							
104 had	4	4	4	4	4	4	4
57 had	4	4	3	4	4	4	3
29 had	4	4	3	4	3	4	2
33 had	4	4	3	4	2	4	1
4 had	4	4	2	4	1	4	...

Sir E. Saunders sums up the results of his investigations in the following words :—

"Thus, then, it appears that of 708 children of nine years of age, 389 would have been pronounced, on an application of this test, to be near the completion of the ninth year; that is, they presented the full development for that age. But on the principle already stated, that of reckoning the fourth tooth as present when the three are fully developed, a still larger majority would be obtained, and instead of 389, the proportion would be as follows :—of 708 children, no less a number than 530 will be fully nine years of age. What, then, are the deviations in the remaining 178? They are the following :—126 would be pronounced eight years and six months, and the remaining 52 eight years of age, so that the extreme deviations are only twelve months, and these only in the inconsiderable proportion (when compared with the results obtained by other criteria) of 52 in 708.

"Again, of 338 children approaching thirteen years of age, no less than 294 might have been pronounced with confidence to be about that age. The remaining 44 would have been considered as follows :—36 in their thirteenth and eight near the completion of their twelfth year."

It must not be forgotten that the periods of eruption of the teeth may be modified by conditions of general health ; just as the first commencement of teething is retarded by rickets, so will the further continuation of the process be interfered with by malnutrition, and a child being long behind time in the cutting of the permanent teeth is an indication of want of vigour, just as is inadequate height or inadequate weight. And the converse would perhaps hold good to some extent, for there is evidence derived from lower animals to the effect that the teeth may, as it were, be forced.

Thus, at one of the Royal Agricultural Society's shows, a pen of pigs was disqualified on the ground that their teeth showed them to be older than the age under which they were entered. But the owner, anxious to vindicate his own good faith, brought conclusive proof that they were not, but that they had been highly fed and cared for, and that this had had the result of hurrying on the change of the teeth.

A similar fact has been noticed with regard to cattle.

The late Mr. S. Cartwright has published a table which embraces a much more extended period, and gives results obtained from 3,074 cases. After describing the order and the periods of eruption of the permanent teeth, he makes the following remark :—

"These periods I find form a moderately fair average. I have particularised them for the sake of affording you some idea of the times of replacement of the various classes of teeth; but exceptions are so frequent, that it is not possible to give with accuracy the exact time for their change. These tables will show you the times of appearance of the teeth in the given number of cases—upwards of 3,000—which I have collected and which have come under my notice."

The following is a reprint from his fourth lecture, published in the "British Journal of Dental Science," May, 1857 :—

3,074 cases.	Upper incisors.	Lower incisors.	Upper canines.	Lower canines.	Upper anterior bicuspids.	Lower anterior bicuspids.	Upper posterior bicuspids.	Lower posterior bicuspids.	Upper anterior molars.	Lower anterior molars.	Upper posterior molars.	Lower posterior molars.
Between the 5th and 6th birthdays : Out of 170 children	5	17	...	...	...	...	1	...	34	48	...	...
,, 6th and 7th : Out of 340 children	52	207	...	...	3	1	2	4	182	199	...	...
,, 7th and 8th : Out of 496 children	180	407	...	...	19	7	3	5	472	479	...	...
,, 8th and 9th : Out of 530 children	459	524	8	7	85	38	16	12	524	524	...	...
,, 9th and 10th : Out of 454 children	435	451	20	40	143	60	51	32	453	453	6	11
,, 10th and 11th : Out of 322 children	318	321	48	98	199	104	110	69	322	322	18	26
,, 11th and 12th : Out of 303 children	303	303	112	166	231	167	166	123	303	303	51	79
,, 12th and 13th : Out of 203 children	203	203	136	159	175	149	144	102	203	203	103	118
,, 13th and 14th : Out of 140 children	140	140	115	120	133	116	122	93	140	140	100	113
,, 14th and 15th : Out of 86 children	86	86	79	83	86	86	79	77	86	86	78	79
,, 15th and 16th : Out of 30 children	30	30	29	30	30	29	30	28	30	30	30	29

Before we enter upon the subject of irregularities in the development of the permanent teeth and the various disturbing causes, it will be advantageous to give some further attention to the conditions under which the alveolar processes are formed, and to the laws which regulate the growth of the jaws.

Development of the alveolar processes in connection with second dentition.—In the earlier pages it was stated that the alveolar processes are formed after the dental papillæ are developed, and that at the time of birth they have risen up to the level of the developing teeth. Within two or three months they arch over and nearly enclose the teeth, thereby evincing a more rapid rate of growth than the teeth themselves. When the teeth are ready for eruption, the anterior wall of each alveolus is absorbed to the extent of about half its whole depth. The teeth emerge, and the alveolar processes again commence to grow, but not, as in the former cases, more rapidly than the teeth; they now keep pace with the teeth. At the time the development of the several teeth is commenced the papillæ are placed at their ultimate depth in the jaws. They do not grow into, but up from, the maxillæ, and the alveoli grow with them. At the period of eruption the lower end of the truncated and unfinished root reaches to the bottom of the socket, the position of which as regards depth is not changed with the gradual lengthening of the root of the tooth. After emergence the depth of the alveolus is equal to the length of the root of the enclosed tooth, the subsequent growth of the root at its base being equalled by the development of the alveolus at its free edge.

When the permanent teeth are ready to emerge, the process of absorption is again called into requisition, and the labial wall of each alveolus is, in the anterior part of the jaws, removed, the loss of bone being extended to a point corresponding to the neck of the emerging tooth. This condition is shown in Figs. 19 and 22; but the following illustrations exhibit in a remarkable manner the dependency of alveolar on dental development. The dentition is in many respects irregular; but the point to which we would draw attention is the extremely broken line described by the alveolar margin both in the upper and lower jaws. It may be seen that the terminal edge of each socket corresponds with the neck of the contained tooth, however irregularly the latter may be placed with respect to its fellows —exception, of course, being made to those teeth which have not yet passed through the gum. On the right side of the lower jaw the first temporary molar is retained, and on the left the second temporary molar is present. In each case the tooth and its alveolus are raised to a higher level than is usually attained by the temporary teeth, and higher than the adjoining first permanent molars and their sockets. This elevating process has no doubt been effected after the tooth itself had

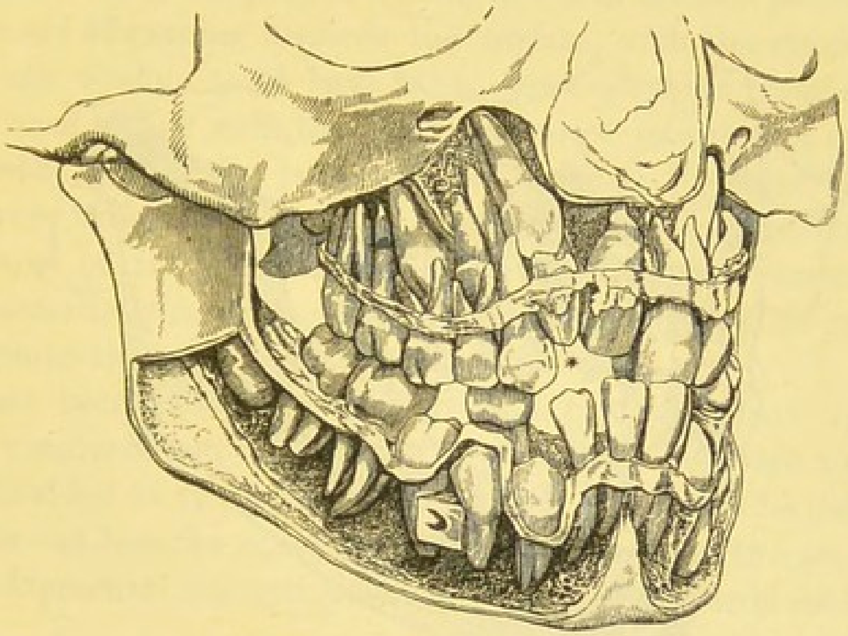


FIG. 24.—The upper and lower jaws of a subject about fourteen years of age; showing the relations of the alveolar processes to the teeth. In the upper jaw the temporary canine and the first and second molars are retained. *A supernumerary tooth has taken the place of the permanent lateral incisor, the lateral being forced backward towards the palate. The central incisor has been obstructed in its descent, and the root consequently curved. The permanent canine is far advanced in its development, but its descent is obstructed by the supernumerary tooth and the lateral incisor. In the lower jaw the first temporary molar has been retained, and raised to a higher level than usual, and with it its alveolus.

been matured, and shows in a remarkable manner the relation of alveolar development to the changes of position in the teeth. It is not uncommon to find temporary molars present, even in patients of advanced age. Thus, in a patient over fifty years of age, the second lower temporary molars have been retained. They range with the adjoining teeth, and perform their part in mastication. The teeth generally are of the usual size, and the jaw and alveolar processes maintain the usual depth. In this case the temporary teeth and their alveoli must, at the period of second dentition, have been raised to the level of the adjoining parts of the dental arch. Other instances present themselves in which the persistent temporary teeth do not gain the general level. The cause is, however, usually very apparent: the contiguous teeth hang over, and, as it were, hold down the depressed tooth; and here again the socket corresponds to the level of the neck of the tooth. There is no disposition on the

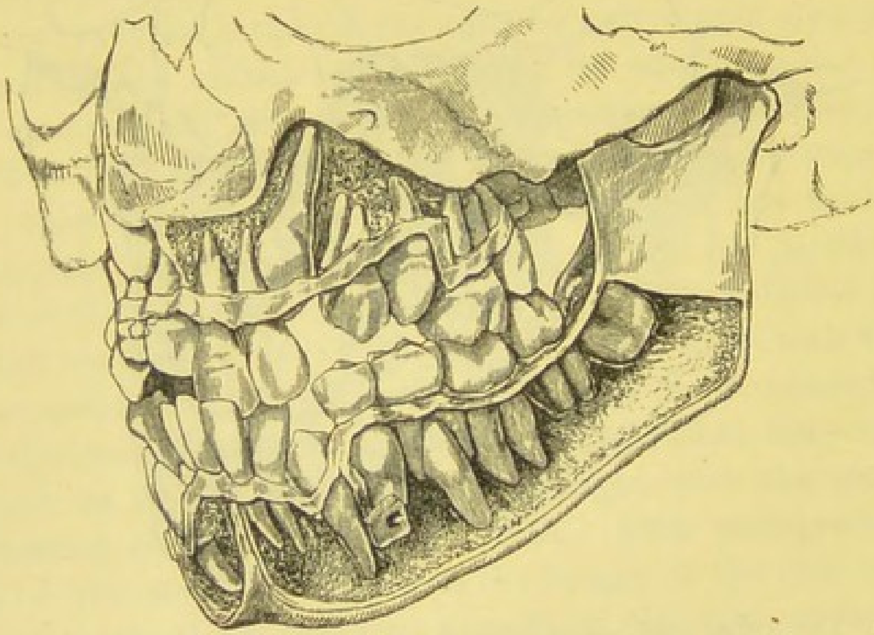


FIG. 25.—View of the left side of the specimen figured No. 24. In the upper jaw the irregular line described by the alveolar margin is shown in connection with the permanent teeth. In the lower jaw, the first and second temporary molars are retained, and both the teeth and their alveoli are raised above the level of the permanent teeth and their sockets. Both this and the preceding figure illustrate irregularities in the position of the permanent teeth, and will be referred to in connection with the subject of irregularity.

part of the bone at this point to grow up to the general line of the alveolar processes independently of the tooth to which it gives implantation. In the one case we have a tooth raised above, and in the other held down to, the normal height of a temporary tooth; and in each the alveolar development has strictly conformed to the position of the tooth.

The appreciation of the foregoing conditions will be found of great practical value in respect to the treatment of irregularities in the position of the permanent teeth. Diseased action in the structures may, however, modify the relations of the one part to the other. We have seen a case in which the alveolar processes were enormously thickened, and so raised that the teeth lay in grooves; and instances are not very uncommon in which development of the osseous tissue is arrested. But the results of normal action only have as yet been considered. The consequences entailed by disease upon the permanent teeth and their sockets will be treated in a future page.

On comparing the jaws of a child in whom the first permanent molars are advancing towards the surface, with the maxillæ in which the wisdom teeth have taken their ultimate position, we are at once struck with the great difference in size, not only of the teeth, but of the jaws themselves; and it seems at first sight very difficult to explain how the smaller can assume the characters of the older specimen, without having recourse to the indefinite idea of general expansion by interstitial growth throughout the whole substance of the bones.

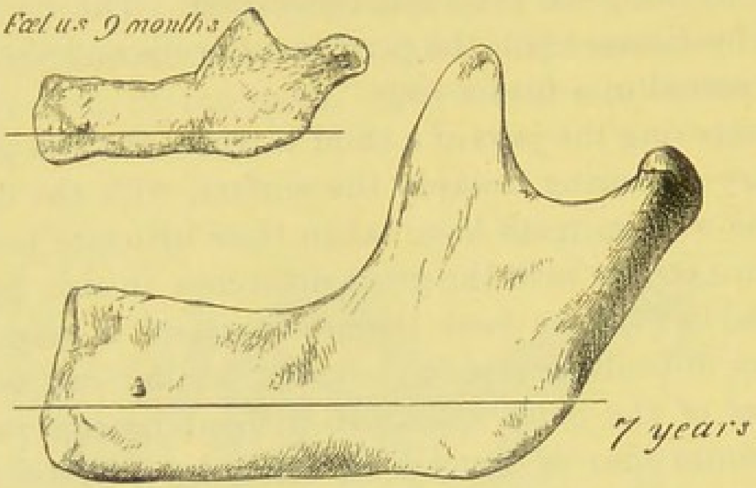
It has been shown how the alveolar portions grow up, are partly removed, and again grow up; how they are from time to time moulded to the required forms; and it will not be difficult to point out how the other parts of the jaw are, by the progress of developmental changes, gradually advanced towards the adult form.

In the earlier editions of this work certain actual measurements of a particular series of jaws were given; but as we have found that students have experienced some little difficulty in grasping the meaning of the passage when placed before them in this form, it has seemed preferable to embody the results of these investigations in the accompanying diagrams.

As some variations, due to individual peculiarities, such as greater or less development of the chin, exist between different specimens, these diagrams are drawn up according to average dimensions taken from a considerable number of jaws, and are drawn to scale.

The horizontal line represents the level of the anterior portion of the inferior dental canal in the fœtus, and the corresponding portion in the adult jaw, which may be taken as separating the alveolar portion, strictly subservient to the lodgment of the teeth, from the basal portion which subserves other purposes.

On comparing the jaw of the nine months fœtus with that of a seven years child it is seen that that portion which lies below the line has more than doubled in its depth; but on looking at the adult and the aged jaw it is apparent that this



FIGS. 26 AND 27.

portion of the bone has attained its full development in depth, or very nearly so, at the age of seven years, and that it remains comparatively unchanged after that time until the death of the individual.

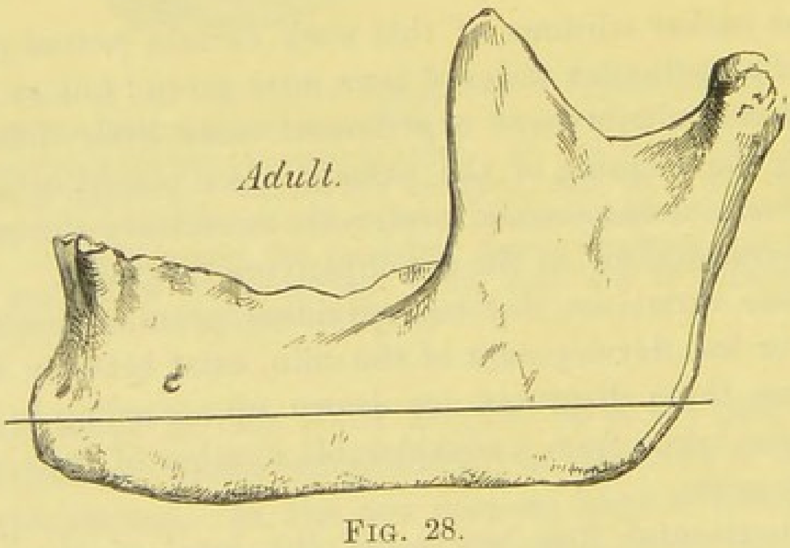


FIG. 28.

Looking, however, at the alveolar portion above the horizontal line, it is apparent that it does not attain to its full development till after the permanent teeth are in place, and that so soon as the teeth are lost, it disappears, so that in the aged jaw here figured it is almost absent.

Such measurements prove very conclusively the difference between the basal and alveolar portions of the jaw, and bring prominently forward the entire dependence of the latter on the teeth, a point which cannot be too strongly insisted on, as it has practical bearings, to be alluded to in a future page.

In the nine months subject, when the anterior teeth are about to be cut, the inferior dental canal is nearly straight from end to end, its whole length corresponding to that portion which in the adult lies under the bicuspids and first permanent molar, and forms scarcely more than one-third of its entire length. The straightness of this portion is permanently preserved in all the specimens examined. The

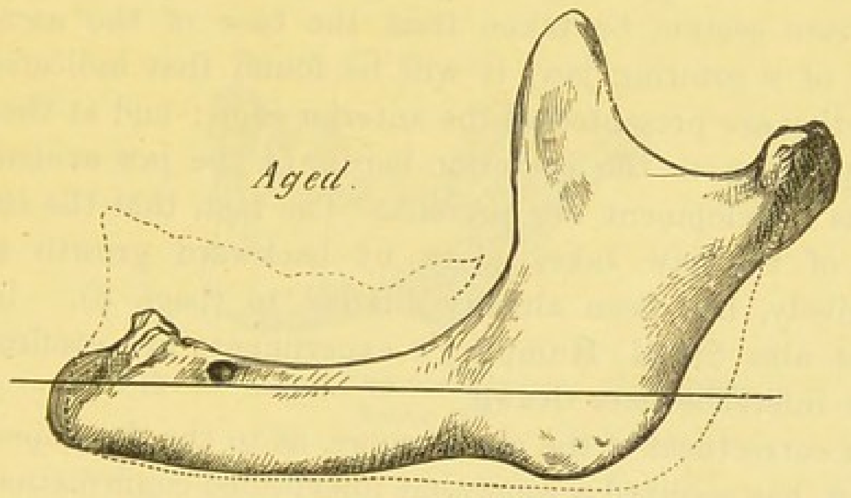


FIG. 29.

middle third is slightly curved upwards, and the posterior portion is still more curved, and if prolonged, would pass through or immediately in front of the articular process. The course of this posterior third traverses the ascending ramus of the adult jaw rather obliquely, and in the great majority of cases corresponds with the direction of the condyle rather than that of the ramus. These points have been entered upon with some degree of minuteness, in consequence of their affording evidence as to the manner in which the jaw becomes lengthened to so great an extent by additions at its posterior portions.

In tracing the growth of the jaw backwards, we may take the inferior dental canal as marking pretty accurately the line of growth followed by the condyle, and the external oblique line as that which has been followed by the base of the coronoid process. For the sake of facilitating description, it may be assumed that the backward growth takes place at three points—in the sub-articular cartilage of the condyle, in the periosteum investing the coronoid process, and in that investing the angle.

The progressive growth of the coronoid process is effected in the usual manner of sub-periosteal development—that is, by the ossification of cells and of connective tissue; and here, again, the modelling process effected by the supervention of absorption is called into requisition. If all the bone which is developed were retained, we should have the breadth of the condyle extending forward over half the alveolar margin. If a transverse section be taken from the base of the ascending ramus of a growing jaw, it will be found that indications of absorption are presented at the anterior edge; and at the point corresponding to the posterior border of the jaw evidences of osseous development are present. The fact, that the enlargement of the jaw takes place by backward growth almost exclusively, has been already alluded to (page 8). In this respect also Sir G. Humphry's experiments are confirmatory of the inference here drawn.

The correctness of the above views, as to the development of the jaw, has received a somewhat unexpected confirmation from two examples of arrested development of the one ramus of the jaw whilst the other has attained its normal size. The first of these two specimens[1] was brought before the Pathological Society by Mr. Edward Canton; it occurred in a girl of generally stunted growth, in whom the whole left side of the face was flattened, and the external ear was almost absent. At the post-mortem examination the zygomatic and auditory processes were found to be altogether absent, while the glenoid cavity was represented by a perfectly smooth surface.

As is seen in the figure, on the left side of the jaw the ascending ramus is a very short, narrow process terminating in two points, which may perhaps represent the coronoid and condyloid processes. But there is nothing to be seen at all like a condyle at the summit of this process, and therefore,

1 Figured and described in Pathological Society's Transactions, vol. xii., 1861, p. 238.

there being no articular surface, there can be no articular cartilage.

But it has just been pointed out that the backward and upward elongation of the jaw takes place in great part by ossification in this articular cartilage, just as a long bone grows by ossification progressing in its epiphyses. Hence the absence of the condyle accounts perfectly for the arrest in the development of this portion of the jaw; it will, however, be noticed that the vertical development of the horizontal ramus, which is entirely correlative with that of the teeth, has not suffered in a like degree: the teeth have been developed, and consequently the alveolar portion of the jaw has attained to something approaching its normal depth

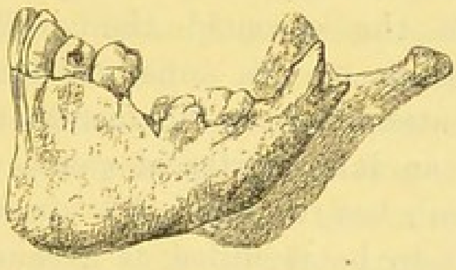


FIG. 30.—Mr. Canton's specimen of stunted lower jaw.

and width. The length of this aborted side of the jaw does not exceed that attained by that of a child aged two years and a half.

The great elevation of the incisor teeth is simply the consequence of imperfect antagonism, an explanation rendered the more certain by their serrated edges, which have obviously not come into contact with the upper teeth.

On the inner surface of the stunted process, at a level corresponding to that of the crown of the second molar tooth, is the inferior dental foramen, which is much smaller than that of the right side. The mental foramen is entirely absent, the nerves and vessels having been apparently wholly used up in the substance of the bone.

A second specimen, which is in the museum of the Odontological Society,[1] presents somewhat similar characters. Of

[1] Transactions Odontological Society, March, 1872.

its history nothing whatever is known, but it appears to be the jaw of quite an aged person, and the alveolar portions of the jaw having been for the most part absorbed after the loss of the teeth, the fact of the entire dependence of the growth of this region of the jaw on the presence of the teeth is not so strongly exemplified as was the case in the last mentioned specimen. But that the aborted body has at one time been of a depth apparently disproportionate to its backward elongation is probable from the presence along its upper surface of the sharp ridge which is usually left after absorption of alveoli, subsequently to the loss of the teeth. In the spinous process which terminates this stunted ramus, no separate representative of coronoid and condyloid processes can be traced: it is a simple spine, which from its relation with the external oblique ridge would correspond more nearly with the coronoid than with the condyloid process, and presents on its inner surface a prominence apparently giving attachment to ligaments or muscles. There is not a trace of an inferior dental canal, and consequently no mental foramen; but whether this absence of its proper vascular supply is to be regarded as a cause or an effect of the stunted growth is an almost insoluble problem. The tubercles for the attachment of the genio-hyoid and genio-hyo-glossus, which probably marked the median line of the body, do not correspond with the position of the mental prominence on the outside of the jaw, which latter has partaken in the asymmetrical development of face which must have existed and is considerably displaced to the right.

A case of arrested development of both sides of the jaw, not shared in an equal degree by the alveolar borders, is related by Sir G. Humphry.[1] The chin was in a plane two inches behind the edge of the upper alveolar edge, but the alveolar border of the lower jaw took a wider sweep than the body of the bone, which it consequently overlapped. The teeth were as large as in a well-formed jaw, so that they were forced to spread out in a fan-like manner.

The manner in which additions are made to the posterior border of the jaw has been described in connection with the growth of the jaws of very young subjects. During the

[1] "Medico-Chirurgical Review," vol. xxvii., 1862.

period of youth the process is continued, and as the subject approaches manhood the angle becomes fully pronounced. At the same time, the mental prominence and the points for the insertion of muscles attain their permanent characters. In each case the increased size is produced by sub-periosteal development upon the pre-existing bone. The development of the jaw may, in some respects, be compared to modelling. Portions of new tissue are laid upon that already formed, and reduced to the fitting size and shape, and again renewed at such points as the attainment of the ultimate form of the part may require.

Still, even during manhood, the maintenance of the form of the jaw is dependent to a great extent upon the teeth. When the organs of mastication are lost the whole of the alveolar processes are by degrees removed, the process of absorption being arrested only at those parts where muscles are inserted; neither is the waste limited to the alveolar margin. Both the outer and inner surfaces of the bone are reduced, and even the interior becomes more porous than during the period when the teeth were present. The spinæ mentales, however, retain nearly their full size, although the angle of the jaw about which the masseter muscle is inserted, suffers considerable loss —not, however, until that muscle is thrown partly out of use by the loss of the teeth, and consequently of the capability of mastication. If two jaws be taken, the one full of teeth, the other from an old edentulous subject, and in each the dental canal be exposed throughout its length, we may then, by the use of a file, taking the canal as our guide in removing the bone, reduce the younger to the form of the older jaw, showing that absorption alone is competent to effect the whole change In the one case we have a jaw for the implantation of teeth and for the insertion of powerful muscles for bringing the teeth into effective use, in addition to affording attachment for muscles connected with the organs of speech and deglutition; and in the other, the jaw is subservient only to the latter purposes.

We have hitherto spoken of the lower jaw, which, from its slight connection with the other bones of the face, can be studied in its progressive changes of form and size more readily than the superior maxilla. But if crania of various ages, extending from seven to twenty-one years, be carefully examined, the difference presented by the upper jaw at the several periods, and the manner in which these differences have been produced, may be recognised.

The general principles which have been pointed out as pertaining to the development of the lower jaw may be applied to those **facial bones** which are connected with the masticatory apparatus. The tuberosity is to the upper what the base of the coronoid process is to the lower jaw. From this point the alveolar line is lengthened. At the age of seven years, the second molar is buried high up in the tuberosity. Soon after the expiration of the twelfth year the distance between the pterygoid process and the first molar will have increased sufficiently to allow the second molar to take its place in the dental line, and by the expiration of the twentieth year the third molar is usually found in its normal position. Up to this period, the facial bones are connected to each other and to the bones of the cranium by sutures only; and in the soft tissue within these development of bone takes place.

The **maxillary bones,** while their processes are increased in length, are moved bodily forward, the rate of growth keeping pace with the increase at the tuberosity. Coincidently with development, the modelling of certain parts by superficial absorption is carried on. By this process the anterior surface of the lower border of the malar process is removed, and thus thrown backward. In the seven years' specimen it lies immediately above the anterior third of the first molar; at twenty-one it holds a similar position with respect to the second molar, thus showing a recedence equal to the width of one tooth.

As respects the changes of form and position which the **glenoid cavity** undergoes during growth, but little need be said. Here we have articular cartilage, beneath which the required amount of bone is slowly developed in the same manner as the subarticular cartilage of the lower jaw.

Mr. Shaw some years ago pointed out that the **cranial portion of the skull** differs but little in dimensions even if the comparison be made between giants and persons of ordinary stature, whereas the face and all the bones which enter into its formation differ much; and this is very marked in the lower jaws. This is apt to give to the faces of such overgrown people a coarse animal aspect; the orbits also are pretty constant, and the adjustment of the varying sized face to the unvarying orbits and cranium is largely effected by the size of the frontal and maxillary sinuses. (Med. Chirurg. Trans., vol. xxvi., 1848.)

The Dental Arch.—The general thesis has been laid down that, with the trifling exceptions already alluded to, the twenty anterior permanent teeth occupy an arch but little different in size or shape from that occupied by the twenty deciduous teeth; and an interesting proof of this proposition is afforded by a series of models of the same mouth from the age of four to that of twenty-one ("Studies on the Growth of the Jaws," Trans. Odontological Society, 1892). In these I found that in the replacement of the temporary by the permanent teeth an increase in the anterior posterior length from 26·5 millimetres to 27·2 took place, and in width also rather less than a millimetre.

But the case is quite different in the anthropoid apes, in which the inter-maxillary suture remains permanently, or, as in the chimpanzee, for a long time, open. In the chimpanzee the inter-maxillary bones gain in the female six millimetres of length and in the male eleven millimetres; in the orang four and seven; and in the gorilla three and eight millimetres respectively. In the two latter there is a growth forwards of the maxilla at its edge as well as of the inter-maxilla.

This suggests the idea that the prognathism of the African races may be due to a late obliteration of the inter-maxillary suture, but of this I have not been able to procure any evidence as yet.

The series of models showed several very interesting points. One was that a bilateral asymmetry (which was ultimately met by the extraction of a tooth on one side) had asserted itself at a time when precisely the same teeth had been shed and replaced upon the two sides.

Another respect in which the mouth was irregular lay in the height of the lower incisors. These had grown up too high in spite of the fact that the upper incisors were vertical instead of being inclined outwards; and so the lower incisors, so far from having no opposing teeth, were driven to take a position sloping inwards. Thus two forms of slight irregularity occurred which could by no possibility be referred to merely mechanical causes.

Zsigmondy ("Archiv fur Anatomie und Physiologie," 1890) has published diagrams of the teeth and dental arches of three individuals at the ages of six, and of two of them at fifteen, and of one at seventeen years of age, which, while showing a slight increase in width across the region of the second milk molars and certain other variable changes not common to the three cases, broadly speaking go to confirm the conclusions advanced on the last page.

The accompanying figure shows the amounts of the respective permanent teeth completed at various ages, and it will be found, in relation to the question of root-filling in young subjects, of importance.

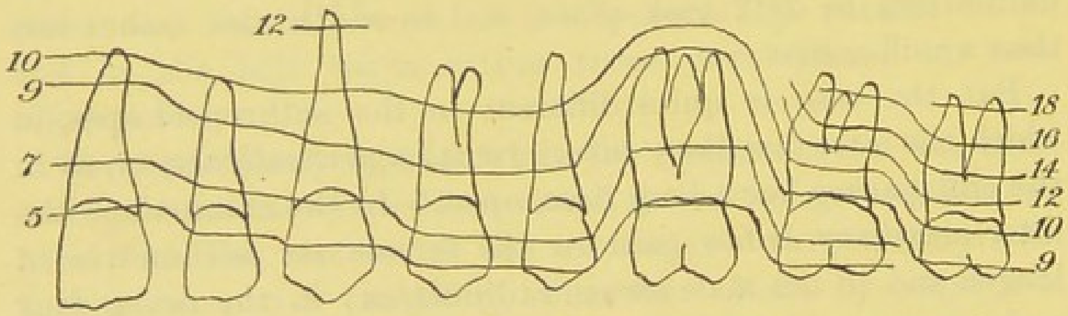


FIG. 31.

ABNORMAL DENTITION.

Abnormalities of the Teeth.—The number, form, period of eruption and arrangement of the teeth may, any or all of them, be abnormal; and these abnormalities again may be accidental in the individual or they may be inherited.

Thus the late Dr. McQuillen[1] gave some striking examples of the transmission of characteristics apparently trifling from parents to children. In one family the upper lateral incisors bit inside their corresponding lower teeth in the father, and in three out of four of his children; the fourth child had not cut these teeth at the date of the observation. In another family the father, son, and grandson alike never had any lateral incisors in the upper jaw; a second son had them exceedingly dwarfed; and some of the latter's children had them so stunted as to make them unsightly, so that they were extracted for the purpose of inserting artificial substitutes. In a later number of the same journal a family in whom no permanent teeth at all are found, is mentioned as being well known to many American dentists.

Within the author's own experience no less than three families have been met with in which the same teeth (lateral incisors) are generally absent, or, if present, are stunted in greater or less degree.

The late Mr. Weiss has recorded the transmission of the peculiarity of well-defined additional lingual cusps in the upper molar from a father to six of his children.

An instance of the congenital absence of bicuspid teeth is given by Mr. Heath,[2] and in my own practice I have lately met with an example of the absence of the left upper

[1] "Dental Cosmos," vol. xii., p. 75.
[2] "Injuries and Diseases of the Jaws," p. 185.

lateral incisor in three sisters; on the right side these teeth are present.

Numerous other examples might be collected, but the foregoing will suffice to illustrate that a strong tendency to hereditary transmission of peculiarities is found to exist.

Dr. Sim Wallace has recently denied that heredity has any share in the production of dental irregularities, but it is difficult to reconcile this view with such facts as the occurrence of contracted upper maxillæ through many generations as is evidenced by some family portraits; or of the underhung jaws of the House of Burgundy in the Middle Ages, clearly shown in the paintings of Velasquez and others.

Correlations of growth are found to exist between parts of the organism, which, so far as we know at present, have little or nothing to do with one another; but in other examples of this concomitant variation some homological relation can be traced between the varying organs. Such is the case with hair and teeth, which in their origin are closely similar, and which only become strongly differentiated in their after development.

And it has been remarked by Mr. Darwin that those orders of Mammalia which are most aberrant in their dermal coverings—namely, the Cetacea and Edentata—are also remarkable for deficiency or redundancy in the number of their teeth.

For example, the hairless, naked Turkish dog is extremely deficient in its teeth, often having none except one molar on each side, and perhaps one or two imperfect incisors[1]; and the same fact has been observed in a hairless terrier. Inherited baldness has been found associated with inherited deficiency of the teeth, and it is stated by Mr. Sedgwick[2] that in rare cases where the hair has been renewed in old age this has usually been accompanied by a renewal of the teeth.

Mr. Craufurd, as quoted by Mr. Darwin, states that at the Burmese Court there was a man covered with straight silky hair, which on the spine and shoulders was as much as five inches in length. He had no molar teeth, and the incisors were very small; his daughter inherited the peculiarity of a hairy skin, her face, even including the nose, being covered

1 Darwin, "Animals and Plants under Domestication," vol. i., p. 31.
2 "British and Foreign Medico-Chirurg. Review," April, 1863.

with silky hair, and, like her father, she had neither molar nor bicuspid teeth.

These hairy persons did not present any marked peculiarity at birth, save that there was a little hair about the ears, whence it spread all over the body; and it is a significant fact that there was nothing abnormal in their milk dentition. In the case of Julia Pastrana, rendered famous by the exhibition of her stuffed skin after her death, the forehead and the chin were densely covered with hair, and there were said to have been so many supernumerary teeth in the mouth that the appearance of a double row of teeth in each jaw was presented.

Models have, however, been presented to the Odontological Society by Mr. Hepburn, the authenticity of which appears to be beyond question, and these do not exhibit the excessive number of teeth attributed to her; but it would appear that she was affected with a form of general hypertrophy of the gums and teeth, described at a later page; so that, while the old statements about her call for correction, she is none the less interesting to the student of dental irregularities, for she exemplified in a marked manner that hypertrophy of one set of cutaneous appendages goes hand in hand with hypertrophy of the others.

The hairy child exhibited at the Aquarium presented no abnormality in her teeth, although the contrary had been asserted.

Some years ago a Russian peasant was exhibited in London whose face was so hairy that it resembled that of a Skye terrier, and the hair was so long and abundant that it had to be cut in order to enable him to see. His son was also hairy.

The father had no teeth up to the age of seventeen; then he had four teeth in the lower jaw, but none in the upper; whilst the child had the four lower incisors, but no signs of any others. It is remarkable that, on an examination of the mouths made by Mr. Oakley Coles and myself when models were taken, it was found that the man, though stoutly and even powerfully built, had jaws no larger than those of the child; this tallies remarkably with what has been inferred on other grounds as to the dependence of the growth of the jaws upon the existence of the permanent teeth.

This man bore no particular resemblance to his mother, his brother, or his sister; his father was unknown, the man having been born during the absence of the reputed father, who was a soldier.

The late Mr. Moon[1] gave two striking family histories. The mother had normal teeth; the father (who was dead) was said to have had only two incisors, and those pointed. There were four children, of whom one (male) had normal teeth; a female, aged ten, did not strongly resemble the others, and had teeth only slightly abnormal; another, aged eleven, had all the incisors and canines small, sharply pointed, and hooked at the points, her hair was scanty and inclined to fall out, and her eyes were defective; another, aged fifteen, had her upper incisors, canines, and premolars mere sharp, curved cones; her hair was scanty and fair.

Another family presented a boy who had no toe nor finger nails at birth; his hair was absent for a year, and at the age of nine he had scanty light hair, no eyebrows, and very scanty eyelashes. He had four temporary canines, two permanent upper incisors, which were recurved and pointed, and only two molars (the upper temporary).

The sister, aged eight, had conical lower incisors, and only one upper incisor yet erupted, which was normal. Three others had hair and teeth normal.

The mother of these children had no upper lateral incisors, and she had never had first lower molars, second bicuspids, or third molars; the father was in all respects normal.

A most interesting case of total absence of dentition is that of an Armenian boy, aged thirteen, a patient of Mr. Krikor Sarkissyan, of Aintab, Syria. This boy was born in 1888 of healthy parents; at birth he had no hair, and his hair at present is very soft and white, resembling wool, though that of his brothers and sisters is abundant and brown. At two years of age, as no teeth had made their appearance, he was taken to Mr. Sarkissyan, who has since kept him under observation. No teeth, either temporary or permanent, have ever erupted, although when last reported on he had worn full upper and lower dentures for four years. His father's and mother's teeth are normal, as are those of the other children, twelve in

[1] Transac. Odontological Society, May, 1877.

all, of whom three were born after this boy. He has always been small, pale, and weak, probably through deficient mastication; his finger and toe nails are normal, and there is no sign of mental aberration. From models taken at the age of thirteen, it is seen that both upper and lower jaws are

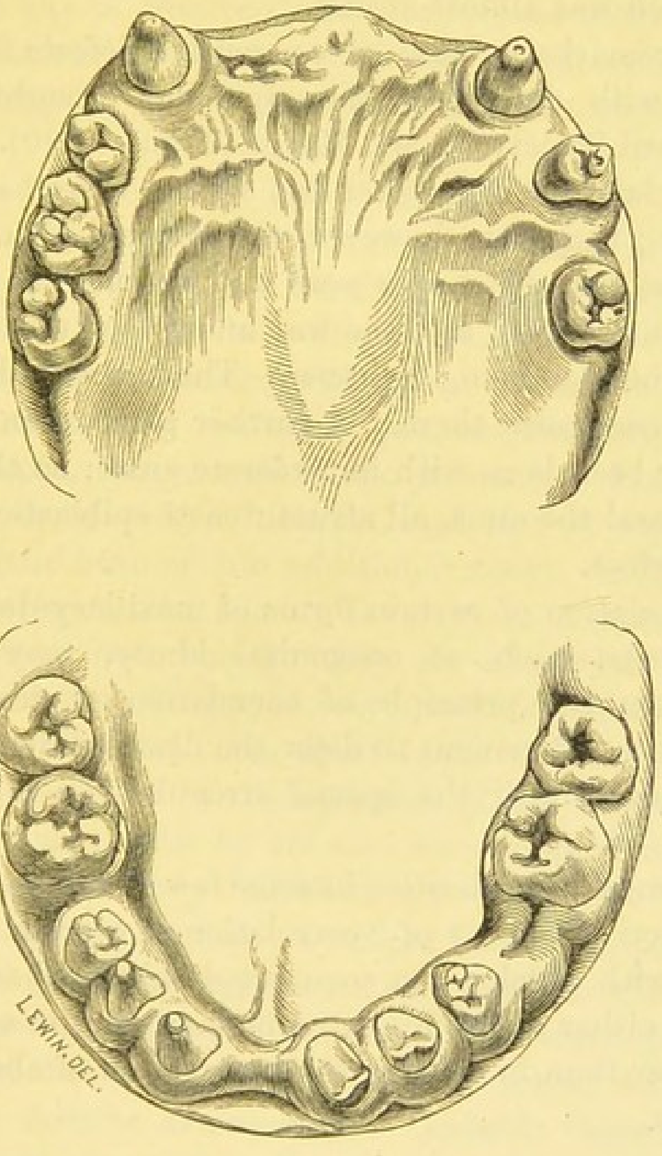


FIG. 32.—Models of the mouth of a girl, aged eighteen. Mr. Maggs' case.

small: in the upper the width between the alveolar ridges is 1·7 inches, and the antero-posterior length 1·35, while in the lower jaw the width is 1·85, and the length 1·55. The larger size of the lower jaw may account for the underhung appearance noticeable in a photograph of the boy. The alveolar ridges are shallow, that of the upper jaw only falling ·15 inch below the palate, which is very flat, and they are very thin-edged like those of an aged person in whom extreme absorption has taken place.

In another case met with by the author a deficient development of both the maxilla and mandible, on one side only, was accompanied by reduction in size of the external ear, the lower lobe of which was almost absent.

A very remarkable case of congenital defects in dentition, associated with defects of the eyes, was brought before the Odontological Society by Mr. Maggs (Trans. 1890). The teeth were both deficient in number and size, as is well shown in the illustration; they were, however, well covered with enamel, and free from caries. The eyes were very deficient in size, myopic to an extreme degree, and she was under treatment for chronic glaucoma, her age being eighteen. The iris was almost absent, but the lenses were there. A further point of interest lies in her having been born with imperforate anus; so that the eyes, the teeth, and the anus, all structures of epiblastic origin, were alike imperfect.

The association of certain forms of maxillary deformity with other defects, such as congenital idiocy, may perhaps be explained on the principle of correlation of growth; but it will be more convenient to defer the discussion of this branch of the subject until the special irregularities alluded to are described.

Thus, dental irregularities in some few instances are referable to the action of the law of "correlation of growth." In all the instances with which I am acquainted this law has operated in producing either deficiency or redundancy in the number of the teeth rather than in causing the assumption of abnormal forms or position.

Abnormalities in Number of Permanent Teeth.

Thirty-two being the number of a normal series of permanent teeth, any deviation, whether it be in an excess or in a diminution of that number, will constitute an irregularity; in other words, there may be irregularity from there being too many or too few teeth. Each of these forms of departure from the normal series is far from rare; but of the two forms it is perhaps more common to find that in which the teeth are in excess, one or two supernumerary teeth, as they are termed, being present.

Supernumerary teeth may spring up during the second dentition in any part of the alveolar arch, and either may resemble those of special members of the normal series, or may deviate from any of the recognised forms, and assume a somewhat irregular conical shape, sufficiently characteristic in itself to enable them to be at once recognised as supernumerary teeth.[1]

Several cases, occurring either in the first or the second dentition, have come under my own observation in which five equally well-formed incisors occurred in the lower jaw. In neither case was it possible to determine, from an examination of the crowns of the teeth, which was the extra tooth. A third lateral incisor in the upper jaw, undistinguishable from the normal tooth, I have seen in one case only. Instances of a third canine or of a fifth bicuspid, and also of supplemental molar teeth (the form of the additional tooth being perfectly normal), have been seen even in lower races of mankind, in a gorilla, and in a lion, though they are somewhat rare; but examples in which an ill-shaped tooth without determined form is found placed between the front teeth or behind them, or even holding the place to the exclusion of the normal member of the set, are met with by all who are engaged in practice. The number is commonly limited to one, or at most two, supernumerary teeth symmetrically arranged; but I have seen a case in which there were four supernumerary teeth, forming a group with the upper incisors and canines. The front part of the mouth looked to be studded over with teeth, without any attempt at a definite arrangement. Indeed, there was some little difficulty in recognising the normal members of the series; for while the supernumerary teeth to some extent resembled normal front teeth, the latter were ill formed, and approached the former in character. As cases like the foregoing occur from

[1] Seeing that supernumerary teeth assume two distinct forms, the one being regular, the other irregular, it might, perhaps, be advantageous, when speaking of those which in no respect differ from members of the normal series, to use the term supplemental, reserving supernumerary for the irregular-shaped teeth. As, however, there is every gradation between them, too much stress should not be laid upon this distinction.

time to time, in which the recognition of the supernumerary tooth or teeth is attended with difficulty, it becomes necessary that we should, if possible, establish the special characters which are peculiar to supernumerary teeth as distinguished

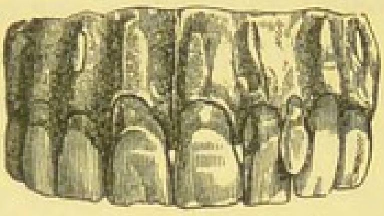


FIG. 33.—Shows the front view of a specimen in which a supernumerary tooth external to the front teeth occupies the space between the lateral incisor and canine teeth.

from faulty-shaped normal members of the series. In the absence of such knowledge, we may allow a supernumerary tooth to remain and exclude the normal tooth from its place, as shown in Fig. 34, or we may be induced to remove a badly

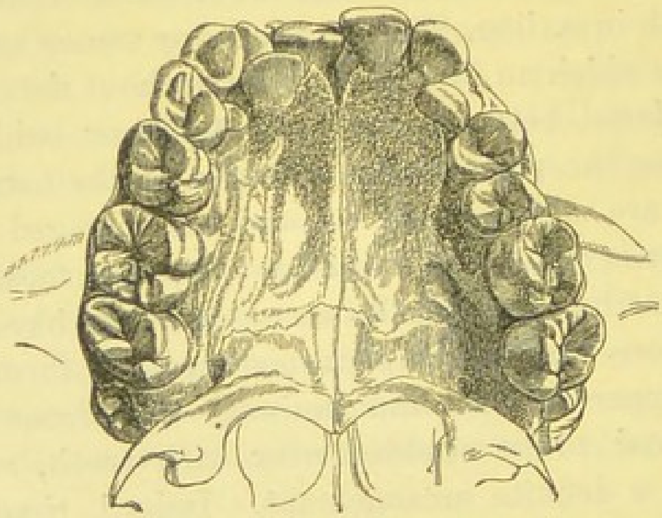


FIG. 34.—A palatal view of the specimens shown in Figs. 24 and 25. The supernumerary tooth is situated between the canine and the central incisor of the right side.

shaped tooth under the impression that it is not a member of the series.

Yet, where the discrimination depends upon very nice shades of difference, the characters, even if recognisable by the eye, can scarcely be conveyed in a written description. After removing from a large series those which are not distinguishable from normal forms, we have remaining teeth the crowns of which may exhibit the following characters: The lingual and labial surfaces are not distinguished by any difference of form. The enamel terminates on the neck of the tooth in an even line, differing in this respect from the terminal line in ordinary teeth. The crown of the tooth in the majority of cases presents a simple cone with a sharp apex; in other instances the point will be replaced by an irregularly depressed surface, corresponding in character to the masticating surface of a bicuspid or molar. More rarely the conical or cylindrical form is lost, and in its place we have a more or less flattened crown, the grinding surface being marked longitudinally with

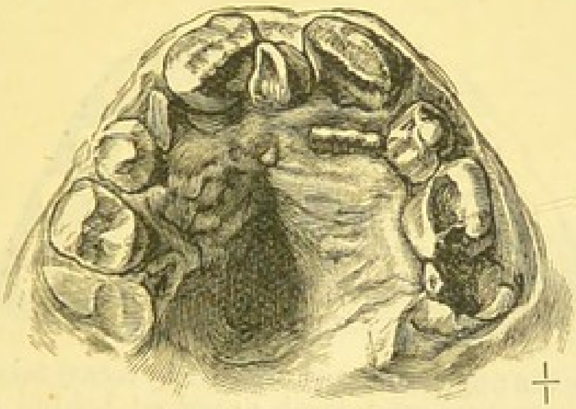


FIG. 35.—Supernumerary tooth situated between the central incisor teeth.

a deep fissure. Several examples have come under our observation in which the crown has been divided in three or four plates, meeting at a common centre in such a manner as to produce a cross. It would, however, be hopeless to attempt to describe more than the general characters of supernumerary teeth, inasmuch as the minor differences of form are infinitely varied; no two are precisely similar.

The roots of supernumerary teeth are almost invariably single. The crown not uncommonly presents a certain amount of complexity, and approaches to the form of a molar tooth; but we do not remember to have seen a single specimen of a strictly speaking supernumerary tooth in which the root was divided.

The history of supernumerary teeth has not attracted that degree of attention at the hands of practitioners which the subject deserves. There are several points the investigation of which would be attended with advantage. Thus we find that supernumerary teeth, for the most part, are matured and make their appearance before the permanent teeth situated in the same part of the mouth.

In Fig. 34, a supernumerary tooth holds the place of the lateral incisor, which, with the central, is held back from taking the normal position. In the specimen from Sir E. Saunders' collection, two supernumerary teeth (Fig. 37) occupy the place of the central incisors. One of the excluded teeth has come through above the alveolar line.

Again, in Fig. 36 there are two supernumerary teeth, and

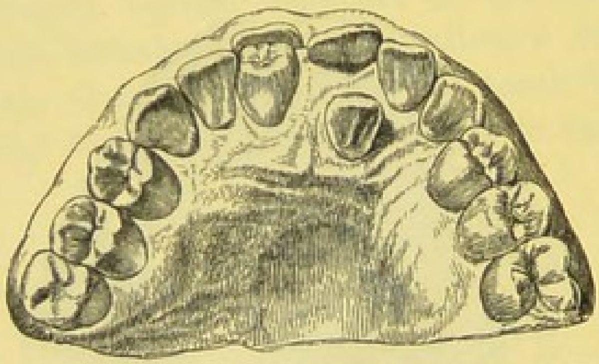


FIG. 36.—Shows the appearances presented by a cast taken from a mouth in which two supernumerary teeth appeared behind the incisors, one resembling to some extent an incisor, the other altogether irregular in shape.

one of these has to a certain extent interfered with the position of the central incisor. Now, in each of these instances the abnormal have preceded the normal teeth, and occasioned the malposition of the latter. But it may happen that a supernumerary tooth appears in the place and at the time of a normal tooth, the latter having been retarded in its development by the presence of the former. In one case a central incisor of the upper jaw was cut at the usual time, and by the side of it a supernumerary. The latter was at once removed, under the strong belief that the absent central tooth would after a time make its appearance. The expectation was realised, but three years elapsed first. The neighbourhood of the incisors must be regarded as the most common position for supernumerary teeth to occur, and they are more often met with in the maxilla than in the mandible. But Hayman records an example of three bicuspids occurring on each side of the lower jaw; the additional teeth, which were small and poorly formed, were behind the normal teeth. An extraordinary case of supernumerary teeth has been put upon record by Professor Cope, in which the dental formula was—

$$\text{i. } \frac{5}{4} \text{ c. } \frac{1}{2} \text{ pm. } \frac{3}{0} \text{ m. } \frac{3}{3}\,\frac{3}{4}.$$

The first two molars were furnished with accessory lobes, thereby further showing the tendency to redundancy of parts. A brother of the patient had—

$$\text{i. } \frac{4}{4} \text{ c. } \frac{1}{1} \text{ pm. } \frac{2}{1} \text{ m. } \frac{3}{3},$$

and a sister—

$$\text{i. } \frac{3}{3} \text{ c. } \frac{1}{1} \text{ pm. } \frac{2}{1}\,\frac{2}{2} \text{ m. } \frac{3}{3},$$

a grandmother having i. $\frac{5}{4}$.

Instances, however, are not wanting in which the additional teeth appear among the molars. In a patient of the writer's, a

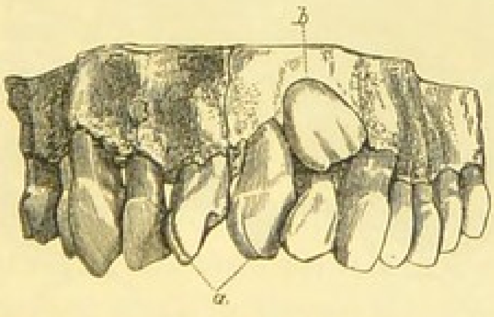


FIG. 37.—Shows the front view of a specimen in which two supernumerary teeth (*a*) hold the place of the central incisors, while the left central (*b*) has appeared above the alveolar line. We are indebted to Sir E. Saunders for the use of this specimen.

diminutive tooth, resembling a small and badly formed wisdom tooth, appeared on each side of the mouth external to the first and second permanent molars of the upper jaw. The age of the patient and the appearance of the teeth themselves led to the supposition that they were the representatives of the wisdom-teeth. Within two or three years the eruption of the true wisdom-teeth in the usual position showed that the supposition was incorrect.

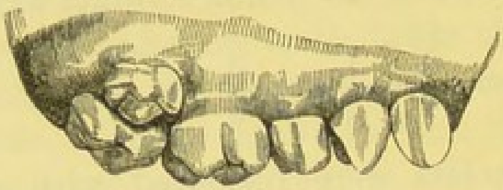


FIG. 38.—Shows a supernumerary tooth placed externally to the first and second permanent molars of the upper jaw.

Instances have, however, occurred in which an additional molar tooth has been undistinguishable as regards form from a normal member of the series, and a similar occurrence has been remarked in respect to the bicuspids.

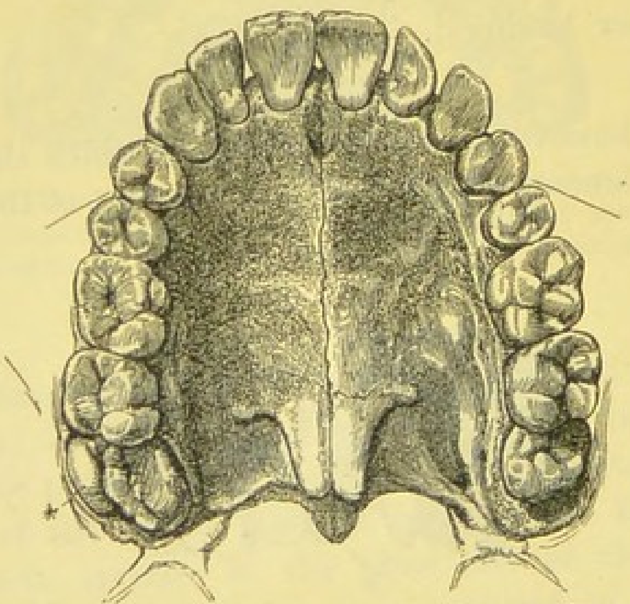


FIG. 39.—A palatal view of an upper jaw in which a supernumerary tooth occupies the external portion of the socket of the right wisdom-tooth.

The accompanying illustration is taken from a specimen in which a wisdom-tooth and a supernumerary occupy the same socket. Although in this case the hard palate is thickened in a peculiar manner, and terminates in four processes, yet the jaw is well formed as respects the dental arch, and the teeth are both well developed and well arranged. In this instance, the form of the jaw can have had nothing to do with the development of the additional tooth. Indeed, I do not know that any connection between good or bad development of the jaw and the occurrence of supernumerary teeth can be traced. Still my own personal observations would, perhaps, justify me in stating that supernumerary teeth are more frequently found in perfectly than in imperfectly developed jaws.

FIG. 40.—Supernumerary tooth from between the second and third molars of the lower jaw.

The relations of supernumerary to the normal teeth during the development of the former are not, in the absence of actual observations, readily understood.

It has been suggested that the frequent appearance of supernumerary teeth in the incisor region may be due to atavism, there being six incisors in the typical mammalian dentition (cf. Wilson, "Brit. Dent. Assoc. Journal," 1885; Albrecht, "Anat. Anzeig.," 1879; Edwards and Turner, "Journal Anat. and Phys.," 1885; and Tomes, "Dental Anatomy," 1904, page 575). And some support is lent to this idea by what has been observed in cases of cleft palate, in which an extra tooth, the so-called "precanine," is found beyond the cleft. A few instances have been put upon record of the occurrence of supernumerary teeth in the milk dentition which have been followed by corresponding representatives in the permanent set. Bateson (Proc. Zool. Soc., 1892) has recorded a very large number of instances of supernumerary teeth occurring in animals.

As to the manner in which supernumerary teeth have been supposed to arise, it has been remarked by Mr. Bland Sutton that supernumerary teeth in the middle line of the palate and of the pre-maxillæ are due to the inclusion of epithelium between the two sides during development. Mr. J. G. Turner (Trans. Odont. Soc., 1900) says that supernumerary teeth are most commonly met with in the region of the internasal fissure and of the oral ends of the orbito-nasal fissure, thus showing the possibility of teeth developing in the lines of the clefts.

As they so very rarely occur in the temporary dentition it is clear that they cannot be referred to it; and although they often precede, in point of time, the normal successional teeth of the particular part of the mouth, they probably belong to the second series.

And, although several observers have pronounced the opinion that rudiments of other than the two normal dentitions are to be found in man, namely, traces of pre-milk and post-permanent teeth, yet no one has seen any traces of teeth intermediate between the milk and the permanent teeth.

Modern views as to the budding off of teeth from the common dental lamina, however, render the occurrence of supernumeraries easier to account for than the older view, in which it was thought that each permanent tooth germ was strictly derived from the neck of the enamel organ of its predecessor.

Mr. Woodhouse has also recorded some cases of supernumerary wisdom-teeth (Trans. Odont. Soc., 1876).

When supernumerary teeth make their appearance they should be extracted as soon as their character is clearly established.

Instances may, however, occasionally present themselves to the practitioner in which a supernumerary tooth may be retained with advantage ; but these will, for the most part, be confined to those cases in which, from neglect, the whole of the teeth have been allowed to remain until all chance of the normal tooth coming into its proper position on the removal of the intruder is lost.

Under the head of abnormality in the number of the permanent teeth, those cases in which the **dental series is more or less defective** yet remain to be considered.

In another connection (p. 64) some instances have been cited of a total or partial absence of the permanent teeth.[1] In two casts taken by the late Mr. Harrison from a patient under his treatment, one molar occupied each side of the upper and lower jaws, and these four molar teeth, with four incisors (two in each jaw), were all the permanent teeth. According to the statements of the patient and of her friends, the temporary teeth presented no peculiarities either as regards their number or the manner or the time of their shedding. A

[1] In the Museum of the Odontological Society are several models of cases in which the teeth were deficient, and allusion has already been made to the subject in discussing the origin of various abnormalities (pages 63 and 64).

temporary canine tooth was retained in the upper and lower jaw; the other members of the milk set were shed at the usual time, but, with the exception of the four central incisors, their successors were wanting. A case has also been described in which there was an almost total absence of the temporary series, yet permanent teeth not only made their appearance at the usual time, but took their place with great regularity as respects arrangement. Now, although these two instances may be looked upon as very rare and exceptional ones, yet they prove that temporary need not necessarily precede permanent teeth, and also that temporary are not necessarily

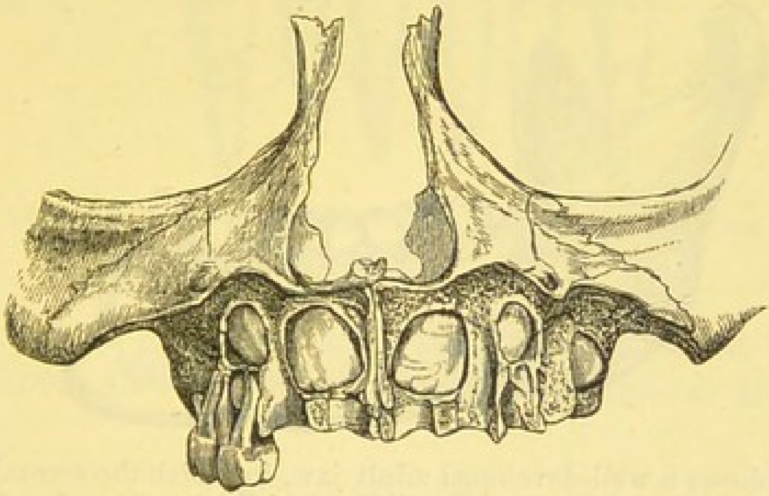


FIG. 41.—Front view of an upper jaw of a young subject. The temporary alveoli show that the temporary lateral incisors were wanting, and the absence of permanent lateral teeth is also shown.

followed by permanent teeth, and this fact is of interest in connection with recent researches upon mammalian tooth development.

Although these great diminutions in the number of the permanent series are rarely seen, the absence of one or two members of the set is far from uncommon. Several families the members of which are destitute of lateral incisors in the upper jaw have already been cited. Although it is usual for abnormalities, whether consisting in an excess or a deficiency of number, to affect both sides of the mouth, yet this symmetry is not always met with. I had two patients (sisters) in whom the right upper lateral incisors are absent; the left laterals are small, but otherwise well formed.

We are indebted to the late Mr. James Parkinson for a specimen of a young jaw in which both the temporary and permanent lateral incisors are wanting.

The son and daughter of a gentleman who had no lateral incisors in the upper jaw each bore the marks of their parentage in respect to the teeth. The son had but one lateral incisor, and that was a very small and imperfectly developed tooth. The daughter had, however, two lateral incisors. They made their appearance at a very late period, and presented the characters common to supernumerary teeth, each tooth being nothing more than a small sharp-pointed cone; and other

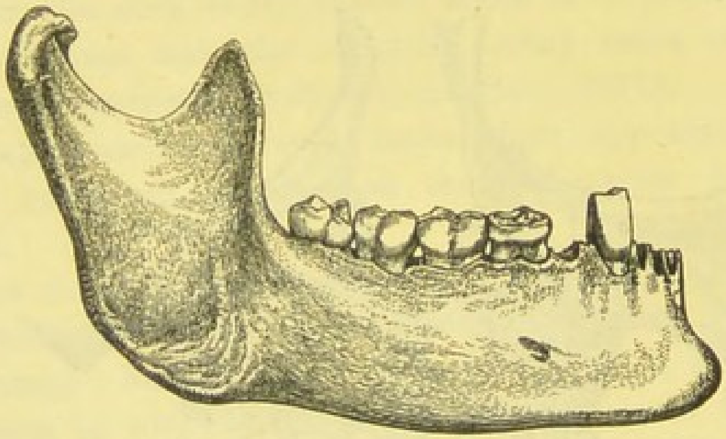


FIG. 42.—Shows a well-developed adult jaw, in which the second temporary molar is persistent, no second bicuspid having been developed.

instances of inherited peculiarities have already been given at page 61.

We believe when one description of tooth only is wanting it will generally be found that the lateral incisor is the missing member. Perhaps we should except from this rule the wisdom-teeth. They, however, are so extremely irregular in all respects, as compared with the other teeth, that we are seldom in a position to declare them absent, although they may not have appeared above the surface of the gums. But if the third molars are less frequently absent than the lateral incisors they stand next in the order of absentees. The second bicuspid is sometimes absent, and its place may be supplied, as in the preceding illustration, by the retention of the second temporary molar.

From a strictly practical point of view, these cases of deficiency in the number of the second set of teeth have but little interest. By those, however, who are interested in

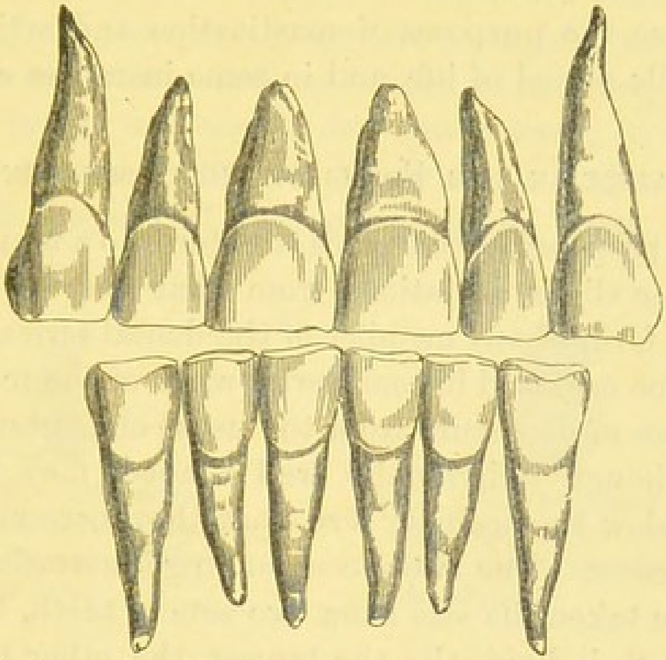


FIG. 43.—A front view, life-size, of an unusually large set of front teeth, of the upper and lower jaws.

morphological questions, they will not be passed over with indifference, although our present knowledge of the subject

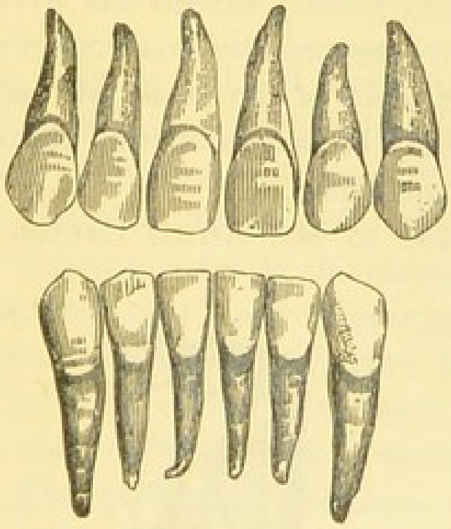


FIG. 44.—A front view, life-size, of an extremely small set of permanent front teeth from the upper and lower jaws.

will not enable us to recognise the cause which has produced the defect.

It is, however, of great practical importance that we should be fully aware that Nature sometimes fails to produce those permanent teeth which have been preceded by temporary teeth, and that in such cases the latter will, if allowed to remain, serve the purposes of mastication and articulation up to the middle period of life, and in some instances even later.

Abnormality in the Forms of the Permanent Teeth.

It is not proposed at this place to enter into a minute description of those slight deviations from what may be regarded as the typical form of any member of the dental series, but a little space may be occupied in considering some of the more strongly marked cases of departure from the usual characters.

Teeth, though individually well shaped, may be so much above or below the ordinary size, that they become disfiguring to the possessor. The two accompanying illustrations (Figs. 43 and 44) are taken life-size from two sets of teeth, the one composed of teeth individually the largest, the other the smallest, we have ever seen.

In these examples, the peculiarity has been common to all the members of the respective sets of teeth ; but we shall sometimes find in the same mouth teeth excessively large associated with teeth excessively small. For example, the central incisors may greatly exceed the average size, while the lateral teeth are represented by small cones only. Then, again, the corresponding teeth of the same jaw may differ in size and form. The one may be large and well formed, the other small and imperfectly developed.

We are indebted to Mr. Alfred Canton for the very large

Fig. 45.—Shows, natural size, an unusually large wisdom-tooth from the lower jaw.

wisdom-tooth which forms the subject of the above figure, and illustrates the point just mentioned. The tooth is double the usual size, and is the only member of the series which exhibits any peculiarity, either as to dimensions or form.

Irregularity in form is, however, sometimes connected with diminution of size; one tooth may be unusually small and ill shaped, while the other members of the set are well developed. A case came under treatment a few years since, in which one of the upper central teeth was irregular in shape, and about one-fourth of the size of the corresponding tooth (Fig. 46).

Fig. 46.—Deformed and stunted central incisor of the upper jaw.

Fig. 47.—Bicuspid of the upper jaw, with the root imperfectly developed.

From some cause, the diminutive incisor occasioned a good deal of irritation in the gum; this, with the unsightly character of the tooth itself, led to its being extracted. The teeth adjoining the vacated space were, by means of ligatures, gradually brought towards each other, and eventually so far reduced the interval, that the absence of the faulty central was not missed.

The irregularity as regards size will sometimes be limited to the root of a tooth. In the example from which the preceding illustration was taken, the crown has attained the usual size; the enamel, however, exhibits indications of defective formation, and the root is most imperfectly developed (Fig. 47). It can scarcely be supposed that any constitutional condition would cause the production of one defective tooth, and leave uninfluenced other teeth developing at the same time. A strictly local cause may be looked for with much greater chance of success. The prolonged existence of gum-boil in connection with a temporary tooth may produce the result, or the encroachment of a neighbouring tooth upon the formative pulp may lead to the formation of a dwarfed and misshapen tooth.

Slight deviations from the usual forms of the crowns of the permanent teeth need not be described, but it is necessary to mention the accessory cusps which sometimes project from the necks of otherwise normal teeth. Practitioners have been known to seize upon such a cusp, believing it, we presume, to be a supernumerary tooth, and drag out, not only the cusp, but the tooth of which it forms a part.

The case from which the following illustration (Fig. 48) is taken occurred in the writer's practice. A large nodule or cusp projected from the neck of the tooth. It was perfectly covered

FIG. 48.—A permanent tooth, with a large nodule of enamel attached to the neck below the point covered by the edge of the gum.

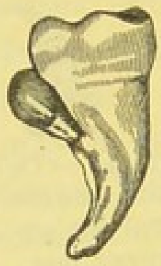


FIG. 49.—A lower molar, with a small tooth projecting from its side.

by the gum, so that its presence could not be suspected, until, in passing the forceps up towards the neck of the tooth, some unusual obstruction was felt.

Supplemental cusps only have been spoken of, but we sometimes see a tolerably perfect little tooth growing out, as it were, from the side of another tooth. In Fig. 49 a small tooth is shown connected with the distal side of the second or third lower molar below the termination of the enamel.

In the museum of the Odontological Society is a molar from the lateral surface of the crown of which a minute but well-formed supplemental tooth projects at a right angle.

A very common deviation from the normal type is to be seen in the upper molar teeth, in which the cusp which lies behind the oblique ridge is stunted or even absent, so that the tooth becomes practically tricuspid instead of quadricuspid. This occurs especially in the second upper molars, and is more common in the higher races of mankind than in the lower (Topinard, "L'Anthropologie," 1892).

It does not, however, appear to be correlated with any abnormality of the roots.

It is not very unusual to find little spherical nodules of enamel attached to a tooth, generally a molar, near to the terminal edge of the enamel. These little "pearls" of enamel are most commonly found opposite to the commencing bifurcation of two of the roots, and are rarely far removed from the normal edge of the enamel.

This was well seen in the specimens exhibited at the British Dental Association Meeting at Manchester in 1892, in which in no instance was the nodule far from the neck; in the only example in which it was lower down than the neck it was situated at an unusually low bifurcation of the roots.

A few specimens suggested the fusion of a supernumerary tooth with the normal tooth, as there were hints of roots as well as of enamel-coated tips.

Deviations in the form of the roots are important to the dental surgeon, inasmuch as they are frequent, and present difficulties, sometimes insuperable, in the filling of the root canals in a satisfactory manner.

There seems to be a general correspondence between an excess of cusps and an excess of roots, though it cannot quite be said that each added cusp is associated with an added root.

The **incisors** may have their roots crooked or bent, or even twisted in a spiral form; in some examples they are bifid. In one case, a lateral incisor of the upper jaw had a cusp rising up from the base of the crown on its lingual surface, this accessory cusp being supported by a small supplemental root.

In the upper **canine** teeth, two or three specimens only have fallen under our notice which have exhibited a tendency to a division of the one large and strong root into two, an actual division being confined to the immediate vicinity of the apex. In the lower canine teeth bifid roots are more common.

The **bicuspid** teeth, unlike the front teeth, are very liable to irregularity in the arrangement of the roots. Normally they have but one root, which is laterally compressed in upper teeth, while in the lower teeth also it is to some extent compressed laterally, though in a much less degree. Very commonly, however, we shall find that the flattened single root of the first upper bicuspid is replaced by two, and sometimes even by three, well-formed roots, holding the same relative position as the roots of the upper molar teeth.

Indications of this division into three roots in the upper, and into two in the lower bicuspids, may often be seen, even where they are not actually separated; and the teeth on the opposite sides of the mouth usually preserve an exact symmetry in this respect.

The differentiation between molar and premolar (bicuspid) teeth, which in some animals—as, for instance, in the horse—

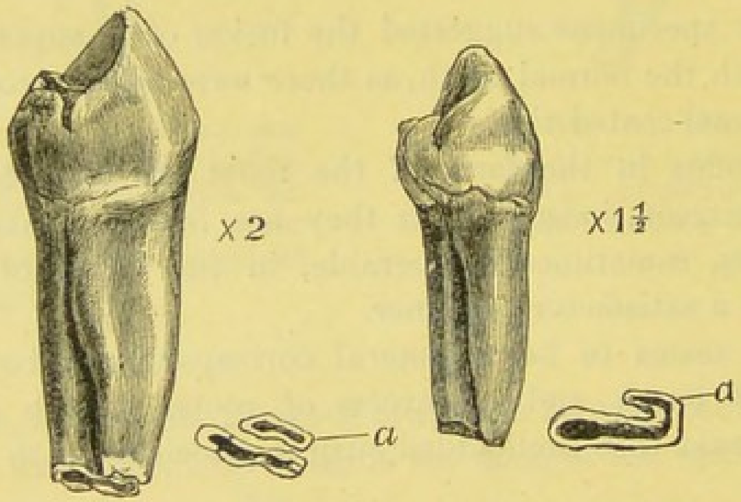


FIG. 50.—Two human lower premolars, the roots of which show two stages towards complete division.

can hardly be said to exist, is not carried to the fullest extent in man; and it is interesting to note that in the anthropomorphous apes the bicuspids have three roots in the upper and two in the lower jaw as a normal condition.

Whether or not we are disposed to accept such facts as the occurrence of three-rooted bicuspids as indications of reversion to an ancestral type, there can be no doubt that the explanation of the occurrence of this abnormality in the roots of the bicuspids is to be found by a reference to the teachings of comparative anatomy.

The bicuspids of the lower jaw, although their roots may be bent, but seldom terminate by two roots.

When a lower bicuspid tends to have two roots, they are peculiarly formed, the flattened apex being bent round so as to form an approach to a second (anterior) root, and this may go on to complete division. The meaning of this has been discussed elsewhere ("Dental Anat.," p. 555, whence the accompanying figure is borrowed); it is manifest that any attempt at root filling would here be futile.

Among the **molar** teeth, the first permanent molars will be found to be the most constant, and the third the least constant, in the number, shape, and position of their roots. Three may be regarded as the typical number of the roots of the upper molar, and two as that of the lower molar teeth. Now, although

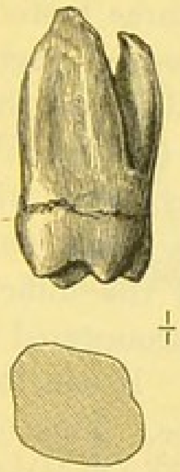


Fig. 51.—An oblique-rooted upper molar.

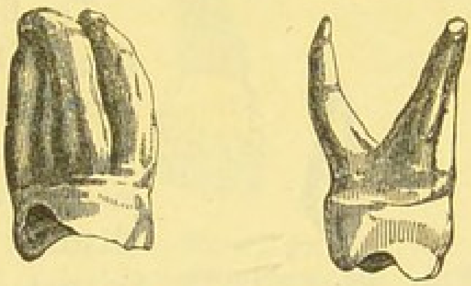


Fig. 52.—Shows two first permanent molars of the upper jaw. In the tooth to the right the two labial roots are united and reduced to one, and in the left-hand figure the posterior labial and the palatal roots are united so as to form one broad and flattened root.

we find occasional exceptions to these rules in the first permanent molars, they are very unusual. In the three teeth from the upper jaw which are figured, the three roots are, by the confluence of two, reduced to two in number; and we have seen one or two cases in which the two roots of a first permanent lower molar were united so as to form one conical mass.

On the other hand, we may have irregularity from an increased in the place of a diminished number of roots. The lower molar may have three or even four roots, and the corresponding upper teeth four in the place of three roots. But, as was before stated, these departures from the normal number and arrangement of the roots are very uncommon in the first permanent molars.

In the second permanent molar, however, they are by no means rare, and in the wisdom-teeth the typical form is very seldom produced.

A form of abnormality of the roots of upper molars has been pointed out by Mr. Booth Pearsall (Brit. Dent. Assn. Transactions, 1890), to which he has given the name of "oblique-rooted" molar. In these, in place of the two buccal roots standing side by side so as to give on section a squarish outline to the neck of the tooth, where it is grasped by forceps, one buccal root has slid inwards, and may be more or less fused with the palatine root, so that ordinary forceps get but a poor grip of the neck.

FIG. 53. — Shows, life-size, a wisdom-tooth from the upper jaw.

The first two of the three teeth figured (Fig. 51) on the preceding page fairly represents this abnormality, which occurs also in temporary upper molars. Unfortunately this is not correlated with any distinct anomaly of the crown, so that it is not suspected until the difficulty in grasping it has been encountered and the tooth perhaps broken. It can, however, be detected with a probe. This obliquity may occur in upper molars which have only two separate roots, or even in those in which all three are fused together.

No rule can be laid down for the form and number of the roots of the dentes sapientiæ, so variable and inconstant are the forms assumed by these teeth. In one case the tooth is terminated by a single conical root; in another, the one is replaced by five, or even six, small roots. The preceding figure is taken from a wisdom-tooth of the upper jaw, the single sharply-pointed root of which occasioned pain whenever the crown was pressed upon. This, which is natural size, may be compared with the figure of a wisdom-tooth given in a previous page (p. 78), in illustration of the limits between which the third molar may range.

The accompanying figure (Fig. 54), which is borrowed by the permission of the Council of the Odontological Society, represents a tooth, the root of which is expanded out at its apex into a cup-shaped disc, on the margins of which are several foramina by which the nerves and vessels gained access to the pulp. The tooth is more fully described in the transactions of the society.[1]

There appears to be good foundation for the statement that the upper wisdom-teeth in the lowest savage races have their three roots distinct,[2] although, on looking over a large number of skulls in various museums, we have found exceptions to this rule.

The great variability in the size and shape of the wisdom-tooth in civilised races, its occasional absence, and the irregularity of the period at which it is erupted, may, when con-

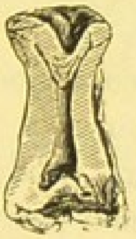


FIG. 54.

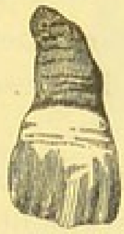


FIG. 55.—Showing a central incisor of the upper jaw, the root of which is deficient in size.

trasted with its large size and regular form in the lowest savage races, be taken as an indication that the wisdom-tooth is slowly disappearing, and that there is a strong probability that in future generations it will be normally absent. Moreover, comparative anatomy lends a certain support to this conjecture, inasmuch as in some anthropomorphous apes, where it is a proportionately larger tooth, it is erupted at an earlier period, coming into place before the canine tooth. On this matter Professor Huxley[3] says: "In the Gibbons, the permanent canine emerges contemporaneously with, or before, the last molar; but in the other anthropomorpha the last permanent canine is cut, ordinarily, only after the appearance of the last molar."

[1] Transactions of the Odontological Society, new series, vol. iii., p. 200, 1871.

[2] Owen. Anatomy of Vertebrates, vol. iii., p. 320.

[3] Huxley. Anatomy of Vertebrate Animals, p. 486.

In connection with irregularities in the number and form of the roots of the teeth, unusual deviations in the length may be mentioned. The corresponding teeth will vary slightly in almost every instance where a comparison can be made; but in a few cases the departure from the normal length will be greatly in excess of what may be regarded as the average standard. Mr. J. Parkinson gave the writer a pair of canine teeth which had attained the length of one inch and three-eighths, the roots alone measuring one inch. Excessive length in the root of a tooth cannot be productive of injury to the tooth itself; but the opposite condition, excessive shortness in the root, is often connected with the early loss of the tooth. Instances are sometimes found in which, although the crown of a tooth has acquired the usual size, the root is extremely short and weak; consequently the implantation is deficient in that strength and firmness necessary to insure the durability of the organ.

By the term **dilaceration** is meant a condition resulting from a displacement of the calcified portion of a tooth from the tissues which were instrumental in its production, the development being continued after the normal position of the calcified part had been changed. Supposing, for example, the crown of an incisor when partly formed to be moved from its position upon the pulp, and turned outwards or inwards, or to either side, and there to remain in a state of rest, the development of the tooth may then be continued with this displacement of one-half of the crown permanently preserved.

In some cases the amount of distortion will be slight, in others so great and so disfiguring that the tooth is necessarily sacrificed. We have seen specimens in which the crown of an incisor has been placed at a right angle with the root.

A good example of dilaceration as a result of injury occurred in the practice of Mr. Tucke, of Truro. The temporary central had been knocked out at the age of two and a half years; the dilacerated successor was cut at the age of eleven and a half years; nearly half the crown had been calcified prior to the injury, and this is of course perfect, even as to the enamel formation; in the displaced portion the enamel was very imperfect in front, but tolerably perfect at the back.

The instances of dilaceration which have fallen within our own notice have been limited to incisor, canine, and bicuspid teeth. There is no reason why the molar teeth should not be subject to the deformity equally with the front teeth, excepting that in the case of the former the situation in the mouth renders them less liable to accidental disturbance.

In the majority of dilacerated incisors the bend takes place at or near the neck; the bayonet shape caused by a second bend bringing the crown back into the general direction of the root is rare in incisors but common in bicuspids.

To the naked eye the displacement of the crown is sufficiently

FIG. 56.—Shows three instances of dilaceration. The figure to the left is taken from an upper bicuspid, the crown of which had been moved on the pulp. The centre figure is that of a central incisor removed from a boy in consequence of the cutting edge of the tooth being directed towards the tongue. The boy had received a blow upon the mouth. The right-hand figure shows the appearance presented by a section of an incisor similarly deformed to the preceding example, although its development has yet to be completed.

apparent, but the coincident derangement of the tissues can be seen only by the aid of the microscope. If, however, we take a thin section from a tooth the crown of which has been moved on its pulp during the period of calcification, we shall find the dentinal tubes greatly bent or disturbed in their course at the point of injury. The relations of the enamel, the dentine, and of the cementum, are also interfered with at a corresponding point.

There is another deviation from the normal condition which, as it affects the forms of individual teeth, must be included under the present heading—viz., the union or **gemination of contiguous teeth.**

When two teeth are permanently united, the union must have been effected through the medium of their respective pulps prior to the calcification of the teeth themselves (true gemination); or the connection must have resulted from diseased action involving teeth placed in close apposition (false gemination). Cases of this latter class, being the result of exostosis, will be considered in connection with that disease. In the specimen which forms the subject of the following figure, the pulps of the central incisors must not only have come in contact, but have been pressed upon each other with sufficient force to cause the left to have become to a slight extent imbedded in the right tooth-pulp. The development of the united crowns having been perfected, each tooth had its root separately produced.

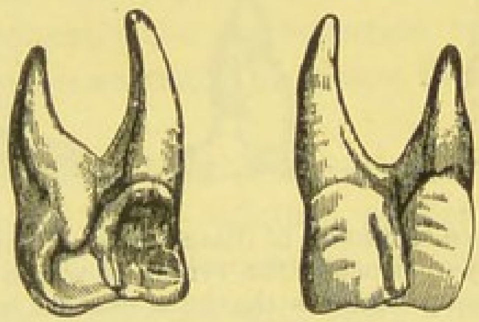


FIG. 57.—Shows a view of the lingual and of the labial surfaces of two permanent central incisors of the upper jaw, the crowns of which are united.

In a very interesting specimen, for the use of which we are indebted to Mr. Styers, of Nottingham, the central and lateral incisors were united throughout their whole length. The line of confluence, though sufficiently marked for recognition, was not deeply cut, consequently the four teeth at a short distance looked like two extremely large but symmetrical central incisors.

Union of the lateral incisor and canine is now and then met with. The following figure (Fig. 59) is taken from a specimen in which both the crowns and roots of the lateral incisor and canine are united. The appearance produced by this large tooth was objected to on the part of the parents, who induced a dentist to make an artificial division by means of a file. The operation resulted in opening the pulp-cavity, and consequently in the death of the united teeth. Extensive alveolar abscess followed, for the relief of which Sir John Tomes removed the teeth nine days after the operation of filing. In this example, although the union was perfect, and effected by the dentine of each tooth being, at the point of junction, common to the two, yet the position and size of each tooth was defined by a depression running the whole length of the teeth; and, corresponding to the depressed line on the surface, there existed a contraction in the common pulp-cavity. In examining connate teeth, it will sometimes be found that a supernumerary has become united to a normal member of the dental series. Two cases have fallen within the writer's observation, in each of which

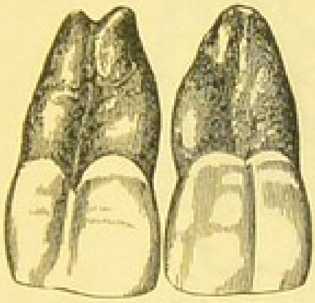


FIG. 58.—Shows the permanent central and lateral incisors of the upper jaw, united throughout the whole length of the teeth. From a specimen lent to the author by Mr. Styers.

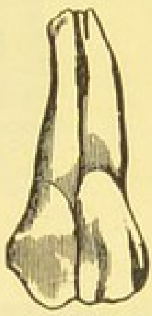


FIG. 59.—The permanent lateral incisor and canine from the right side of the upper jaw, united.

a lateral incisor was united to an equally well-developed supplemental lateral. In one example, the teeth had been removed from the upper, in the other the teeth remained in the lower jaw of a patient. In a third case, each central incisor of the upper jaw had joined to its median side a supernumerary tooth, equal to about one-half of its own breadth, thus producing by the union two front teeth individually one-third larger than the normal size.

Union between a canine and a bicuspid, or between the two bicuspids, or between a bicuspid and first molar, excepting as the result of diseased action set up long after the development of the teeth has been completed, is of very rare occurrence.

The molar teeth are not, however, equally exempt from a sort of gemination. Many specimens have been preserved showing permanent union between the second and third molars. In the example figured, the third molar passes obliquely between the palatine and posterior labial roots of the second molar, and is united to each of them.

In another specimen, the second and third upper molars are united at several points, without the ordinary position in the jaw of either tooth being materially altered. The masticating surface of the wisdom-tooth is upon a higher level than that of the second molar; but the difference is not greater than is

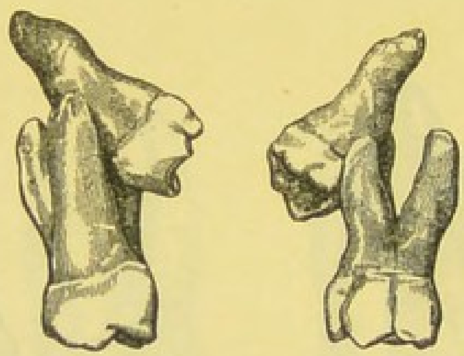


Fig. 60.—Shows the second and third molars united. The right figure represents the two teeth from the labial aspect; the left, from the lingual or palatal aspect.

often seen to exist between the corresponding teeth in the mouths of patients.

In examining a series of connate permanent teeth, it will be found that where the crowns are involved, the union is effected by a continuity both of the dentine and of the enamel, the connecting portions of the tissues being common to the two teeth, and by dentine and cementum, or by cementum only, where the union is limited to the roots.

In the one case, both the dentinal and enamel pulps were united, and thus produced a geminated tooth; in the other case, the union must have been effected after the crowns of the teeth were developed, and at the time the roots were forming. In cases of union occurring under the latter circumstances, the medium of connection may be limited to the cementum, much in the same manner as we see the contiguous roots of the same tooth bound together by the interposition of cementum. Those examples in which, by the large development of cementum consequent upon disease, two contiguous teeth become united, must not be classed with such as may be regarded as cases of congenital union. The cementum may be the uniting medium in either case; but in the one the cementum will not exceed the normal amount, in the other it will exist in excess, and constitute a disease.

Perhaps we shall not find a more fitting place for considering those deviations from the normal forms of the teeth which

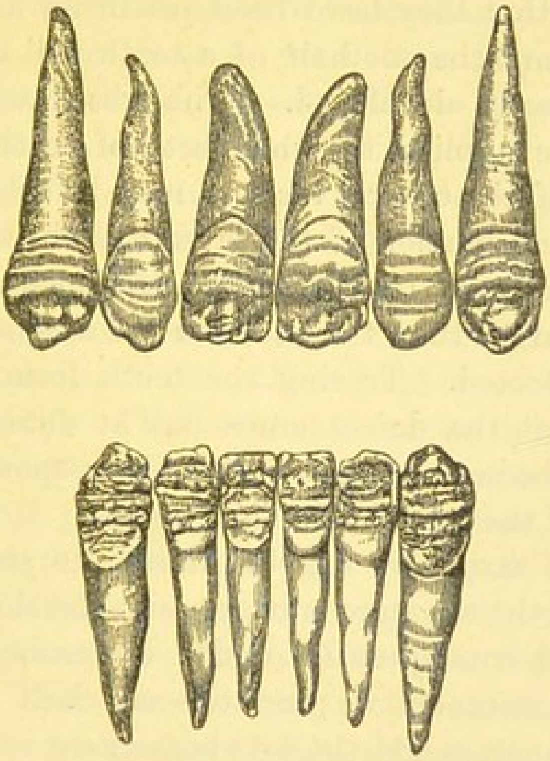


FIG. 61.—Showing the front teeth, grooved from the alternation of perfectly and imperfectly developed portions of enamel.

are consequent upon **interrupted development** of the dental tissues. The crowns of the affected teeth, instead of presenting the beautiful smooth and glossy surface characteristic of finely-developed enamel, are disfigured by the presence of an irregularly grooved or pitted surface, and are often considerably diminished in size. The incisors are commonly very thin and compressed, while the canines and the cusps of the molars are terminated by sharp points. By the aid of the microscope we may learn that the tissues are not only deficient in quantity, but that they are defective also in quality. Neither the enamel nor dentine is perfectly developed; the elements of the former are imperfectly combined, hence the tissue is porous, yellow, opaque, and very fragile, and in the latter the dentinal tubes are wanting in that uniformity of size and arrangement which they exhibit in well-developed teeth.

The condition of system which operates so unfavourably upon the developing teeth frequently passes off before they are perfected; consequently those parts of the teeth which are formed after the health has improved assume the normal appearances. It is very common to find teeth which show most distinctly that they have been produced under two conditions of system; the one half of a tooth will be imperfectly, the other perfectly developed. The observation may with equal justice be applied to whole sets of teeth. The whole of the crowns of the central incisors may be altogether imperfect, while a small portion of the lateral teeth near their necks will be well formed. In the canine, the good portion of the crown will be larger than the bad, and the second molar will be altogether unaffected. Tracing the teeth from front to back, we may see that the defect crops out at definite points, and that there will be in this respect a strict correspondence between the two sides of the mouth (cf. Fig. 31).

The defect of structure will be limited to such portions of the several teeth as were undergoing development at the same time, and consequently under the same constitutional state. If, for instance, we find the one half of the crowns of the central incisors and the first permanent molars imperfect, one-third of the lateral teeth will be in a corresponding condition, while the defect will not extend over more than a fourth of the crowns of the canines. Again, if the extent of the defect be limited to the cutting edges of the central incisors, the lateral incisors may be free from imperfections.

As yet, those cases only have been described in which the dental tissue exhibits over a certain portion of a tooth obvious signs of a defective organisation. But we sometimes find teeth which are marked by grooves and ridges, very regularly disposed. The grooves are the result of imperfect, and the ridges of perfect development of the enamel and subjacent dentine. It has been pointed out by Dr. Grevers (Odont. Trans. 1895), that the defect which is visible on the surface as a groove or pit is continued through the whole thickness of the enamel; it passes obliquely downwards towards the neck of the tooth—in fact follows the course of the "incremental lines," which represent what was, at the time when the defect occurred, the outer surface of the enamel. These transverse markings, resulting from alternations in the developmental process, find an exact parallel in the striæ produced by similar causes on the nails. Owing to the more rapid and persistent growth of the latter, it is often possible to see the mark left by a severe illness in the form of a transverse groove across the nail, this being the result of a temporary cessation of its development. Although it is not in all cases easy to trace this ridged, or pitted, or honeycombed condition of the teeth to the presence of serious indisposition of the patient during the period when the defective portions of the teeth were being developed, yet it can scarcely be doubted that the imperfect organisation of the teeth, if not the result of some acute disease, such as measles, influencing the system generally, was consequent upon some constitutional condition (see also Chapter on Defects in the Structure of Teeth). The fact that if one tooth is affected, those parts of other teeth which correspond in respect to the period of formation will present a similar condition, precludes the supposition that the effect has been produced by any merely local cause. The evidence points to a general cause, but it will not uncommonly be very difficult to discover the precise nature of that cause. The parents may tell you that your young patient has been particularly healthy from the time of birth, having at no time suffered from more than a very trifling and short-lived indisposition. On inquiry, you find that the temporary teeth were well developed, lasting their time, and then dropped out. The writer has a preparation in which the jaws are particularly well grown, and the temporary teeth unusually fine; yet, on removing the bone to show the permanent teeth, it was found that the latter were honeycombed to a great extent. The term hypoplastic has sometimes been applied to teeth showing defects of this nature.

The converse of this is often seen. The temporary teeth may be lost from caries at an early period, and still the permanent teeth may to all appearance be well shaped and free from structural defects. There is ample evidence to show that the condition of the temporary set cannot be taken as a positive indication of the nature of the succeeding permanent teeth ; neither will the evidence furnished by the parent in all cases enable us to account for the presence of the peculiar form of defect in the teeth to which attention has been directed.

When the enamel is thoroughly craggy and **honeycombed,** Mr. Jonathan Hutchinson terms them "mercurial" teeth, in the belief that this malformation is almost always due to the free administration of mercurial medicines in infancy, and his views on this matter are endorsed by so careful an observer as the late Mr. Moon.

One of the writer's own patients, who had teeth thus deformed, in answer to an inquiry as to the health he had enjoyed during childhood, replied, that he had slept with his head on ice, and been fed upon calomel all his early life. This answer, elicited without any sort of leading question having been asked, was at least striking; and, on the other hand, it is matter of the greatest difficulty to be sure that a child has not had mercury given to it, for even without its ever having had convulsions, it is exceedingly likely that some nurse has, at some time, made use of teething-powders to ensure her own repose, and of the teething-powders in the market the majority contain mercury.

Mr. Hutchinson's attention was first called to this matter by noticing the frequency with which children who had suffered from convulsions had these teeth, and at first he associated them directly with the convulsions; but after going more carefully into the matter, he came to the conclusion that it was the treatment directed to the cure of the malady, rather than the malady itself, that was to blame. The causation of this deformity of the teeth by mercury can hardly yet be considered as a thoroughly established and accepted fact, but it has, at least, a high degree of probability.

Syphilitic Teeth.—It is believed that the effects of hereditary syphilis may often be traced as the cause of a peculiar dwarfed condition of certain teeth. Attention has been drawn to this point by Mr. Jonathan Hutchinson,[1] who has pointed

[1] Transactions of the Pathological Society, vol. ix., p. 449, and vol. x., p. 287, and Transactions of the Odontological Society, vol. ii., p. 95, 1857, and Mr. Moon's Trans. Odont. Society, vol. ix., 1877.

out that, inasmuch as specific inflammations do not occur during the period of intra-uterine life, the teeth belonging to the deciduous series are not liable to be affected, though they may be afterwards lost by exfoliation consequent on stomatitis and periostitis. On the other hand, the occurrence of specific affections of the mouth soon after birth may be readily supposed to affect the permanent teeth which are at this time developing, and certain characters are enumerated as indicative of such interference with the growing teeth.

The incisors and canines are of small size, and peg-shaped; the crown is notched, the notch being in the main a concavity from the one corner to the other, though there may be secondary notches in this general concavity.

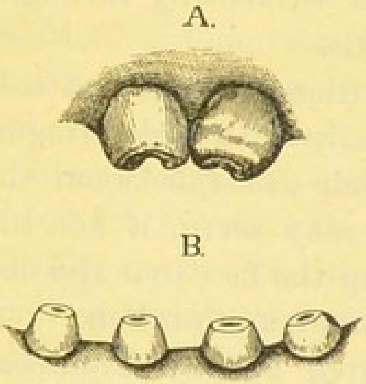


FIG. 62.—"Syphilitic" incisors; copied from Mr. Hutchinson's Paper (*loc. cit.*).

The existence of a "circumferential notch" encircling the canines near their points, is also noted by Mr. Hutchinson, but is by him attributed to a "circumferential wearing" of the one tooth on its opponent. This explanation is inadmissible; the groove running round the crown of the canine near its apex is simply the mark of a temporary arrest of development, and is precisely analogous to the similar groove across a nail which sometimes is seen after a serious illness. It is very possible that the arrest of development may have been brought about by an attack of stomatitis, and a similar circumferential groove would probably be found encircling the incisors at a point lower down on their crowns, seeing that calcification of these teeth is in advance of that of the canines. As, however, the true origin of the groove on the canine was not recognised, the presence or absence of similar marks on the incisors is not mentioned.

Teeth described as "syphilitic" have a dusky, opaque appearance, and are small relatively to the size of the jaws, so that distinct intervals are left between them; moreover, they are of a very soft character, so that they speedily become worn down, and the characteristic transverse notch obliterated.

It must, however, be borne in mind that even though the association of teeth of this form with inherited syphilis is fully established, it by no means necessarily follows that they are the direct result of attacks of stomatitis. The influence of inherited syphilis is capable of profoundly modifying the nutrition of many parts of the body, and it is quite as likely that its effects would be brought about directly, as that they should be manifested secondarily through the intervention of an attack of stomatitis.

Moreover, constitutional syphilis attacks the hair, the nails, and the skin generally with great frequency, and the homological relation which exists between the teeth and various dermal appendages may serve, if not to explain, at least to render less surprising the fact that the developing teeth should be a chosen site for its manifestation.

It has been pointed out by Trousseau[1] that the various syphilitic affections of the mouth in a child are rarely seen before the second week, and seldom manifested after the eighth month (unless they have previously made their appearance).

It becomes, then, a matter of importance, in deciding upon the correctness of Mr. Hutchinson's views, which have been unreservedly accepted in a paper by Mr. Berkeley Hill,[2] to ascertain with precision the extent to which calcification has proceeded in the affected teeth at this period of the child's development. Unfortunately, the jaws to be found in museums have almost invariably been macerated, and the minute calcifying tips of the permanent teeth lost, so that it is not easy to acquire definite knowledge on the subject; moreover, the statements of various authors differ in the times assigned to the commencement of calcification in the permanent teeth.

1 Trousseau. Clinical Lectures (New Sydenham Society's translation). "On Infantile Syphilis."

2 Monthly Review of Dental Science. June, 1872.

According to Magitot[1] the follicles of the permanent incisors and canines first appear three months before birth, and calcification first commences on the papillæ of the central incisors in the first month after birth, though calcification on the first permanent molars had commenced as early as the twenty-fifth week.

One point, however, appears to have been overlooked by Mr. Hutchinson, namely, that the calcification of the temporary teeth is not so far advanced at the time of birth but that we might expect them to be influenced by the occurrence of disturbing causes during the first month or two after birth. On reference to page 3, it will be seen that only the tips of the temporary canines are calcified, so that any interference with its development might probably be marked by a groove around it below the tip.

At the International Medical Congress the existence of any type of tooth modified by hereditary syphilis was strongly denied by Dr. Magitot, Dr. Quinet, and others, but many of their arguments were directed against, not the true syphilitic tooth, but a honeycombed tooth (which they called an "eroded tooth"), and so missed their mark. Nothing was there brought forward by the opponents of Mr. Hutchinson which could weigh against the evidence brought forward by that gentleman, by Professor Parrot and Mr. Moon; and it may be stated in general terms that ophthalmic surgeons, who have many excellent opportunities for judging, are mostly agreed in accepting the existence of this type of tooth as evidence of inherited syphilis, and our own limited experience is wholly in the same direction. It would take very numerous positive and accurate records of cases to prove the contrary; on the one side we have notes of cases, carefully compiled family histories, &c., and on the other mere vague expressions of disbelief.

Rickets might *à priori* be expected to produce characteristic effects upon the teeth, but it does not do so with any certainty, nor is there any class of tooth that can be definitely associated with this disease.

But delay in the eruption of the teeth is a very constant symptom in rickets, and one very valuable for diagnostic purposes. In this connection may be noticed the belief strongly held

[1] Magitot. "Comptes Rendus," 1874.

by Sir James Crichton Browne that premature eruption of the teeth goes hand in hand with a neurotic condition and general feeble physical development. There are not many statistics available regarding the variation in the dates of the eruption of deciduous teeth, but Dietlein (Anat. Anzeig., 1895) gives the dates of the eruption of permanent teeth from 7,500 individuals (compare tables on p. 47).

The averages come out as below :—

	Upper.	Lower.
Central incisor .	7 yrs. 10 mths.	7 yrs. 4 mths.
Lateral incisors .	8 ,, 9 ,,	8 ,, 3 ,,
Canines	11 ,, 9 ,,	10 ,, 9 ,,
First premolar . .	10 ,, 2 ,,	10 ,, 10 ,,
Second premolar .	11 ,, 3 ,,	12 ,, 4 ,,
First molar . . .	7 ,, 5 ,,	7 ,,
Second molar . .	12 ,, 10 ,,	12 ,, 4 ,,
Third molar. . .	24 ,,	24 ,,

According to this observer the teeth of high-class school children are erupted earlier than those of lower grades. Amongst German town-folk, generally dolichocephalic and with high, narrow dental arches, the upper laterals are deficient in a number of cases (nearly three per cent.), whilst amongst country-folk, generally brachycephalic with broad, flat arches, they are rarely absent.

He says also that girls, who at that age are ahead of boys in growth, get their canines about nine months sooner than boys.

Irregularity in the period of the eruption of teeth is not, as a rule, of great importance. Some degree of variability seems consistent with perfect health, and an otherwise normal arrangement of the teeth; but sometimes teeth will, from accidental malformation, or even from no cause that can be traced, be greatly delayed. The wisdom-teeth are not rarely retained in the alveolar border till advanced age, when the other teeth have all been lost and replaced by artificial teeth; and the canines, perhaps because they are developed farther beneath the surface than the other teeth, seem to be, next to the wisdom-teeth, most often retarded in their eruption.

Perhaps no more fitting place will be found in which to notice the alleged occurrence of a third dentition. From time to time notices appear of portions of a third set of teeth being erupted, but none with which we have met carry any conviction with them ; they have usually been reported by those who have not been sufficiently familiar with the irregularities of the eruption of teeth to eliminate the consideration of teeth which may have been merely retarded. Still, recent developments in the study of the origin of teeth from the dental lamina seems to render it more possible than it was formerly held to be.

The molar teeth will vary in different individuals as to the time of their eruption, but the amount of variation is seldom sufficient in extent fairly to come under the head of premature eruption. But in those teeth which succeed to members of the deciduous set, a considerable amount of anticipation of the normal period may sometimes be observed, when the preceding occupant of the space has been prematurely lost. The condition of health may hasten or retard the process, and it is probable that hereditary predisposition may also exert an influence in determining the time at which the deciduous teeth fall out, and make room for their successors. In the vast majority of cases, however, the premature loss of temporary teeth depends upon the occurrence of caries, and the consequent extraction of the diseased organs. Many children suffer so much pain from decayed temporary molars, that the general health becomes disturbed, and their removal is consequently necessitated. Now, it is in these cases that the succeeding teeth sometimes appear prematurely, and consequently out of the usual order. A certain number of examples have fallen under our notice, in which one or more of the bicuspid teeth have appeared as early as the lateral incisors ; and although in one or two instances the teeth have been imperfectly developed, in other cases all indications of faulty organisation have been absent. In a little patient of the writer's, the whole of the deciduous teeth decayed nearly down to the level of the gum, and produced such serious suffering that the child fell into bad health. At the age of three years and a half the decayed teeth were all removed (excepting the second temporary molars), under the influence of chloroform. The operation was succeeded by a restoration to health, and the permanent teeth are now appearing in the usual order, both as respects the time and the place of their eruption. Now, in this case the premature loss of the first has not been followed by the premature eruption of the second set of teeth. In a less healthy subject the result might have been different; or had the teeth been allowed to remain in this case, and, as stumps, had kept up irritation in the gums, it is more than possible that some of the permanent teeth would have been injured, and have appeared prematurely through an inflamed gum.

From a practical point of view, the accelerated is less interesting than the retarded eruption of teeth. The premature appearance of a tooth cannot be prevented, and when in sight, the mischief it may occasion can be ascertained; but when the eruption of a tooth is delayed, there is considerable difficulty in ascertaining either its relative position or individual peculiarities, or whether its presence is likely to be a cause in the production and maintenance of neuralgic pains. In cases such as these a skiagram is often an extremely valuable aid to diagnosis.

It is by no means uncommon to find that certain members of the permanent series do not appear at the usual time, and even after the lapse of some few years are still absent from their usual position; and it is not, perhaps, until long after their presence has been called in question that they penetrate the gum. In one case the right central incisor of the upper jaw appeared at the age of thirteen, that is six years after the fellow-tooth. In a second case, an upper canine pierced the gum at the age of two-and-thirty; and in a third, a similar tooth cut the gum after the patient had passed the age of forty. Again, many cases have occurred in which teeth have been cut at a very advanced age. The recognition of this wide range in respect to the time of the occurrence of a process which is coincident with a known epoch of general growth of the body suggests an inquiry into the condition of the teeth themselves at the period of eruption, and also into the nature of the process of eruption in these exceptional cases. In reference to the first point, we have to learn whether, when the eruption of a tooth is retarded, its development is equally delayed, and whether the former is consequent upon the latter condition, or whether the one process may be quite independent of the other. To meet the second question, two processes by which a tooth may come into view must be recognised. In one, the tooth itself presses forward, and makes its way to the surface; in the other, the gums recede and expose the tooth, which, having been stationary, would have remained in concealment but for the recedence of the gums.

In the cases of retarded eruption of special teeth in which we have had an opportunity of examining the teeth themselves, there has been no evidence to show that the development of the dental tissues had been interrupted. The roots may be shorter than usual, and the crowns faulty in respect of form and organisation, but the presence of these defects does not

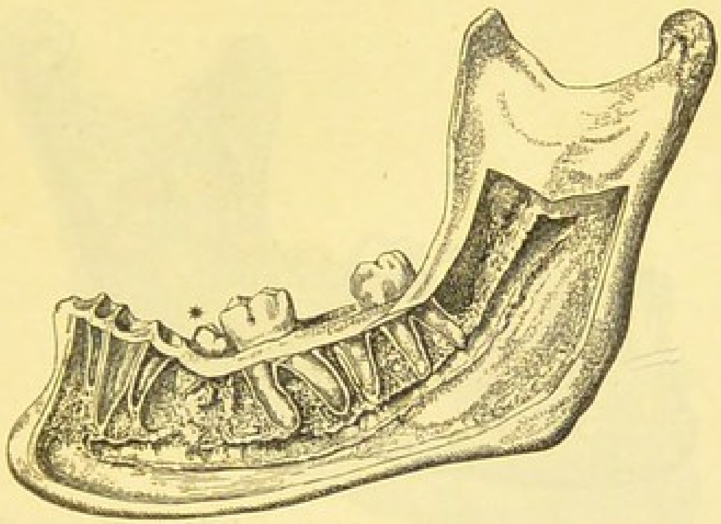


FIG. 63.—Shows the persistence of the second temporary molar retarding the reception of the second bicuspid, which is shown, by the small size of the crypt in which it was contained, to have been stunted and deformed. The temporary tooth is marked by the asterisk. The author is indebted to Sir Edwin Saunders for the use of this specimen.

prove that the production of the tooth was delayed. Indeed, there is a want of decisive evidence in support of the opinion that the actual development of the teeth is delayed much beyond the usual period, although the numerous cases of late eruption would at first sight favour the supposition. The period of eruption does not, therefore, in these exceptional cases, bear any necessary relation to the time at which the development of the teeth was completed. In some examples, the obstructing cause is sufficiently obvious, but in others we fail to see why the tooth did not take its place in the series at the usual time. In the case of a female, the upper canine was absent, a space being left between the first bicuspid and lateral incisor. At the age of forty-five, the missing tooth slowly protruded itself. Now, in this instance the way was not prepared by the loss of a tooth, neither were the gums receding; hence we are at a loss to see why the eruption of the tooth was delayed, or why it appeared at that age rather than at any other. The case is, however, instructive, as respects the process of eruption in retarded teeth. There is no reason for assuming that the development of the tooth was later than of the corresponding tooth which appeared at the usual time; supposing, then, it to be admitted that the tooth was completely developed before the process of cutting commenced, is the

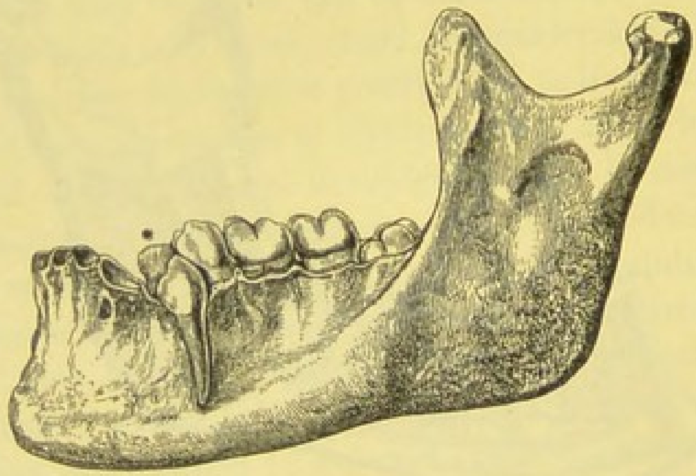


FIG. 64.—Showing the first bicuspid retarded in its eruption by the presence of a temporary tooth. The bicuspid is a perfectly well-developed tooth, but the outer wall of the alveolus is absent. The temporary tooth is marked by the asterisk.

process itself in some respects different from that which occurs when teeth are cut under ordinary circumstances? When the process is normal as respects the time and the stage of development of the tooth, the crown appears through the gum long before the root has attained its full length. The crown is in great part brought towards the surface of the gum during, but not necessarily by, the progressive lengthening of the root. Now, when the eruption is accomplished subsequent to the development of the root, the movement of the tooth must be effected by some other means than by the progressive lengthening of root. The completed tooth has to change its place without itself undergoing any change. The bone which stands in its way must be absorbed, and the lower portion of the socket, from which the root of the tooth moves, must be closed behind it by the deposition of bone.

In many cases, however, the retarded teeth become exposed to view by the absorption of the superjacent gum, the teeth themselves being perfectly stationary. The pressure on the gum caused by artificial teeth will not uncommonly cause its absorption and the exposure of a hidden tooth, and this tooth, once having been laid bare, will often move to a level other than that which it had previously occupied. The manner in which this takes place, and the effect produced, may be seen on

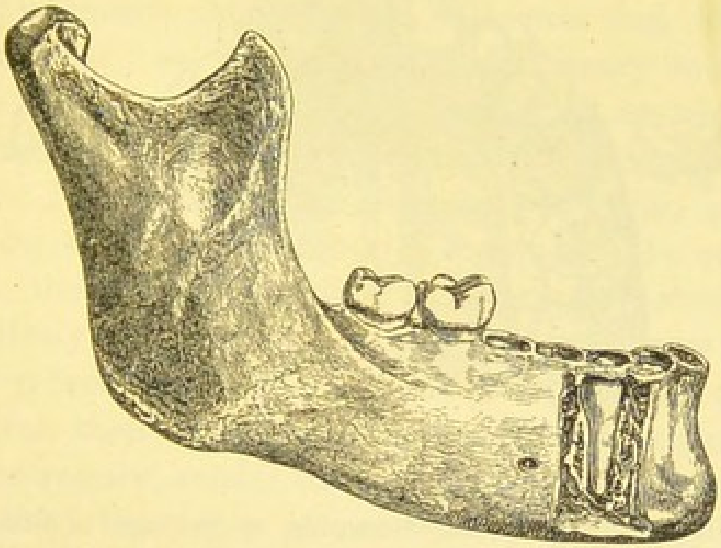


FIG. 65.—An adult lower jaw, with the canine retarded in its eruption. The outer plate of the jaw has been cut away to show the position of the tooth.

referring to the figures illustrating irregularities in the position of the permanent teeth.

This very late eruption of a tooth is by no means rare, three typical cases having been noticed in the author's practice in the same number of years. In the first case a man, aged 75, was suffering considerable inconvenience from the eruption of a left lower wisdom-tooth, a full lower denture having been worn for some years; in the second case the corresponding tooth was erupting at the age of 60, although the molar immediately in front was still standing; in the third case a horizontally placed lower left bicuspid became exposed after a plate had been worn over it several years.

The cause which most commonly retards the cutting of a permanent tooth is strictly a mechanical one. The space which should afford a place for the missing tooth is already occupied either by a persistent deciduous tooth, or by the crowding together of the contiguous permanent teeth. Under these circumstances, the normal occupant of the spot either is held back or takes some extremely irregular position. In the accompanying figure, the second bicuspids of the upper jaw were retarded by the presence of the temporary molars. The deciduous tooth on the one side of the mouth had lost all its

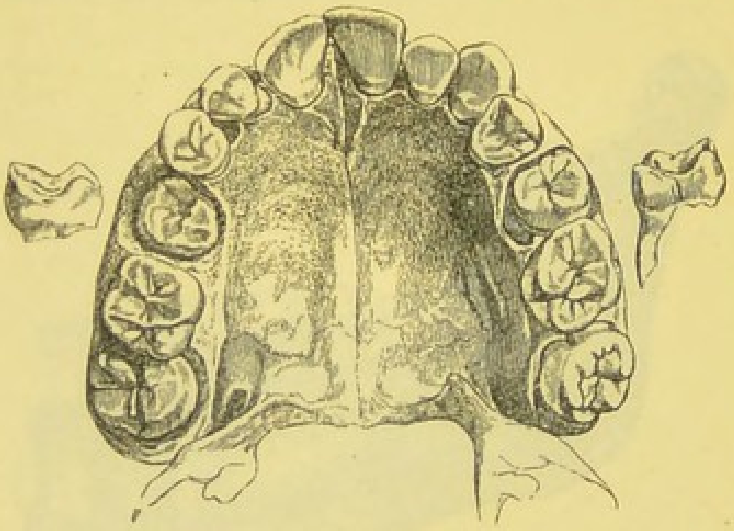


FIG. 66.—Showing the second bicuspids, at the age of fifteeen years, retarded by the presence of the preceding temporary teeth. A very similar condition existed in the lower jaw of a child supposed to have been murdered (the St. Luke's mystery), in whose case an erroneous estimation of age had been based upon its absence.

roots, and there appears no reason why the bicuspid did not take its place at the usual time; but on the other side the temporary molar has retained the greater portion of its palatal root, and was consequently held firmly in place to the exclusion of the bicuspid. Although in this example the usual period for the replacement of the temporary molars has not been exceeded by more than two years, it is not on that account less instructive.

When a temporary tooth does not fall out at the usual time, it becomes a serious question whether we should allow it to remain, whether we should wait until it becomes loose before its removal is attempted, or remove it irrespective of this consideration. It is also desirable that the question should in each case be settled before the period of replacement has been long passed by. Now, in the example which forms the subject of the last figure, the bicuspid on the right side has been slightly, perhaps not injuriously, retarded by the temporary molar, but the latter tooth would have speedily given place to its successor. Not so, however, on the left side of the mouth. The retention of the palatal root on the part of the deciduous tooth would have enabled it to hold possession of the position, to the exclusion of the second bicuspid, producing, perhaps, a similar result to that shown in Fig. 64. But if we resolve upon removing deciduous teeth in all cases when the normal period arrives for their replacement, the practice will now and then lead to disappointment; we may remove a temporary tooth which is destitute of a successor, as shown in Fig. 42, or we may make way for an imperfect tooth, inferior in every respect to its predecessor. These exceptional cases are, however, of such rare occurrence, that, although they should not be entirely disregarded, their influence upon our practice should be but comparatively slight. Then, again, the temporary tooth may not only retard the permanent tooth, but it may also lie at a lower level than the adjoining teeth, and consequently, if allowed to remain, render little or no service in mastication.

Regarding, then, the persistence of temporary teeth as a cause which commonly operates unfavourably, not only by retarding the eruption of permanent teeth, but also by producing irregularities in the dental series, their removal must, as a general rule, be attended with advantage.

The wisdom-tooth is sometimes prevented from assuming its proper position by being situated actually beneath the second molar. Thus, a second upper molar was extracted at the Dental Hospital, between the roots of which was a hemispherical cup of bone with a perfectly smooth surface, which was at first sight imagined to be a portion of the floor of the antrum. On examining the mouth, however, the crown of the wisdom-tooth was found to occupy the space whence the tooth had been extracted, so that the cup of bone proved to be a portion of the bony cell in which it had lain buried.

CAUSES OF IRREGULARITIES OF THE TEETH.

Before proceeding to discuss the varieties and treatment of irregularities of the teeth, it would seem desirable to consider, in a general way, those influences that tend to bring about a deviation from the normal.

Heredity.—Irregularities of individual teeth, not determined by any absolute want of space, are usually of more or less accidental nature, being due to such causes as the undue retention or premature extraction of temporary teeth, &c.

But this is not always the case; an apparently capricious irregularity of a particular tooth or teeth sometimes runs through the majority of a family, and irregularities apparently the most trivial may be, in fact, congenital. Thus in a case recently examined, although there is no crowding in the jaw sufficient to account for it, the right upper central incisor is, to a slight extent, twisted on its axis, and lies a little behind its fellow-tooth. Precisely the same irregularity existed in the father, and will be apparently repeated in another child, in whom the tooth is as yet only partially erupted.

A remarkable example of inherited irregularity has come under the author's own notice. In the father there is a history of several teeth never having been present. Several of them in the molar region, though having more than ample space at their disposal, are very short, half or less than half of the crowns being visible. Some irritation and slight discharge of pus takes place from time to time about these teeth. This state of things is repeated in a daughter and in a son, who appear to be unable to cut their teeth properly; teeth are either absent or just make their appearance, and then fail to grow to their full length, although there is little abnormality about the teeth themselves. Just as in the case of the father, these half buried teeth from time to time give trouble. Irregularity affecting a considerable number of teeth may be said to almost always involve material irregularity of the alveolar portion of the jaws, and usually this takes the form of inadequate width or curvature of the arch. Under this head fall V-shaped arches, saddle-shaped arches, disproportions between the two jaws, &c., and here inheritance comes in very strongly. Just as faces or their individual features show strong family characters, so do the jaws. An instance of this is to be seen in the portraits of Charles V. and his son Phillip II. of Spain, who, with the others of the family whose portraits have come down to us, were evidently underhung and disfigured by the great and prominent "Burgundian" lower jaws.

Although numerous examples present themselves in which parentage cannot be adduced as a cause for V-shaped dental arches, yet in many families this peculiar conformation of the mouth will be found as an hereditary characteristic, traceable back in family portraits for many generations, and shared by the great majority of the members of the families at the present day.

Special interest appertains to the consideration of the probable causes of this deformity, inasmuch as Dr. Langdon Down,[1] after making observations upon a very large number of congenital idiots, found, with hardly an exception, that there was always a diminution of width between the posterior bicuspids, and an inordinate vaulting of the palate; in fact, a typical V-shaped maxilla. Although the typical characters of the V-shaped maxillæ are dependent in some degree on the presence of the permanent teeth, Dr. Langdon Down is of opinion that this malformation may be detected at a much earlier period, and he is so convinced of its constancy that he relies upon its presence as a diagnostic test whether the idiocy of the individual be truly congenital, or be the result of pathological processes occurring at some subsequent period.

Dr. W. W. Ireland[2] confirms these results by an examination of the mouths of eighty-one cases of congenital idiocy, amongst whom he found two cases of cleft palate and thirty-seven of deeply vaulted keel-shaped palates. He noted the peculiarity

[1] Transact. Odont. Soc., vol. iv., 1871.
[2] Journal of Mental Science.

as especially marked at the posterior portions of the palate. But the correctness of these inferences is denied by Dr. Kingsley, who, after adducing the fact that contracted palate may be, and, indeed, often is, associated with a high order of intelligence (which does not tell for much either way), quotes some very important observations made by himself upon upwards of 200 idiots of very various nationalities on Randall Island. He found no case of pronounced V-shaped arch, and very few contracted in the bicuspid region, on the whole very few dental irregularities. An examination of three or four hundred of the inmates of the Paris asylums showed substantially the same result; but on visiting Dr. Langdon Down's asylum he met with a much larger proportion of dental irregularities and of contracted arches. Dr. Kingsley attributes this to the fact that these latter patients are drawn from higher ranks of life, where dental irregularities are more common, and appears to lean to the conclusion that, though in their jaws and in their minds they are degenerate and enfeebled representatives of their families, it is to their family traits rather than to their idiocy that they owe their contracted mouths.

Dr. J. W. White and Dr. Stellwagen, visiting a large Pennsylvania school for feeble-minded children, found large and well-formed jaws to be the rule; and upon the whole Dr. Kingsley concludes that, "taking the idiots as a class and comparing them with the lower order of society as found in this country, there were no more irregularities in the one than in the other."

It has been alleged that *crétins* are apt to have contracted jaws; but this Dr. Pierce, of the Pennsylvania Dental College, denies.

Civilisation.—Mr. Coleman[1] has examined a large number of children with a view to tracing the connection between the general development and that of the jaws, and the conclusions at which he has arrived are so instructive as to call for mention in this place. The antecedents and parentage of the children brought to an hospital must always be a difficult, if not an impossible, subject of inquiry, but not so their appearance, which will afford a fair guide in determining whether they

1 Transactions of the Odontological Society, 1864, p. 233.

are coarse, brutal, and low-bred, or whether they bear the stamp of a higher civilisation, in other words may be spoken of as "well-bred."

Taking children of "well-bred aspect," no less than sixty-nine per cent. were found to have more or less contracted, badly developed jaws; whereas, taking children of decidedly low aspect, only from seven to eight per cent. manifested this condition of the jaws. Amongst children of doubtful aspect, who could not certainly be referred to either of the above classes, twenty-four per cent. had contracted jaws, thus coming in an intermediate position betwixt the first two classes. Talbot concludes that among the degenerate classes in Spain, Italy, Switzerland, and Greece, deformities of the jaws are less numerous than in Americans, Germans, Danes, and Dutch, and still less than in English and Swedes; on the whole he considers that the higher the intellectuality the more numerous the deformities, and again that these deformities are more numerous among the better classes than the poorer (Internat. Dent. Journal, Jan., 1898).

That the comparative disuse of the organs of mastication among civilised races, who cook and thoroughly soften their food before masticating it, should have led to a less powerful development of the jaws, is a thing that might fairly be expected, and were the occurrence of contracted jaws a thing *per se*, it would have comparatively little significance. But it happens that the V-shaped conformation of the jaws is often associated with other deviations from the standard of healthy organisation; thus it is extremely common for the subjects of this malformation to suffer from enlarged tonsils, and to present many indications of weak health, whilst it is rare to meet with it in strong, robust persons.

It was remarked by the late Mr. Mummery in the course of a very extended series of observations on the teeth of savage races, that irregularities of the teeth and contracted jaws were as rare as destructive attrition was common amongst them, whilst precisely the contrary was true of civilised races.

And Messrs. Cartwright and Coleman report that they did not find any example of contracted jaws in the large collection of skulls contained in the crypt of Hythe Church—skulls which are certainly of very great antiquity, though their precise history is, we believe, a matter of dispute.

Dr. Nichols, who examined the mouths of "thousands" of Indians and Chinese in the Rocky Mountains, met with only one trivial case of irregularity; and Dr. Kingsley found no example of contracted jaws amongst 300 Chinese.

Dr. Talbot ("Osseous Deformities of Head, Face, Jaws, and Teeth," 1894) has collected a very large series of measurements of the upper jaws, both transverse, longitudinal, and vertical (*i.e.*, height of vault of palate), with very interesting results, which, however, are too lengthy to fully summarise here.

He found that the average width of the jaws of early Britons was greater than that of existing English people by ·20 of an inch, and as between ancient Romans and modern South Italians by ·07 inches.

There is a marked difference between the width of the jaws in poor patients taken from hospital practice and those of the well-to-do classes, the latter being materially smaller; and he also found that the range in size is far greater in mixed races than in those who have for long periods kept, or been kept, to themselves.

Very much the same laws hold good for the longitudinal measurements as for the transverse.

As regards height of vault, this is greater in recent than in ancient crania.

Dr. Talbot infers from his records, which are a storehouse of facts on the subject, that **mixture of types** is a fertile source of irregularity; that is to say, for instance, that a dolichocephalic father with a contracted arch, large and irregular teeth, and a mother of brachycephalic type, with well-formed arch and small teeth, would be likely to have progeny with irregularities both of cranium and jaws.

This hypothesis, though probable enough as one factor, must not be pushed too far, as Dr. Whitney found a good deal of irregularity in the jaws of Hawaians taken from old interments, and they have long been a very isolated race.

Although irregularity of the teeth is rare in its occurrence in uncivilised races of men, yet it does occur, as is exemplified in a skull of an Australian in the Oxford University Museum, in which the lower incisors are crowded, whilst close beside it in the same case there is an orang in which the left second upper premolar is not erupted, though the dentition is quite complete, and the right premolar stands between the canine and the lateral incisor.

And in the same museum there is a gorilla skull, the lower jaw of which is somewhat contracted, so that the molars do not articulate correctly, and the premolars pass wholly inside those of the upper jaw.

Sexual Selection.—It may be that, as was, we think, suggested by Mr. Cartwright, a form of selection may have had something to do with the frequency of the occurrence of undersized jaws in the well-to-do classes. For if the type of face nowadays considered to be beautiful be investigated, it will be found that the oval, tapering face, with a small mouth, &c., does not afford much room for ample dental arches. On the other hand, the type of face which we consider bestial has a powerful jaw development. Perhaps generations after generations seeking refinement in their wives may have unconsciously selected those whose type of face hardly allows the possibility of a regular arrangement of the full number of teeth. At any rate there is something tangible in the hypothesis, and grounds for argument *pro* and *con;* but much as we respect Dr. Kingsley's opinions, we fail to see that he has, in referring back dental irregularities to disturbed innervation, done much in clearing our notions of their *raison d'être,* even granting that his point were proven, which we do not concede.

One of the most common causes of displacement is the **persistence of the temporary teeth,** as a very slight obstruction is sufficient to deflect a growing tooth from its proper path. Fig. 76 may be taken as a fair example of irregularity arising from this cause. The temporary teeth being retained, their successors have consequently taken a position behind them, which allows the lower teeth, when the mouth is closed, to pass in front of the new teeth; this, in the absence of mechanical interference, renders permanent the malposition.

It has been usual to assume that the **premature extraction** of the temporary teeth occasions contraction of the jaw, but we do not think that any anatomical facts can be brought forward in support of the supposition. If a temporary tooth be removed, the crowns of the contiguous teeth may lean towards each other, and give an appearance of contraction, but it does not really involve a diminished size of that part of the jaw from which the tooth has been lost. In the case from which the following illustration is taken, the two central incisors were lost long before their successors were ready for eruption ; hence the sockets became obliterated, and the alveolar ridge made good ; but we do not see the slightest trace of contraction in the jaw. It has been stated by Mr. Cartwright,[1] that if the central incisors happen to be cut at birth, and at once removed, on account of the injury inflicted on the mother's nipple, the laterals when erupted do not obliterate the space.

Then again, if specimens be examined in which the two sets of teeth are present, it will be seen that the implantation of the temporary teeth occupies but a very small place in the alveolar ridge, as compared with that occupied by the crypts of the permanent teeth. Now, it is extremely difficult to conceive how the removal of the temporary teeth can induce the jaw to contract upon the crowded and growing permanent teeth. Organs in an active state of development induce the expansion of parts about them, and there is no good reason for supposing that the teeth form an exception to this rule. The persistence of the first, which are placed immediately in front of the second set, may, and frequently does, interfere with the outward progress of the latter; but we cannot see how the removal of the temporary can produce a prejudicial influence upon the arrangement of the permanent teeth. In the case shown in Fig. 67, the temporary incisors have been shed some time prior to the eruption of their successors; yet there is no indication of contraction of jaw. A case came under the writer's notice recently, in which the child had been destitute of temporary teeth, excepting only the second temporary molar on the right side of the lower jaw ; the maxillæ were, notwithstanding, well formed, and the permanent teeth appeared with an unusual regularity of arrangement. Had the development of the jaws depended upon the presence of temporary teeth, we should surely have seen in this case some amount of contraction.

1 Transactions of the Odontological Society, 1863, p. 132.

A case is recorded by Dr. Lines in which, in consequence of an accident, all the lower teeth were lost except the second temporary molars, prior to the attainment of the sixth year; yet two years later the permanent incisors, canine, and first permanent molars were all in place, with ample room left for the bicuspids; and in the upper jaw, where fewer temporary teeth had been lost, there was more crowding.[1]

And that there is not any contraction resulting from the early loss of temporary teeth was endorsed by the late Dr. Gross, of Philadelphia, and the late Dr. Forbes, of St. Louis.

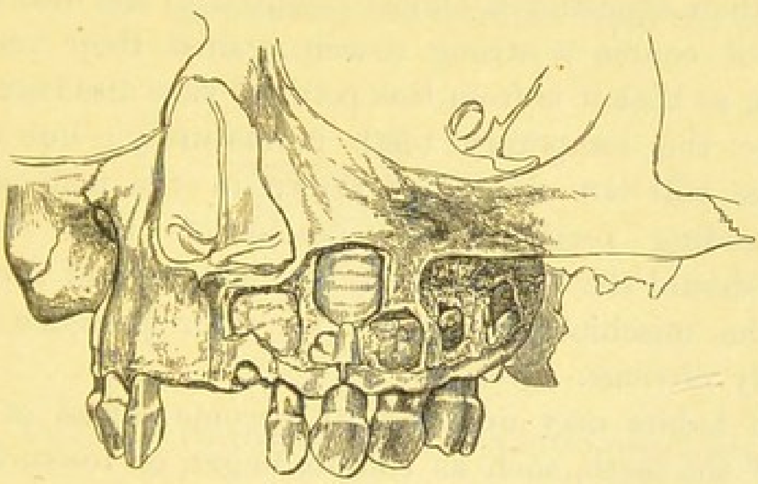


FIG. 67.—The upper jaw of a subject between six and seven years old. The central incisors had been lost, and the alveolar ridge had become rounded by the obliteration of the sockets of the temporary teeth and the development of new bone. If the premature loss of the temporary teeth were followed by contraction of the jaw, the condition should be shown in this case.

Subsequently, however, there may be some amount of practical inconvenience resulting from the premature removal of the temporary teeth, but it is from effects other than contraction of the jaw. The newly-cut incisors, in the absence of adjoining teeth, will sometimes lean away from the median line, leaving a central opening between them, This is, however, an evil that generally cures itself. The canines and bicuspids, when they appear, force the slanting teeth into the vertical position, and the space becomes obliterated.

There is, however, inconvenience experienced from early extraction of the milk canines, which should generally be left,

[1] Monthly Review, Dental Science, January, 1877.

even when the incisors are crowded; unless, indeed, the ultimate extraction of a bicuspid is clearly foreseen, when there is less reason for retaining them, as the encroachment of the lateral and bicuspid upon the space wanted for the canine will then be unimportant.

Crowding may also result from the loss or extraction of the second temporary molar prior to the full eruption of the first permanent molar, inasmuch as the latter tooth is thus enabled to move forward into the space allotted to the second bicuspid.

The fact that the temporary teeth are organs of mastication, and that their efficiency is almost essential to the health of the child is of course a strong reason against their premature extraction, so that it is from this point of view disadvantageous to remove the temporary teeth prematurely; but the disadvantages will not always be shown in the malposition of the succeeding teeth at the period of their eruption. Whereas should the first teeth be retained beyond the normal period, the mischief resulting from their presence will be sufficiently obvious.

Certain habits may undoubtedly become causes of irregularities of the teeth, such as thumb, finger, or toe-sucking, lip biting, pouting, and mouth breathing. These may be further considered when discussing the malformations which they tend to produce, or with which they appear to be connected.

Alveolar abscess arising from a diseased temporary tooth may cause displacement of its permanent successor.

Considerations prior to treatment.—Before the course of treatment is decided upon, the conditions presented by the jaws must be carefully studied, and it should be known whether the deformity is hereditary or accidental; and it must also be ascertained whether the jaws are contracted at their bases—at that point where the alveolar portion merges in the body of the bones. And it is equally important that we should learn whether the malposition of the second has arisen from the tardy shedding of the temporary set. If the case presented for treatment exhibits a form common to the family of which the child is a member, we shall probably have to encounter greater difficulty than if it be a solitary example. After the teeth have been moved, there will be a greater tendency in the one case than in the other to relapse to a vicious position. Supposing the V-shaped arch be forced into the elliptic form in a case where the base of the jaws is below the normal size, the position of the teeth individually will be so oblique, as respects the jaw, that they will become unsightly; and, moreover, it is questionable whether the subsequent alveolar development will be sufficient to secure a firm implantation. Hence, in cases which present this character, it may be desirable to remove permanent teeth, one on either side of the jaw, more especially when the front teeth are unduly prominent, and consequently require to be brought inwards. If the malposition has resulted from the persistence

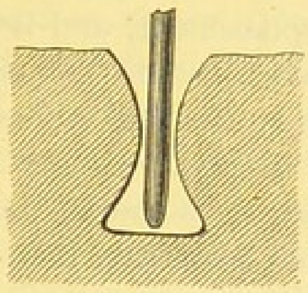


FIG. 68.—Diagram to illustrate relative resistances.

of temporary teeth, the permanent teeth will tend to fall into the elliptical arrangement so soon as the obstruction is removed, from causes which have been explained on a preceding page.

Whatever course of procedure is decided upon, there is one point which must carefully be kept in mind: when once the root and its socket are fairly complete the direction of the long axis of the tooth may be changed, but that is all which can usually be effected. The apex of the root will remain fixed, or nearly so; while the crown of the tooth will move in an arc of a circle the centre of which lies at or very near to the apex of the root. It is, therefore, of the utmost importance in estimating the probability of success to estimate as far as possible the position of the apex of the root; and it is obvious that those cases in which the irregularity is due to some such mechanical cause as the retention of temporary teeth will yield to treatment far more readily than those in which the alveolar border is more largely involved.

Chase, however (Cosmos, December, 1897), points out that if we shake a post embedded in clay we dilate the end of the hole sometimes (Fig. 68). He therefore thinks that the relative resistances of the cervical and apical portions of the sockets of teeth require to be considered, in order to minimise the tendency to move the end of a root in the opposite direction. To counteract this tendency he proposes to cap the teeth operated on, so as to carry prolongations over the gums, and get his pressure exercised there instead of upon the crown of the tooth, and *vice versâ*. Similarly, where a molar is used as an anchorage, it may be prevented from tilting (which it may otherwise easily do) by a deep collar carefully cemented on.

It must be remembered that at the time when a tooth is first erupted its socket is much larger than the tooth itself; hence its very easy displacement, and its equally easy return to its normal position when the disturbing cause is removed.

Were it in our power so to grasp and control the tooth which we desire to move as to press equally upon the side of its socket in its whole length, it might be possible to move it bodily sideways, instead of rotating it upon a centre at or near the apex of the root.

But it is seldom that such a force can be applied, and since the forces at our disposal ordinarily do not act in that way we may take it that for all practical purposes the apex of the root moves little or not at all.

And it is often not at all necessary that the position of the bottom of the sockets should be changed, although the margins require to be reduced or increased to a semicircle of different radius. Now we know that moderate pressure constantly maintained upon bone will lead to its absorption; if therefore the crowns of the teeth be steadily and constantly pressed upon, that portion of the socket which receives the pressure will gradually disappear. The immediate result will be an enlargement of the socket, in which the tooth will for the time move freely; in other words, it will become loose. This condition, if long continued, would lead to the early loss of the tooth; hence, to ensure success in our operations for readjustment, new bone must be produced in those parts of the socket from which and towards which the root of the tooth has moved. The fact of a tooth becoming loose under undue pressure, shows that the absorption may proceed more rapidly than development of bone.

The recognition of this fact, which may be assumed as a constant condition, suggests a very important question—viz., at what rate in respect to time can new alveolar bone be developed, when the removal of the pre-existing tissue has been induced by pressure? The determination of this point will also assist in determining the degree of pressure which can be used most advantageously, and the length of time it will be necessary to employ mechanical means for retaining the tooth in the position into which it has been forced. If an extreme case be taken for treatment, the extent of change produced, supposing the treatment to be permanently successful, will amount to the destruction of a considerable portion of the existing and the production of new alveoli.

In the absence of any facts gained from dissections, in respect to the period required either for the redevelopment of alveoli, or the degree to which absorption and subsequent repair is carried, we are thrown upon the general results obtained in the treatment of cases, and upon the conditions which are found to obtain in the development of alveoli during the eruptive period of dentition. It has been shown that the socket grows up contemporaneously with the gradual development of the tooth, but in this case the process of growth is extended over many months, and the results obtained in the reduction of irregularities do not tend to show that the alveloar reparation is more rapid than the original alveolar development.

If, for example, slightly projecting teeth are by means of pressure brought rapidly into the proper line, and are then left without mechanical restraint, they will speedily return to their former place, and become firmly fixed in their sockets in a much shorter time than they would have done if retained in the newly-acquired position. This circumstance would seem to indicate that in moving the teeth the sockets had been stretched or bent rather than absorbed; or else that bone is reformed in an old position more quickly than in a fresh one. But the first rapid movement of a tooth is attributable to another cause.

The immediate consequence of continued pressure upon the crown of a tooth is irritation and thickening of the peridental membrane; and this results in the tooth being raised in its socket to an amount equal to the increased thickness of the membrane.

The root of the tooth, from its more or less conical form, acquires, when raised in the socket, an increased range of motion, without the alveolus itself becoming enlarged. Instances in which these conditions are produced by disease are of daily occurrence. A tooth is attacked with pain, and in a few hours the patient discovers that the tooth has become too long, and feels slightly loose. The increased mobility is recognised if the tooth be grasped between the thumb and fingers; but it will at the same time be found, that although it readily yields within certain limits to pressure, yet that the movement is abruptly stopped when the side of the root comes in contact with either wall of the socket. A piece of india-rubber compressed between two teeth will in the course of a few hours force them apart, each tooth becoming tender to the touch and slightly loose; but although the teeth on the removal of the caoutchouc for a time stand apart, they will speedily resume their former positions, become firm, and free from tenderness. In this case, it can scarcely be assumed that the socket became enlarged by absorption, and again contracted by deposition, although the separation was greater in amount than could be accounted for on the supposition that the peridental membrane alone yielded to the pressure; but the difficulty of explanation disappears on finding that the teeth are slightly raised in the sockets. In these instances we have examples of the manner in which the position of a tooth may, under pressure, become changed, without the socket undergoing any enlargement. In the treatment of cases, we find that within the first few days the misplaced teeth show most satisfactory results, and we are apt to conclude that the difficulty will be readily overcome; but in subsequent examinations we fail to recognise a corresponding amount of progress. The involved soft tissues readily yield, but until removed or weakened by absorption, the bone of the sockets resists the further movement of the teeth. Destructive inflammation will be set up if the pressure be too great, and if it be too slight the teeth will not move, or the movement will be so slow that both the patient and practitioner become wearied before a successful result has been gained. A certain amount of slight irritation in the socket is a necessary attendant upon the treatment, otherwise absorption of the socket would not be induced. Other conditions being the same, the age of the patient will influence the results. The younger the patient, the more readily can the teeth be moved; the older, the more difficult will the operation become.

Duration of treatment.—Admitting, then, that sockets partly removed under treatment will be restored, the question arises as to the time which will be occupied in the restoration—in other words, how long will it be necessary to hold the teeth in the newly-acquired situation? If unrestrained by mechanical means, and uninfluenced by antagonistic teeth, the old position will in some forms of irregularity soon be regained, and it would almost appear as if there were a natural law tending towards the maintenance of a conformation when once assumed, although an irregular one.

We constantly hear of and see cases in which teeth have been reduced to regularity, and have subsequently regained the objectionable position, notwithstanding the assurances which have been held out that such untoward results need never arise. There is, perhaps, no point in the whole field of dental surgery that yields a finer harvest to the charlatan than that afforded by the treatment of irregular teeth. The patients are necessarily young people who have not passed from the care of their parents. There is a great desire on the part of the latter that the teeth should be good-looking, or at least not ill-looking; at the same time, there is great unwillingness, both with the patient and the parent, that the treatment should be extended over a long period of time. The presence in the mouth of a mechanical apparatus pressing upon the teeth interferes with the comfort of the young patient, and the frequent attendance at the house of the dentist encroaches upon the hours allotted for study. Both circumstances render prolonged treatment irksome, impatience is shown, the instructions are neglected, and, as a natural consequence, the results fall short of those which might have been obtained had the treatment been consistent.

It is in accordance with the experience of those who have devoted their attention to the treatment of irregularities, that where, for example, the front teeth have been brought inwards by mechanical means, and where mechanical means are required to hold them in place until they become permanently fixed, the treatment must be continued for twelve months. It may not be necessary that the apparatus should be constantly worn for the whole period, but it cannot be wholly thrown aside. Towards the latter part of the time, it may be worn occasionally only; but even after the lapse of twelve months, should the teeth show any indication of movement from the desired position, mechanical restraint must be resumed.

In a general way it may be said that those irregularities which are or seem to be due to mere accident are easier to correct and are less prone to relapse than those which are inherited peculiarities, or than those which are, so to speak, a part of a general scheme of conformation of the face and jaws.

The foregoing remarks apply generally, but each case will present its own peculiar characteristics, and the treatment must be varied to meet them. The age and sex of the patient, the state of health, the degree of susceptibility to irritation and pain, the number and condition of teeth present, the tendency to caries, the size of the teeth themselves, the size and form of the base of the alveolar portion of the jaw, and the configuration of the same part in the parents—all these points must be taken into consideration before a course of treatment is determined on.

METHODS EMPLOYED FOR THE REGULATING OF TEETH.

From what has already been said it will have been gathered that **pressure** is in the vast majority of cases the means to which we resort to carry a misplaced tooth into a better position. This pressure may be constant, as in the use of spring appliances, or it may be intermittent, as happens when wooden pegs, compressed wood blocks, or screws are applied.

Some prefer constant, others intermittent pressure; but it may be noticed that even spring pressure is more or less intermittent, as, unless the pressure be very severe, the tooth soon moves as far as the spring has been bent and there rests till the readjustment of the plate.

We think that preference must be given to those agents which tend to exert a constant elastic pressure, with a degree of force easily under the control of the operator, such as springs of various forms, and elastic bands.[1]

Dr. Coffin has carried out the use of piano-wire springs for the expansion of the dental arch with a degree of nicety and success not hitherto attained by others, and he claims for his method a far more general applicability than has usually been attributed to it. In fact he employs his expansion-plate for the correction of the vast majority of the cases he treats, sometimes combining it with the use of separate elastic wires to make pressure in other directions, and sometimes trusting to nature to reduce the teeth to a regular arch after the increased space allows of this happening. The plate employed is of very thin vulcanite, capping the teeth to give a better grip upon them. Dr. Coffin advocates[2] strongly the use of

[1] Many ingenious and useful methods of applying elastic bands are given in Dr. Kingsley's work on "Oral Deformities."

[2] Transac. International Medical Congress, 1881.

gutta-percha for taking all impressions for regulating purposes. Gutta-percha, owing to its low specific heat, can be employed very hot, and therefore very soft; he recommends that it be thoroughly softened in very hot water, placed in the tray, and the tray and its contents dipped into cold water and held there a few moments. No great excess should be used, and the tray having been firmly pressed up, best by the patient biting it home, it is to be after a little time abruptly removed and at once placed in cold water. If by accident there be any considerable excess hanging over the back of the tray, this should be carefully supported till it has cooled, lest by its weight it drag the back part of the impression. The model thus obtained is not scraped nor in any way tampered with, and the plate is vulcanised upon it, with the wire in place. The form of the wire will be understood at a glance by reference to the following figure. The tendency to oxidise in the vulcaniser is counteracted by tinning the wire, which is prevented from sticking to the vulcanite by a piece of tinfoil laid under it. The plate is only split with a saw after being worn a day or two, and the edge of the split carefully finished and smoothed. The halves are then strained a little apart, and given any direction that may be desired, and as the case progresses the power is from time to time increased by stretching them further apart. Such a plate is by far the best method of expansion yet introduced. It is perfectly regular and constant in its action, very comfortable, very light and small, and it can be without detriment removed for cleansing as often as the patient desires.

The expansile force can, by suitably shaping the plate, be made to operate specially upon individual teeth, or upon several teeth, or upon the whole arch.

And the results attainable with a minimum of discomfort to the patient are very remarkable. The figures here given are taken from casts lent by Mr. Walter Coffin, and refer to the result of only six months' treatment in a child of fourteen years of age.

A great deal may be accomplished by the expansion of the arches. The effective regulation of unsightly teeth without extraction is so attractive both to patient and practitioner, that a word of caution needs to be said upon the subject. Expansion, and the retention of the whole number of teeth, is only good treatment where the teeth are of fairly good quality; if

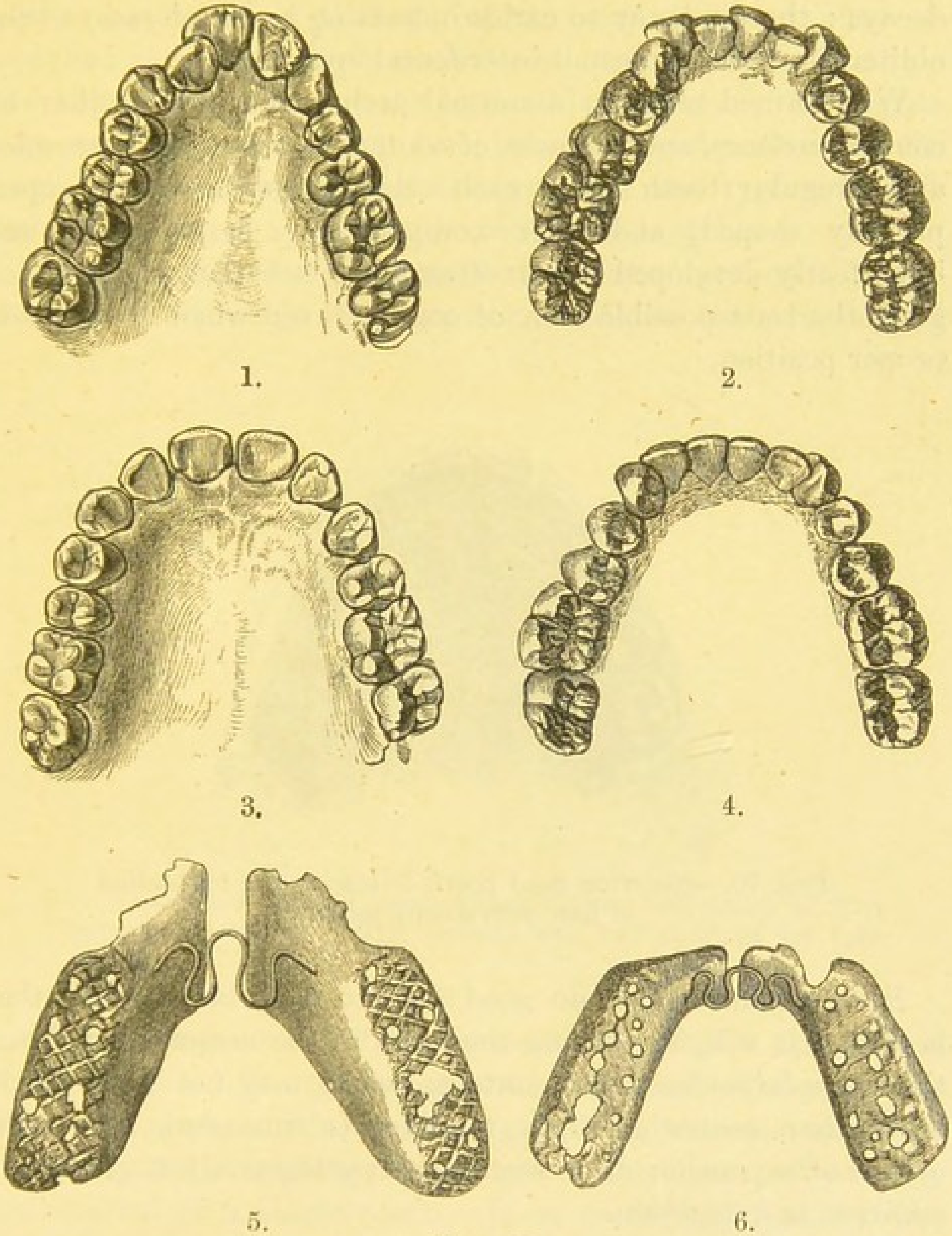


FIG. 69.

1. Model of upper jaw of child of 14, before treatment.
2. Model of lower jaw of same case.
3. Model of upper jaw of same case six months after treatment.
4. Model of lower jaw of same case.
5. Dr. Coffin's expansion plate, *upper* jaw.
6. Dr. Coffin's expansion plate, *lower* jaw.

there is any tendency to interstitial caries, then the interests of the patient are far better served by the symmetrical extraction of two or four teeth, thus providing space for the remainder.

For it must not be forgotten that an isolated tooth rarely decays : the tendency to caries increasing in direct ratio to the obliteration of the normal interdental spaces.

Well-formed teeth in a normal arch touch one another by convex surfaces, and the area of contact is very small ; crowded and irregular teeth touch each other by surfaces not appropriately shaped, and over comparatively large areas, and imperfectly developed teeth often have not that shape which gives the least possible area of contact even when they are in proper position.

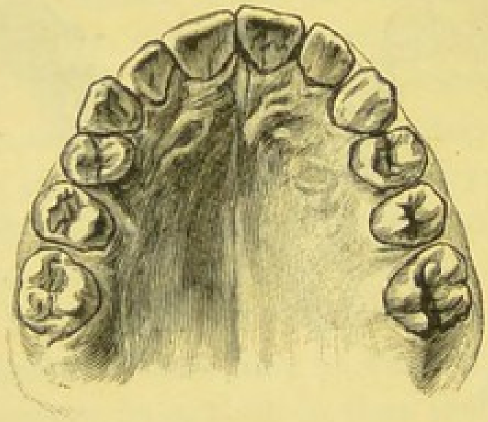


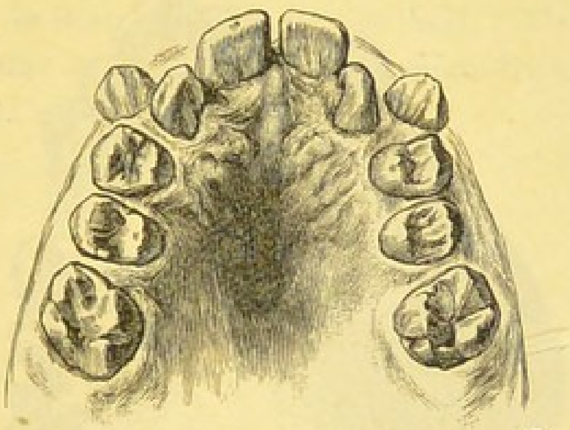
FIG. 70.—Showing good result following the extraction of first permanent molars.

Now, expansion will do good only to a certain point ; that is to say, it will, by placing the teeth in the normal arch, bring their proper surfaces into contact, but it may not make them other than somewhat tight together (ultimately), and some degree of expansion may often be advantageously employed in addition to extraction.

All teeth move a little in their sockets, and so rub against one another. When the contact surfaces are small and in the right position, this does no harm beyond rubbing small flat facets ; but when the area of contact is wide, then attrition of the surface of the enamel becomes injurious, and the diminished interdental spaces can, with difficulty, be kept clean, even with the most assiduous attention.

Hence the thoughtful practitioner will not allow himself to be misled by the idea that every individual, with or without due jaw space, ought to have thirty-two teeth preserved, no matter at what cost of wearing plates and the like; and it may further be remarked that the whole facial region is often so modelled as to necessitate small dental arches. It is hardly a desirable object to endeavour to mould the jaws of a delicate lady, with an oval tapering face, into the configuration of the ample jaws of the prize-fighter type, fine and typical though their development as perfect dental arches may be.

If extraction be decided upon for regulation purposes, it is in most cases advisable that opposing teeth in the maxilla and



$\frac{2}{3}$

FIG. 71.—Showing bad result following the extraction of first permanent molars. The patient was lost sight of for four years.

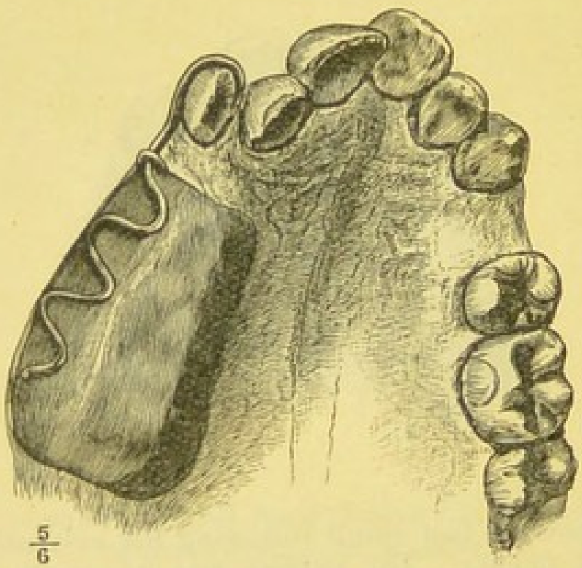
mandible be removed. The cusps of the bicuspids and molars of the upper and lower jaws are mutually interlocked when the mouth is shut, and this locking of the bite prevents the remaining teeth availing themselves of the space afforded by the removal of a single tooth. It is preferable, furthermore, that the extractions be symmetrical on both sides of the jaws, otherwise there will be a tendency for the central incisor teeth to be pushed away from the central line of the face.

It will be noted that in the case of general expansion there seems to come into play a tendency in the teeth to assume a regular position as soon as they have the chance—in other words, that, given space, irregularities tend to correct themselves.

The maximum elasticity of piano-wire is obtained in the W-shaped spring, as employed in Coffin's expansion plate. This shape of spring can also be utilised unilaterally, and is one of the most effective methods of retracting canine teeth (Fig. 72).

In positions where space does not admit of a W-spring, considerable elastic power is obtainable by making one complete turn of a spiral coil in the piano-wire between its point of attachment and its free end (Fig. 79).

Of course, the variations in the arrangement of springs are almost infinite and must be left chiefly to the ingenuity of the operator.



$\frac{5}{6}$

FIG. 72.—A W-spring in use to retract a canine tooth. Only a part of the vulcanite plate is sketched.

Constant elastic pressure is also secured by means of rubber bands or strips, which are attached to hooks on a plate, or to metal collars previously fixed with cement to a tooth or teeth. In suitable cases they are very effective, but care must be exercised to avoid the rubber slipping up on to the gum, and thus giving rise to more or less severe inflammatory mischief.

Intermittent pressure may be given by many forms of appliances, of which the jack-screw is perhaps the most powerful (Fig. 73). This device may be employed for the expansion of the whole arch, or for the thrusting outwards of individual teeth; it may be used either acting directly upon the teeth, or in conjunction with a plate, a split or detached portion of which it impinges upon. The latter plan is preferable, as being less likely to injure the teeth, and also as rendering the attachment of the screw more easy. Of course, care must be taken to effectually secure the screw, lest it be swallowed.

In the majority of cases the fairly constant pressure obtainable by some form of spring seems preferable to the distinctly intermittent action of a jack-screw; yet there are a few cases where the latter answers admirably, for its power is greater than that of any other device in general use.

An apparently neat method of regulating teeth has been advocated by Dr. Farrar ("Dental Cosmos," *passim*), which consists in attaching to the tooth to be moved a belt of gold, which is made to embrace it tightly by a thread and nut, and the power is then applied to the belt. These and other somewhat similar appliances do not seem to have proved as generally useful as they had promised.

FIG. 73.

There are, however, a few cases in which it is, from the shape of the crown, almost impossible to get any removable appliance to act upon the tooth in the direction desired. In such cases Dr. Farrar's method may be employed; or a gold collar with a loop or tag attached, cemented on with a phosphate cement, and some removable appliance made to act upon this.

In still rarer cases, it may be justifiable to bore a small hole in the enamel, in which a wire may get a purchase, this hole being subsequently filled with gold. It need hardly be said that this is an extreme measure, and on no account should a hole be made on any surface which is not fully exposed and fairly exempt from the possibility of the filling failing.

In addition to the method of gradual correction of misplaced teeth, other and more heroic treatment is occasionally adopted. Thus, where the axis of the root of an incisor is correct, and there is room for its crown, but the tooth is rotated upon its longitudinal axis, the operation of **immediate torsion,** that is to say, the seizing the tooth in a pair of forceps and forcibly twisting it round is sometimes practised.

It might have been anticipated that such a procedure would be followed by the death of the pulp and consequent alveolar abscess; but this untoward result happens very rarely, and may almost always be avoided by performing the operation only on thoroughly favourable cases.

Before deciding on forcibly twisting the tooth, the operator should satisfy himself that there is sufficient space for the crown in its new position, and also that the direction of the root is such that it will allow of the crown ranging regularly with the surrounding teeth.

The most favourable period for its performance appears to be the age of nine or ten years, when the teeth are fully erupted, but their sockets have not yet attained their full strength. We have, however, successfully twisted the central incisors in a patient aged fifteen, and in several instances in patients aged thirteen; but, as a rule, it should be done at a much earlier age, for the sockets become very dense and unyielding, so much so that in several cases we have failed to move the teeth with any degree of force which it has seemed safe to apply, and have been therefore compelled to abandon the attempt.

The tooth may be seized by its labial and lingual, or by its mesial and distal, surfaces; and it will often be convenient to change the hold of the forceps after the tooth is partially twisted. Thus, if the tooth stands nearly at right angles to its proper position (as, for example, the right central incisor in Fig. 80), it would be easiest to apply one blade of the forceps to the mesial and the other to the distal surface, but it would not be possible to complete the torsion with the blades in this position, as they would come in contact with the lateral and the other central incisor. Hence, when the tooth is partially turned, the forceps must be applied to the lingual and labial surfaces, by which means the operation may be completed, and the tooth left in a perfectly normal position.

The instrument used should be a pair of straight incisor forceps, the blades of which should be prevented from chipping the enamel by the interposition of some soft substance. Some operators use a slip of sandpaper or sheet rubber for the purpose: others use paper, but this is apt to slip. A piece of thick leadfoil answers the purpose very well, and is free from the objections which apply to the other two. The tooth should be firmly grasped at the edge of the gum, and steadily pressed into its socket and twisted in the desired direction until it is felt to yield; no attempt should be made to loosen it by twisting it alternately in opposite directions, as has been done by some operators, as this loosening is precisely what it is desirable to avoid as far as is possible. As the tooth on being released springs back somewhat, it is generally necessary to twist it somewhat farther than into its normal position. Where the tooth has to be twisted through a quarter of a circle in a subject past the ideal age for regulation, the resistance will sometimes be very considerable, and we have in several instances obtained a thoroughly satisfactory result by turning it through only half the required distance, and allowing it to get firm again; then, after the lapse of a fortnight or three weeks, completing the operation by twisting it through the remaining distance. Although on the first occasion the resistance may have been very great, the tooth generally yields readily to the second attempt, and we think such a course preferable to the use of great force in order to complete the operation at the first attempt.

This method of immediate regulation is also employed to bring outstanding or instanding teeth into line, with perhaps even less risk than for rotation. Mr. Dolamore and others prefer to divide the alveolar process on each side of the tooth with a very fine small Hey's saw before attempting to move it into position. The tooth is thus in no way detached from its bony socket, which is moved with the tooth it supports.

There is generally very little bleeding, and not much pain resulting from the operation, though, of course, the tooth is somewhat loose and tender at first. In order to ensure it being left at perfect rest, and retained in its new position, it is advisable to employ a splint of some sort; an efficient and easily applied splint may be made by bending up a slip of metal so as to loosely embrace three or four teeth, and fixing it with a lining of softened gutta percha or phosphate cement.

Or a model can be taken of the mouth before operation, and a plaster cast made; the tooth or teeth are cut off the plaster cast and placed in their correct positions; to this a metal cap is struck up and is ready to be fixed with gutta percha or cement over the natural teeth immediately after they have been forced into their new places.

This should be worn for forty-eight hours at least, or longer if the tooth remains loose; and it is safer to confine the patient's diet to soft things for a day. The extreme tenderness and looseness will pass off in a day or two, when the use of the gutta percha splint may be discontinued. If there is swelling and tenderness over the socket, this may be painted with liniment of iodine, or a leech applied; but the necessity for any such treatment seldom arises.

We are acquainted with one case only in which death of the pulp ensued; the patient was a child of suitable age, but was a hospital patient, apparently not much tended by its parents, and probably no care was taken after the operation to preserve the tooth from movement. In this case the pulp cavity was drilled into, through the lingual surface of the crown, and the root filled with cotton-wool steeped in carbolic acid. This treatment was perfectly successful, and the tooth after a short time became firmly fixed in its socket. We do not know through what distance the tooth was turned, nor whether it offered more than usual resistance, but the untoward result was attributed to the want of proper care exercised after the operation. But on the whole, the operation of immediate torsion is one which is only advisable when for some reason or other the rectification of position by means of plates is not available.

Another plan of treatment which has been proposed and practised in a few cases with success is to weaken the socket on the side towards which the tooth is to be moved by a cut or cuts with a circular saw in the dental engine, and then, seizing it with a pair of forceps, to forcibly carry it into a proper position.

This has been practised in a few cases by Mr. Cunningham and others, and reports of these cases are to be found in the Transactions of the Odontological Society, 1895.

It seems hardly probable that this method, which cannot be without its danger, will have any general applicability, but the healing and repairs of the socket, which appears to be "sprung" and perhaps slightly broken, as well as cut, has been satisfactory in the cases recorded.

Some difference of opinion exists as to the best mode of pressing the teeth outwards. The older method of procedure, still a favourite method with some, consisted in fitting a metal plate to the lower teeth, from the upper surface of which an **inclined plane** of metal projected, which, on closing the mouth, passed behind the teeth whose position required change. In fact, the lower teeth were by this process artificially lengthened and turned inwards, and consequently the amount of force exerted upon the misplaced teeth depended entirely upon the voluntary action of the lower jaw in closing the mouth. In many cases this method of treatment will be successful, but it is slow, and consequently produces a prolonged impediment to articulation and mastication; and it is open to the further objection that it at best depends in great part upon the voluntary efforts of the patient.

More recently, vulcanite plates fitted to the palate, and extended over the molar teeth, have been adopted. The vulcanite over the masticating surfaces of the molar teeth is left sufficiently thick to prevent the upper and lower front teeth from engaging with each other when the mouth is closed. The plate is made thick behind the lingual surfaces of the teeth to be operated upon, and into these vulcanite blocks, portions of dry **compressed wood or pegs** are placed, in cavities cut in the vulcanite for their reception. Each instanding tooth will have its corresponding cavity in the plate, the formation of which requires some little attention. The form should be similar to that of a shallow drawer, the front of which has been removed, and so proportioned as regards the upper and lower surfaces of the plate in which it is cut, that the section of wood will not fall out into the mouth. The compressed wood should be fitted to the cavity, and left a little thicker at that end which lies towards the gum. If the plate be nicely fitted to the teeth which it caps, it will ordinarily hold in very tightly by springing it over their crowns; and in order that it may do so, Mr. Woodhouse is in the habit of cutting grooves into the plaster model at the necks of the temporary teeth, and then vulcanising upon the model. These grooves should correspond to the edges of the gums upon the lingual and labial aspects of the temporary molars, but they should not extend in between the teeth, as they would cause great soreness were they to result in the vulcanite pressing on the tongue or gum in this

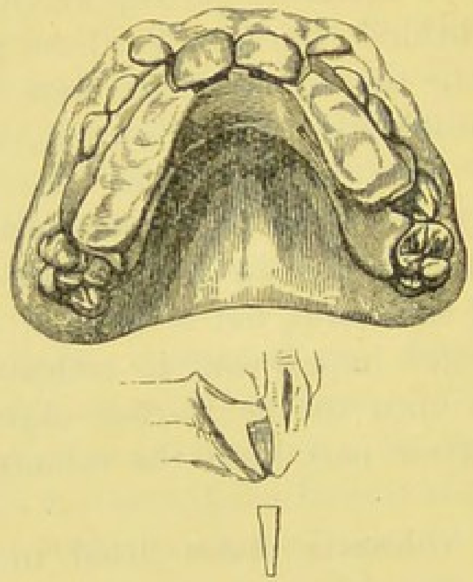


FIG. 74.—Showing a vulcanite plate fitted to the upper jaw, for the purpose of forcing outwards the central incisors. The vulcanite is left sufficiently thick over the masticating surface of the back teeth to prevent the lower teeth from influencing those to be operated upon. The plate is retained by ligatures passed through the vulcanite and round the temporary molars; posterior to the central incisors, the apertures of the cells for the reception of the compressed wood are shown.

Below the figure, a section of the parts *in situ* is given, showing the cell in its length, with the piece of wood removed and placed underneath.

position. But upon the labial and lingual aspects of the crown, ridges upon the vulcanite, which pass just beneath the abrupt bulge of the enamel of the temporary tooth, do not cause pain. However, if a good and suitable model have been obtained, this trimming of it is not necessary.

But if, owing to the unfortunate slope of the teeth, or their absence, or other cause, the plate will not stay in securely, it can be tied in, and there is a particular way of doing this, so much preferable to any other with which we are acquainted, that it is worth description here. The plate having been adjusted to the mouth, holes must be drilled through it for the admission of ligatures, which may be passed round and tied to one or other of the molar teeth on each side of the mouth.

In arranging the ligatures, care must be taken that they do not press upon and irritate the gums. It will be remembered that the gums approach nearer to the masticating surfaces of the teeth on the lingual than on the labial side. Hence the holes in the plate should be made at the point corresponding to the free edge of the gum against which it rests, at the centre of the *lingual* surface of the neck of the temporary molars.

The plate being out of the mouth, long ligatures are passed round the necks of the temporary molars and securely tied; it will be found easiest to make the knot on the labial aspect of the tooth, and then to pass the ends back, one in front and one behind the tooth, so that the free ends hang inwards. The object of having the ligatures very long is that the free ends may now be passed through the drill holes in the plate (which is still out of the mouth) and loosely knotted together, so that they may remain whilst the whole process is repeated on the other side of the mouth. The plate is then put in and held firmly home whilst the ligatures are pulled up taut and tied, the knots being on the lingual surface of the plate, which will then be quite securely held. If these precautions be observed, the ligatures when tied will pass in a straight line from the labial surface of the tooth to the lingual surface of the plate, without interfering with the gums. In selecting the teeth around which the ligatures are to be passed, we must be guided by the forms and the position of the teeth available for the purpose; but should the temporary molars be present it will be well to make use of them in preference to the permanent teeth. The abrupt termination of the enamel renders them particularly suitable for the purpose, and the short period during which they will be retained renders their injury a matter of little consequence.

By the foregoing means the plate may be firmly fixed in order to afford a *point d'appui* for the action of the compressed wood, the cells for the reception of which will be formed on the one side by the teeth to be moved, and on the other three sides by the plate. After compressing in a vice for some hours a piece of dry willow, plane, or some other soft wood, so placing it that the compression may take place parallel with the grain, small strips may be cut off, and from these fragments must be prepared which will fit with moderate accuracy to the spaces formed by the plate and teeth, taking care that the grain of the wood runs parallel with the long axes of the teeth. So soon as the wood commences to absorb moisture it will expand, and in a direction transverse to that of its grain. In expanding either the tooth in front of it must move outwards, or the plate must be driven backwards, and with it the molar teeth to which it is fitted. But as the front teeth are capable of the least resistance, they are the first to yield, and therefore gradually advance before the expanding wood. From time to time the wedges must be renewed, each new piece being slightly larger than its predecessor; and as the teeth move upon an axis situated near the apices of their respective roots, the receptacles become changed in form, and it may be necessary to modify the form of the grooves in the vulcanite plate. If this precaution be neglected, there will be a difficulty in retaining the wood after the teeth have been moved from their original position. When the required amount of change in position is considerable, and the half of this has been gained, it may be necessary to discard the original plate, and substitute a new one fitted close to the teeth operated upon, so as to admit a thinner and more manageable wedge than that which would have been required had the treatment been continued with the first made apparatus.

It is doubtful whether, as a general rule, more than two teeth can be advantageously operated upon at the same time. If, for instance, the four incisors are involved in the irregularity, it may be desired to push forward the central teeth first, and then move the lateral teeth, or *vice versâ*. But in adopting this plan we must not neglect to take means to prevent the teeth first operated upon from retreating to their old place while the others are being forced forward. This may be accomplished by inserting into the vulcanite frame pegs of wood, the free ends of which rest upon the backs of the moved teeth. In this application of the wood the end of the grain will rest upon the tooth, and as there is but very slight expansion lengthwise of the grain, the teeth will be simply held in position.

Instead of using blocks of compressed wood in suitable chambers, the plate may be vulcanised solid in front, and holes drilled corresponding to each of the teeth to be moved. **Hickory pegs** are then inserted into the holes, and cut or filed to such a length that they by pressing on the backs of the teeth just prevent the plate from going home. The bite will soon drive the plate home and in so doing the teeth will be driven forward. This method is very sure and fairly quick in its results, but it requires somewhat frequent attendance on the part of the patient, as no great amount is gained by each change of pegs.

Many practitioners much prefer a **spring pressure,** as this minimises the number of visits.

This may be got in a great variety of ways; a plate similar to that used with wooden pegs may be employed, the holes not been drilled quite through, and a piece of ordinary spiral spring fixed in each, having been previously pulled out somewhat so as to act on compression.

Or springs of piano-wire may be used, a separate one impinging on each tooth; if piano-wire be used it should not be too thick, as a better result is got from a thinner piece with a good deal of spring upon it than from a thicker and stiffer piece. A spring of piano-wire should always, if space allows, have a complete spiral turn somewhere in its course, as this greatly increases its efficacy.

Instead of using vulcanite, metal may be used for the plate; but, as a rule, it is neither desirable nor necessary, and has almost passed out of use. The molar teeth on either side may be capped with vulcanite or gold, the caps being made so that they fit tightly upon the teeth. From these a band of metal is extended in front of the teeth. Holes are drilled in the band opposite to the teeth, and strong silk thread is passed round the neck of each tooth and through the corresponding holes, and tied tightly on the outer surface of the band. The teeth will by degrees be drawn towards the band, but the process is a slow one, and requires frequent renewal of the ligatures.

We have commonly used vulcanised **rubber rings** in the place of silk; with this material the tension is more uniform, and the renewals need not be made so frequently. The fixing of the india-rubber to the band may be a difficulty; tying is impracticable, and hooks could not well be used. We found, however, that by cutting fine slits with a hair saw obliquely half through the metal band, and then passing the two ends of the rubber in a state of tension into them, the ligatures were firmly retained; or rubber rings may be attached to the bar by looping them round the bar and through themselves.

A simple method of bringing teeth forward, which is particularly applicable where the others would be the better for being carried back a little, is to take a stout band or ring of sufficient length, and ligaturing it firmly at each end to strong

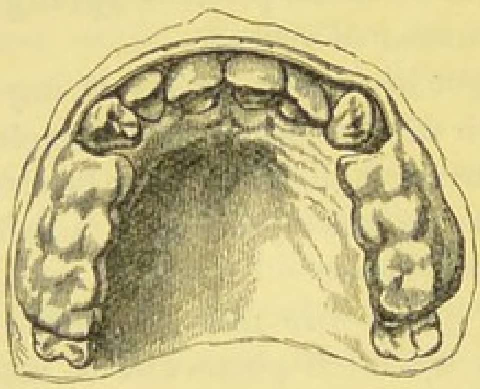


FIG. 75.—Shows a plate capping the molar teeth, with a band extending from them in front of the incisors.

teeth, wind it in and out between the teeth to be moved, carrying it behind those which need to come forward and in front of those which need to go back. In selected cases, where sufficient tension can be got, this method works well; instead of ligaturing the ends to the neighbouring teeth this elastic band can be held by suitable attachments to a plate.

The appliance of a metal bar of regular form, with or without a plate, to which the teeth are pulled up, is made great use of by many practitioners now; it is a very old method which fell out of favour and has again come into use.

It is obvious that if the bar have the form of the regular arch and all teeth which do not touch it are dragged up to it, a good result is attained. The stiff bar may be outside or inside the arch as required, and it may be secured at its ends by bands round molar teeth, by a plate, or by various methods that will occur to those employing it.

In the place of silk or elastic ligatures, Dr. Angle, who has made great use of it, employs fine brass wire, which is passed round the tooth and the bar, and is then twisted up to the required tightness.

A tooth which has originally stood inside the bite and is moved till it stands outside will commonly be prevented from losing its new position by the occlusion of the teeth, but if it is not securely held by these, it will require a retaining plate.

A **retaining plate** useful for a variety of cases is here figured (Fig. 75); when it is undesirable to cap the teeth the band may be brought out to the outside of the teeth through any gap that exists, or if there is no gap, behind the last tooth in the mouth.

Sometimes, however, it will be found that the back teeth of the upper and lower jaws, from having been kept apart during the treatment, have lost their proper antagonism. They become raised in their sockets, and prevent the front teeth from meeting each other; under these circumstances, those portions of the vulcanite plate which extended over the masticating surfaces of the back teeth must be removed so as to allow the teeth to come in contact, while the plate prevents the front teeth from falling back into the former position. In a few days the proper antagonism will be restored, and the plate may be discarded.

Except in those cases where the antagonising teeth serve for maintaining the position acquired by mechanical interference, regulation plates must be worn for many months, and whatever may be the material used in their construction, the teeth to which they are attached gain nothing by being so used. Metallic bands encircling natural for the support of artificial teeth, not uncommonly produce injury to the former; and it is fair to infer that when in protracted cases regulation plates are retained by similar means, some amount of mischief may result. Hence there are many who condemn the use of metal. The question arises as to whether vulcanite is really less injurious to the invested teeth than gold; and, judging from the experience gained by watching the effects of artificial teeth constructed with each, we think we shall be constrained to answer decidedly in favour of the former. Still, before any appreciable hurt can be produced, the frame must be worn for a long time, and supposing it can be attached to temporary teeth, this consideration need not influence our selection of the form of appliance.

Classification.

Irregularities in the position of the permanent teeth admit of division into two heads. Class I. Irregularity in the position of the teeth, mainly of their crowns, the jaws beyond the immediate alveoli of the teeth not participating in the irregularity. Class II. Irregularity in the position of the teeth, the alveolar border and even the jaws beyond these limits being more or less involved.

Such divisions are convenient, but of course the one form passes more or less insensibly into the other.

Class I. admits of further division into (*a*) those cases in which the crowns alone are involved, the ends of the roots being in their proper position, and (*b*) those in which the whole roots are bodily displaced.

Class I. (*a*): When, for instance, we have to deal with an inward displacement of **incisors**, the simplest and perhaps the most common form of irregularity, the sooner it is corrected the better.

No advantage would be gained by waiting till the sockets are fully formed, as the treatment must then involve their partial destruction, and the reproduction of new ones. On the other hand, if the treatment be commenced sufficiently early, the large open sockets will allow the growing teeth to be easily moved forward, and those parts of the sockets as yet unformed will be developed in accordance with the direction given to the teeth. So soon, therefore, as it is discovered that the upper fall within the lower front teeth, the treatment may be commenced. If measures were adopted prior to the establishment of irregular antagonism, we should perhaps be effecting by mechanical interference that which nature would have accomplished with much less inconvenience to the patient. Few can have failed to remark the much greater prevalence of irregularity in the permanent teeth about the time of their eruption than at a later period, in that class of society the members of which do not avail themselves of the services of the dentist, excepting when the presence of an aching tooth can no longer be borne. That in many instances teeth which on their first appearance through the gums hold an objectionable position, will, if left to themselves, ultimately fall into the proper line, is a fact sufficiently well established to warn us against interference until it is clearly shown that our assistance is required. This is especially applicable to the case of the upper canine teeth.

From the frequency with which irregularities are remedied by nature, it has been supposed that there is a *strong inherent tendency towards the assumption of a normal position*, and that

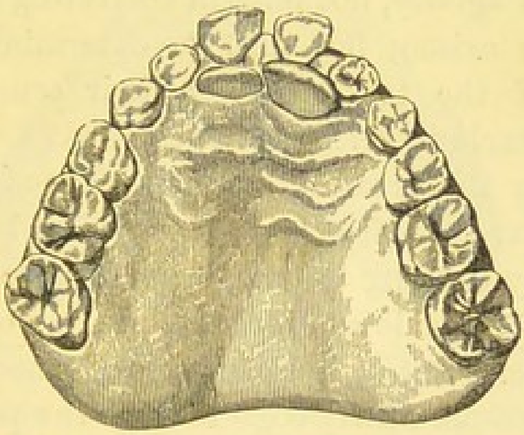


FIG. 76.—Shows the permanent central incisors coming through the gum posteriorly to the persisting temporary teeth, leaving an interval into which the lower incisors pass when the mouth is closed.

teeth will in consequence of this tendency, all mechanical obstacles being removed, take up a regular arrangement.

And although no one can doubt for a moment that there is, and must be, a controlling influence in the organism tending to its assumption of its typical form, yet the existence of certain mechanical agencies which are in constant operation, namely, the pressure exerted by the tongue and by the lips, must be borne in mind. If any tooth projects outwards or inwards beyond the line of the surrounding teeth, it will obviously sustain more than its share of the pressure exerted by the muscles of the lips or of the tongue. And as the lips and tongue act evenly and symmetrically on every part of the alveolar arch, their action will obviously tend to the correction of any irregularity that may have occurred, if a regular disposition of the teeth be not rendered impossible by want of space, or other mechanical obstacle.

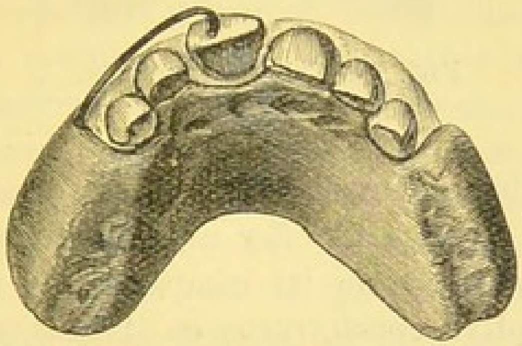
The muscles of the tongue in its varied movements exert a more powerful influence than those of the lips; and thus it happens that a tooth placed inside the arch is far more quickly pushed into its normal position by the operation of natural forces than one which lies outside the line. The natural tendency to perpetually fidget with the tongue anything sharp or prominent in the mouth may perhaps here come into play advantageously. A very slight amount of force, if only it be constantly applied, is sufficient to alter the position of a newly-erupted tooth ; and this even pressure of the lips and tongue is probably a chief agency, not only in correcting any irregularity that may have arisen, but also in determining the regular arrangement of the teeth during their eruption, where no mechanical obstacle interferes with their even disposition.

In describing the treatment of the first-mentioned simple form of irregularity, it has been assumed to be desirable to so raise the bite by capping the molar teeth as to disentangle the upper teeth from the lower incisors, which would hinder their forward passage. But it is not absolutely necessary to do so ; when the teeth come nearly edge to edge the patient will avoid touching them, as they are tender, and so they will escape the locking effect. Dr. Kingsley advocates this method; however, we do not think the patient gains in comfort by the abolition of the capping, but the contrary, and that is really the only point to be considered, as such plates are not worn long enough to do injury by covering the teeth, or by want of cleanliness, which may be perfectly attained if the plate be removable.

Irregularity in the position of the central incisors.—The upper central incisors will occasionally be found to be somewhat widely separated from one another, the frœnum of the upper lip being unusually strongly pronounced, and traceable as far as the gum intervening between the two teeth. The irregularity, though a slight one, is not very easy to remedy, for the early division of the frœnum with scissors or scalpel at the point where it passes between the teeth is not followed by a speedy wasting of the band which is visible upon the gums. In one case the central incisors were not successfully brought and kept together until some of the intervening gum had been destroyed with fuming nitric acid. This condition was, we believe, first pointed out by Mr. Moon.

Separation of the central incisors is not infrequently due to the presence of a supernumerary tooth, which should at once be removed (Fig. 35).

Torsion, or twisting of the central incisors upon their axes, is far from rare. The defect in position may be common to and equal in each tooth, or it may be greater in the one than in the other, or it may be confined to one tooth only. Either the mesial sides may be directed towards the palate, or they may be turned towards the lips; or the one tooth may be

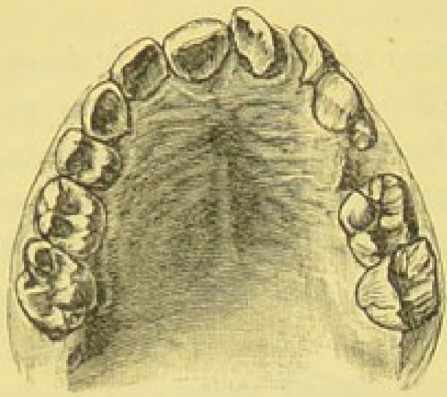


$\frac{3}{4}$

FIG. 77.—Showing device for bringing an outstanding upper incisor tooth into place. Only the terminal point of the gold spring is visible during the wearing of the appliance.

twisted in the one and the fellow-tooth in the other direction (Fig. 80).

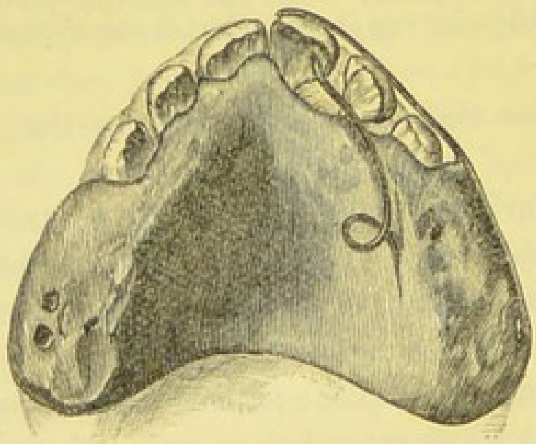
In a case under treatment at the date of publication of the first edition of this work, the right incisor made its appearance at the age of thirteen, with the lingual surface parallel with the median line of the mouth. In this case the tooth is a quarter of a turn out of place; but instances are recorded in which the twisting has extended to as much as half a turn, so that the lingual surface presents towards the lips. We have one example showing this amount of torsion in a bicuspid tooth. In many cases of this kind the malposition has been assumed during the period of development, and is then consequent upon arrested development of the anterior part of the jaw. Sometimes, however, it results from the retention of the temporary incisors. And it is not improbable that the root of a temporary tooth, if displaced by a blow or by a careless operation, may disturb and turn the successor upon its axis while within its crypt. The retarded development or eruption of a tooth may also be cited as a cause of its torsion; and it is not difficult to see how the malposition is then produced. The



$\frac{2}{3}$

FIG. 78.—Rotated incisors.

adjoining teeth being already through the gums, lean toward the unoccupied space, and offer an impediment to the progressing tooth, which, from its comparatively loose implantation at the eruptive epoch, turns on its axis, and descends or



$\frac{3}{4}$

FIG. 79.—Regulation plate fitted with inner and outer wires for rotating an incisor tooth. A later model of the previous figure.

ascends, as the case may be, in that position in which the least resistance to its progress is offered.

In no case is it desirable to lose a central incisor; hence, if we have reason to suppose that the twisted tooth is in itself perfect, it must be brought to the proper position; and should it appear impossible to obtain sufficient space without sacrificing a tooth, we must remove one or other of the more posterior teeth.

It is quite possible that cases may occur in which such a proceeding becomes necessary, although we have rarely met with them in private practice. But before deciding upon sacrificing a sound tooth, we must be well assured that the incisor is not subject to deformity, like that shown in Fig. 24, where, the descent being arrested by the presence of a supernumerary tooth, the root has been developed in an irregularly-curved form. Instances will sometimes present themselves in which the exposed portion of the crown is twisted and directed towards the palate, while the root of the tooth is in the usual position, the crown and the root being joined at an angle, presenting that peculiarity of conformation which has been denominated dilaceration. If, in such a case, a healthy tooth were removed, we should be committing a serious error. It therefore becomes necessary that a very careful examination of the mouth should be made before the treatment is determined on. The position of the root of the erring tooth should be ascertained; this may be done either by a careful examination of the gum, beneath which the outline of the root, if in the usual position, may be felt, or by the aid of a skiagram.

It is scarcely necessary to remark that when the necessity for the removal of a tooth arises, our choice will fall upon an unsound one, should such be present, even though it be at some distance from the point where the space is required.

As regards the treatment to be adopted, we cannot do better than describe the course pursued in the following case, inasmuch as the illustrations necessary for the elucidation of details will serve the further purpose of showing the method applicable to cases of irregularities affecting other teeth.

"The patient was a female, aged fourteen years. The right central incisor up to the age of thirteen did not make its appearance, consequently the crown of the right lateral and left central teeth leaned towards each other, leaving an interval insufficient for the missing tooth to take its natural position. At thirteen, however, the tooth appeared, with its mesial side directed towards the lip; but it was not till a year had elapsed that the case came under treatment. The succeeding figure will show the general position of the teeth; and it may be remarked that the canines were slightly more prominent than the anterior teeth. A careful examination led to the conclusion that, supposing the laterals and the left central incisor were pressed out, so as to range evenly with the canines, sufficient space would thereby be gained to allow the twisted tooth to hold the normal position. Acting under this impression, a plate was made to fit the palate, and attached to the bicuspids by wire continued over the crowns of those teeth on either side of the mouth, and terminated by a small T-like extremity, which, by way of protecting the teeth, was covered with a thin investment of floss-silk. In this manner the plate was firmly retained in its place.

"The next proceeding consisted in soldering to the back part of the plate two bands, composed of gold, rendered elastic by the addition of three grains of platinum to one pennyweight of the ordinary eighteen-carat gold. The free ends of the bands were adjusted to press the two

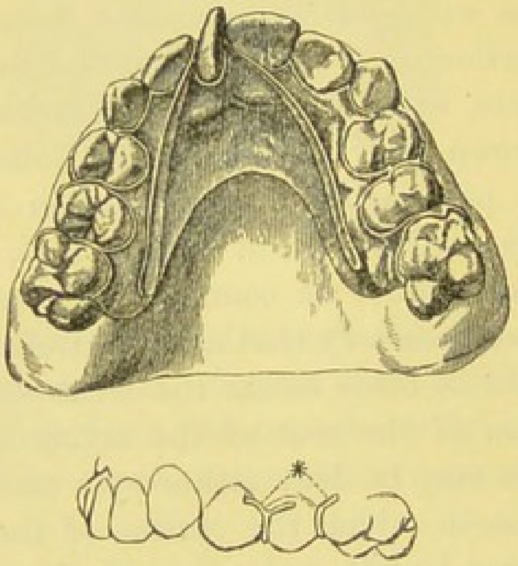


FIG. 80.—Shows the right central incisor twisted on its axis to the full extent of a quarter of a revolution, with the adjoining incisors in close contact with its labial and lingual surfaces. The metal plate used in the first stage of the operation is shown *in situ*, with the two elastic bands of gold soldered to the back part of the plate, and the free ends in a position for separating the right lateral and left central incisor in order to gain space for turning the displaced tooth. In the sketch the manner of adjusting the wire bands for the retention of the plate is shown.

contiguous teeth outwards and away from the irregular tooth, in the manner shown in the following figure.

"In the course of nine days, sufficient effect had been produced to render it desirable that the incisor itself should be acted upon in order that the increased interval should be occupied by the tooth for which it had been obtained. A second plate was constructed. In this a bar of gold was continued in front of the teeth, and attached to the anterior T-piece on either side. Metal cells for the reception of compressed wood were then soldered to the plate and to the band. One was placed so that the wood would press upon the distal angle of the tooth, the other upon the labial surface near the mesial angle. The forces thus brought into play acting in opposite directions, turned the tooth upon its axis, and were sufficient to influence the impinging lateral and central teeth, and force them out of the way of the slowly-turning tooth. In a few days it became necessary to alter the position of the receptacles for the wood, and subsequently to move them from time to time towards the retreating angle of the tooth.

"After the second plate had been in use three weeks, the tooth had so far changed its position that the mesial side stood slightly in front of the left incisor, and the distal side a little posterior to the lateral incisor, presenting a degree of irregularity which would attract but little notice.

"The front teeth having been carried into the desired position, it became necessary to take measures to keep them there until they became firmly fixed in their sockets. To effect this retention, a vulcanite plate was fitted to the palate and to the lingual surfaces of the teeth, extending as far back as the first permanent molars. The bicuspids being a little internal to the proper outline of the arch, pegs of wood were inserted into the vulcanite at the points corresponding to the necks of these teeth.

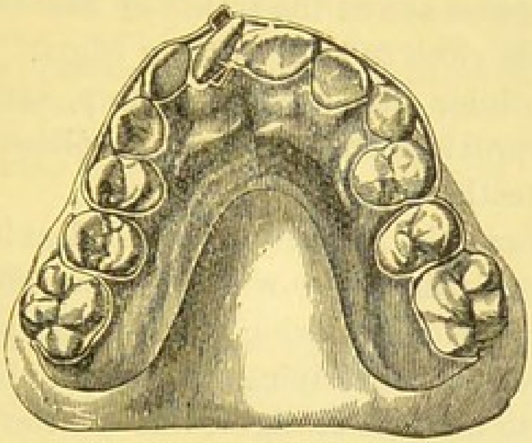


FIG. 81.—Shows the condition of the case illustrated in the preceding figure after the adjoining teeth have been separated by the elastic bands, and the displaced tooth turned slightly from its original position. The plate used in this, the second stage of the operation, is shown *in situ*, with the metallic boxes for the reception of the compressed wood in the positions suitable for effecting the further progress of the treatment. Nowadays springs would generally be employed in the place of the compressed wood.

After adjustment, the pegs projected from the plate sufficiently to press firmly upon the four instanding teeth, and thus perform the double purpose of retaining the plate in its place, and of forcing the teeth, upon which its retention depended, slightly outwards."

Were a similar case now to present itself, the earlier stages of the operation might be more advantageously treated either by first extracting a right and left bicuspid, or by one of Dr. Coffin's split plates (Fig. 69), and the requisite space having been gained by an equable expansion of the front part of the arch, springy pieces of piano-wire might be adjusted so as to press on the angles of the incisor and so rotate it. Or the tooth might be rotated by means of a ring of platinum foil made to fit around its neck: a strip of stiff wire is soldered to the lingual surface of the ring, bent so as to conform roughly to the outline of the palate, and traction made upon the end of the lever thus formed by means of an elastic ring tied to one of the back teeth. This plan we believe to have been suggested by Dr. Dodge.

A simple and efficacious little appliance, adapted to rotate both the central incisors at the same time, is a U-shaped piece of springy gold, bearing at one extremity a short cross-piece of gold wire, and at the other a longer piece, the longer piece of course passing, when it is in place, horizontally across the backs and the shorter piece across the fronts of the teeth, while the bend of the U lies close to their cutting edges. The appliance, in fact, is something like a small clamp, and is similarly applied, the approximation of its cross-pieces effecting the rotation of the teeth.

It must, of course, be securely fastened, lest it be swallowed. It may be made of thin piano-wire, thus avoiding the loss of elasticity consequent on soldering on the cross-pieces.

The easiest way of remedying this loss of elasticity, if it be made of gold, is to make it straight, like a letter H with a very long cross stroke, and hammer the wire which is to form the spring before fully bending it into its curved form.

A method which dispenses with the use of plates, and is efficacious though a little troublesome of application, has been described by Mr. Balkwill (Brit. Journ. Dent. Science, 1881).

"After some consideration of the conditions involved, it seemed manifest that the right principle to work on was to consider the tooth as a pulley, to be rotated by a cord in somewhat the same way that a window-blind roller is moved.

"The following case will illustrate the method finally settled upon in applying this principle:—

"Fig. 82 represents the position occupied relatively by the central incisors of a lad of thirteen, which it was desired to reduce to their normal position in the dental arch.

"A piece of fine silk twist was tied around the middle of the crown of each tooth, the knot being on the front a little nearer the mesial line than the centre of each crown (see Fig. 82, *a*, *b*).

"The two ends of one of the ligatures, say *c d* of the left hand in the drawing, were then passed between the centrals, round on the lingual face of the tooth, and forward between the central and lateral of the same side, as shown in the drawing. It will be seen that if these ends are together pulled transversely to the long axis of the tooth the strain will be to rotate the tooth. The ends of the other ligature were brought round the other tooth, on the right in the drawing, in the same manner.

"A small block of compressed willow-wood was then taken, about the length of the crowns of the teeth, a quarter of an inch wide, and less than an eighth of an inch thick, the compression being in the direction of the thickness. This was placed against the crowns of the teeth so that the length corresponded with and covered the mesial division between

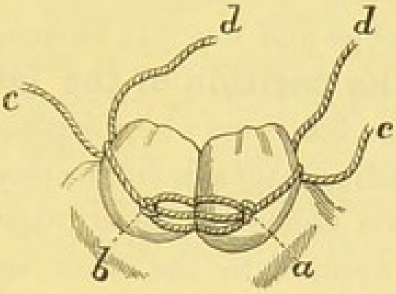


FIG. 82.—Two upper central incisors. A silk twist ligature is tied around the middle of each crown in a knot at *b* and *a*. The two free ends of each of the two ligatures are then passed between the centrals, brought round on the lingual surface, and forward between the central and lateral, as at *c d*, and *c d*, the two ends in each case belonging to the same piece of string to be used as shown in Fig. 83.

the teeth, one of the surfaces of its width being against the anterior surfaces of the teeth (see Fig. 83, *a*).

"It will be seen that it also rested against the two knots (Fig. 82, *a*, *b*). The two loose ends of the ligatures (Fig. 82, *c c*) were then brought over it and tightly tied, and then the two ends (Fig. 83, *d d*) in the same

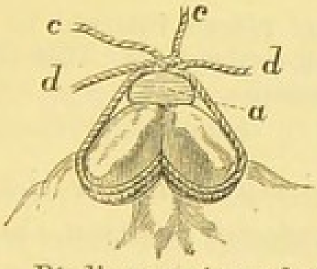


FIG. 83.—Bird's-eye view of the same teeth as Fig. 82. *a*, a small billet of compressed wood tied upon the front of the incisors by means of the free ends of silk, as shown in Fig. 82, *c c*, *d d*, being brought in front and tightly tied there, *c* to *c*, and *d* to *d*. The wood in swelling pulls upon the ligatures and rotates the teeth.

FIG. 84.—Result of action on case drawn in Fig. 82 in ten days.

manner. When the wood swelled it pulled upon the ligatures, and as it pressed upon the knots (Fig. 82, *a b*) at the same time the ligatures could not slip, but rotated the teeth.

"In the case under notice the piece of wood had to be renewed once, and reduced the teeth to the positions indicated in Fig 84 in ten days."

But the process of twisting a tooth on its own axis by means of gradual pressure is one that often necessitates the use of an appliance for a very considerable length of time, and inflicts no small discomfort on the patient; and it has already been mentioned that the same end may be attained by seizing the tooth in a pair of forceps and forcibly twisting it round.

Irregularity in the position of the lateral incisors.—In the upper jaw these teeth may be misplaced in the direction described in the preceding pages in connection with malpositions of the central incisors, hence the description which has served for the one may be applied to the other series of deformities.

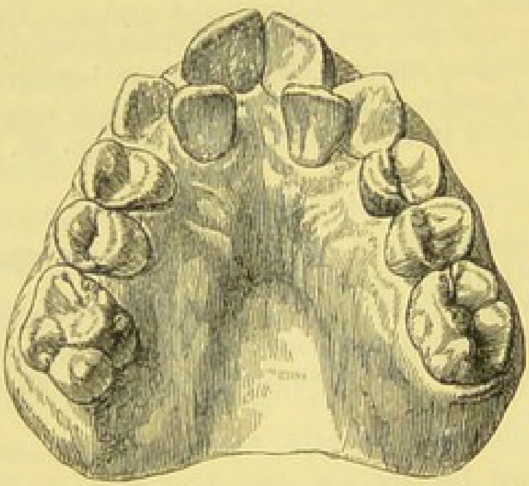


FIG. 85.—Showing the lateral incisors placed internal to the dental arch, the alveolar arch being contracted. This illustration is taken from a cast of the mouth.

Perhaps the most common form of irregularity of the lateral incisors is that in which they take a posterior position, the mesial edge of each lying behind the contiguous side of the central incisor, and the distal edge behind the mesial side of the canine.

In the example figured the teeth have retained the position assumed during their development, when, from the insufficient size of the anterior part of the arch, this or some other form of displacement was a necessity. The canines here hold the place which should have been occupied by the lateral teeth, but had the latter taken their normal position, the former would have been thrown out of the dental line.

We must not, however, in endeavouring to trace the cause of mere misplacement, in cases like the one figured, forget that had a proper direction been given to the teeth as they successively appeared through the gums, the alveoli would have grown up with them, and if the base of the jaw had attained a sufficient size, no irregularity would have occurred, even had the teeth, when within the jaw, been somewhat irregularly disposed.

In the case from which the succeeding illustration is taken, there is no indication of contraction of the jaw. On the one side of the mouth, the teeth are perfectly regular; on the other, the lateral incisor and the canine are directed inwards, and pass, when the mouth is shut, behind the corresponding teeth of the lower jaw. The arch being at this point bent inwards,

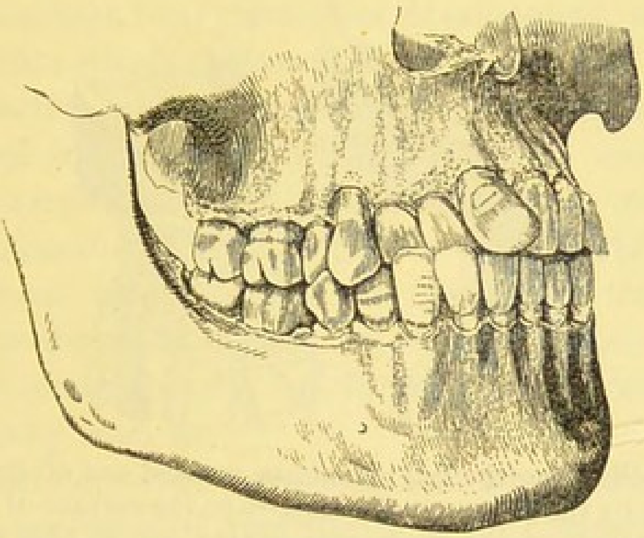


FIG. 86.—Showing the lateral incisor and canine inverted, and the central incisor driven outwards and across the fellow tooth, the alveolar arch at its base being free from contraction.

and the alveolar space thereby contracted, the teeth, in order to find a place for themselves, have forced the central incisor forward, and driven its median edge over the labial surface of the adjoining tooth. In this specimen we have an example of irregularity consequent on the teeth, from some cause (probably the retarded ejection of the temporary teeth), taking an improper direction at the time of eruption, the jaw being normal in size; in the preceding case, an illustration of irregularity consequent upon a contracted maxilla.

A slight degree of eversion and separation of the lateral from the central tooth at the time when the canine is advancing towards the surface of the gum is far from uncommon, and when the latter tooth is impeded in its progress by the presence of its temporary predecessor the disturbance of the lateral incisor becomes still more marked. The following figure shows the effect produced by the foregoing combination of circumstances.

When, from want of full space, the crypt of the canine comes to occupy a position immediately over the root of the lateral incisor instead of one between its root and that of the bicuspid, it has a tendency to press inwards the apex of the lateral's root, and by so doing to make the cutting edge stick out; if things are left in this state until the proper period for the eruption of the canine, the irregularity of the lateral will be a little

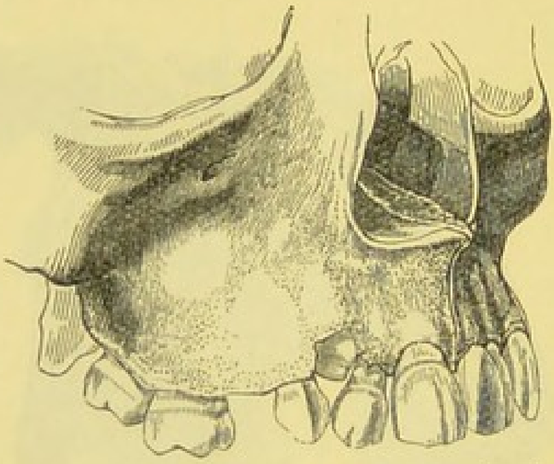


FIG. 87.—Showing the lateral incisor pressed out of the normal position by the canine in its descent to the surface of the gum. The presence of the temporary canine has in this specimen occasioned the permanent tooth taking the oblique direction.

troublesome to correct, and it is, therefore, desirable to give the canine room to pass backwards as early as possible.

In order to do this, the ordinary rule of not extracting the temporary canines should be broken through, and if this appear to be insufficient to allow the canine to get back, the first bicuspid, unless such a course of treatment be otherwise contra-indicated, may be extracted. It is not generally known that this may be done, not only with perfect safety, but even oftentimes with advantage, before it has been erupted, and even before the temporary molar has been shed, by removing the temporary tooth, and thrusting up a fine pair of stump forceps, with which the bicuspid may be reached with surprisingly little disturbance of the surrounding parts. This procedure may often be resorted to in cases where the first permanent molars are sound and space is greatly needed, and with most excellent results as, the space being given at such an early date, the teeth accommodate themselves exceedingly well, and we are convinced that in many cases the subsequent wearing of a plate which would otherwise have been inevitable has been avoided.

When the conical form of the canine, its crown being so greatly wider than its somewhat flattened root, and the strongly prominent convexity of its median side, are taken into account, we shall not be at a loss to see how during its descent the root of the lateral incisor is pressed upon, and the crown consequently forced out of position. Instances are not wanting in which the root of this tooth has been more or less absorbed, to make way for the canine; and we have an example in which the root has been bent during its development, so as to form a hollow, within which the convexity of the canine lay.

In connection with malposition of the canine, a figure will be given, taken from a case in which the lateral incisor has been driven outwards towards the lip by the canine coming through the gum immediately behind the former tooth (Fig. 99).

Under such circumstances the descent of the canine may threaten to force out the lateral, which may become loose and exquisitely tender; but it will speedily recover when the canine is drawn away from it.

The principles which have been laid down for the treatment of the various forms of irregularity in the central, apply equally to the lateral incisors when similarly situated, excepting that the one is, as respects appearance, a less valuable tooth than the other, and may therefore, under certain circumstances, be sacrificed with less hesitation. When, for instance, the lateral teeth are situated as in Fig. 85, we need not hesitate to remove them, supposing the antagonism to be normal, and that a more forward position of the central teeth would leave a wide interval between the lingual surface of the upper and labial surface of the lower teeth on the mouth being closed. But if the central incisors in such a case also passed behind the corresponding teeth of the lower jaw, it would then be certainly right to push all four forwards, as the removal of the lateral incisors would lead to a very unsatisfactory result.

Irregularity in the position of the canine teeth.—Owing to the position in which it is developed, its crypt lying well above and outside that of the other teeth, no other tooth is so frequently out of position when it first emerges from the gum as the upper canine, and no other tooth so frequently, when erupted out of place, gains a correct position without any subsequent mechanical interference.

It is a matter of every-day experience to see a canine outside and above its proper position at the age of eleven or twelve years, which in a few years assumes a perfectly regular position without any treatment; and it is an equally common experience to see quite unnecessary treatment undertaken to remedy what looks like a considerable and disfiguring irregularity, which, if left to itself, would eventually come perfectly right. But this will only happen if there is almost an adequate space for its reception between the lateral incisor and the bicuspid. Apparently the space is often slightly increased by the lateral and central growing slightly forwards, but if the space is very insufficient, interference becomes necessary and should not be delayed.

The incisor and bicuspid may be pressed apart by any suitable appliance, but if there is very little space it may be better to extract a tooth.

The canine is the most durable tooth in the whole series, and hence it seldom should be sacrificed, unless the axis of its root lies in such a direction that it is quite hopeless to attempt to bring it into line.

Teeth erupted high above the alveolar margin and directed outwards have not infrequently short and curved roots.

Thus in one case in which the canine was so placed, and appeared incapable of reduction to its proper position, on removal the root was found to be short and curved. Had an attempt been made to bring it into line, the apex of the root would have been forced through the labial surface of the gum, and the crown would have stood at a higher level than the corresponding parts of the neighbouring teeth. To have sacrificed the lateral or bicuspid for this defectively-developed tooth would have been an obvious error; and to have forced the anterior teeth outwards would have been equivalent to producing a deformity in the whole in order to meet that which had arisen in one of the front teeth. Hence, although the rule that the canine should be preserved is thoroughly a sound one, it must not be blindly followed in every case, but the ultimate prospect of getting it into place must be carefully considered.

When we have reason to suppose that an out or in-standing canine is not in any way defective, yet the space accorded to it is insufficient, and the anterior teeth, as respects the teeth of the opposite jaw, are well placed, it becomes a question which of the neighbouring teeth should be removed. The selection must be made in reference to the condition of the adjoining teeth. Should either the first permanent molar, or either of the bicuspids, or even the lateral incisor, be carious, we shall have no difficulty in making our choice ; and should more than one of these teeth be diseased, we should then select for removal that one which is nearest to the canine. But if all the teeth are sound, the old rule used to be to sacrifice that which is the most liable to become diseased. In Sir John Tomes's lectures on Dental Physiology and Surgery it was shown that the first permanent molar exhibits the greatest tendency to disease ; thus under the age of fifteen the respective liability to loss from caries runs in the following order :— Lateral incisors, $3\frac{1}{2}$ per cent. ; first bicuspids, 7 per cent. ; second bicuspids, $8\frac{3}{4}$ per cent. ; first permanent molars, $68\frac{1}{4}$ per cent. The statistical facts advanced in the lectures have been confirmed by Mr. Underwood, and although later tables do not exactly correspond with these figures, the first permanent molar still remains as undoubtedly more liable to caries than any other tooth.

It is, however, to be noted that had statistics at later ages been taken, the bicuspid would not have come out in so favourable a light. And with the greater and earlier attention now given to the teeth, the preservation of the first molar even when carious is generally feasible—indeed, they are oftentimes more easy to preserve than the bicuspids, especially when not crowded. And although plenty of models can be shown in which a perfectly satisfactory result has ensued after the extraction of first molars, yet there is a liability to unfortunate consequences in the way of tilting of the second molars, and of other derangements of the bite, which does not appertain to early removal of a bicuspid. (Figs. 70 & 71, p. 124.)

On the other hand, it is no rare event to see the first molars of markedly inferior structure, and in this case their ultimate preservation is not likely, so that they become less valuable and should be selected for extraction.

If, however, first molars be extracted, the question of date arises; upon the whole it seems advisable to wait until the second molars are fully erupted and articulate with one another exactly, as they are then less likely to fall forwards into an oblique position, and so lose masticating surface. And it is quite possible to extract first molars and get no gain of space in front of them after all, the second molars coming forwards rather than the bicuspids movingback. (Fig. 71, p. 125.)

Measures must therefore be taken to prevent the second molars moving forwards, either by means of a plate designed for this purpose alone, as sometimes practised by Mr. Woodhouse, or by at once setting to work to pull the bicuspids back.

A large number of models exhibiting the untoward results of extraction of the first molar without taking these precautions were exhibited by Dr. Davenport.

On the several grounds of absence of possible untoward results, the minimisation or abolition of subsequent wearing of plates, the great value of the first molar for mastication, and, perhaps, the easier preservation of the first molar than of the bicuspids, the practice has changed; and nowadays, unless the molars be very bad, most practitioners prefer to extract a bicuspid either before or after its eruption, as may be thought desirable. Canines, as already mentioned, generally fall into place of themselves, but if any appliance is thought necessary, some form of spring pressure is usually the best.

If the first or second bicuspid be extracted—the choice being dictated by the absence or presence of caries, and by the bite tending to lock the teeth in their present position or not, no such untoward result ever happens, and the case may generally be left to nature.

The first bicuspid, of course, gives the more immediate relief to crowding in front of the mouth, and, in the absence of reason to the contrary, should be selected if there be much crowding; if but little space is sought, the second will suffice.

In a patient past the ideal age for regulation by extraction, but in whose mouth a tendency to crowding renders it advisable to obtain room, choice will often fall on the second bicuspid in preference to the first, partly because the slowly closing space is less conspicuous in that situation, and partly because some relief will also probably be afforded to the wisdom teeth when they erupt.

Irregularity in the position of the bicuspids.—It rarely happens that the front teeth are crowded without the bicuspids to some extent participating in the general irregularity. They are usually situated inside the normal position, and are instrumental in throwing the canines out of the proper line, or in giving the appearance of undue prominence to those teeth. The bicuspids may be regarded as forming the base of the semicircular dental curve, which, if contracted, necessarily involves either a deviation from the normal figure, as seen in the V-shaped mouth, or obliges some of the teeth to take either an external or an internal position.

If the curve described by a perfectly well-arranged set of teeth be examined, it will be found that it approaches a semicircle as far as the bicuspids, and that the molars occupy curvilinear lines, diverging slightly as they proceed backwards. The arch admits of division into two parts, the anterior semicircular portion being occupied by the successors of the deciduous teeth, the posterior division by the true molars—teeth which have no predecessors. Should, therefore, the breadth of the jaw at the junction of the two divisions fall below the proper extent, and the bicuspids of either side consequently approach too near the median line, not only will the front teeth be thrown out of the semicircular curve, but the molar teeth will occupy lines which, although diverging from the starting-points, will nevertheless fail to attain an amount of separation, as respects the two sides of the mouth, consistent with a well-developed dental arch. Figure 96 illustrates this condition, and, indeed, shows an indentation in the arch at the points of junction of the molar and bicuspid teeth.

Although it is not a common cause, cases may be found in which disease in the temporary molars, and subsequent alveolar abscess, have occasioned the displacement of the bicuspids; and dead roots of milk-teeth, being apparently less readily absorbed than healthy roots, often oppose the normal eruption of bicuspids. Sometimes the first bicuspids may be driven outwards by disease about the first temporary molars, and like the teeth in the front of the mouth, the bicuspids may be diverted from their proper position by the persistence of temporary teeth.

When one only of the two bicuspids is involved, we shall generally find the second bicuspid to be the misplaced tooth.

In that case the mischief may have been produced either by want of sufficient space for a regular arrangement, or from the presence of the whole or a part of its predecessor.

When the former cause has led to the deformity, the degree of displacement will vary in accordance with the amount of contraction of the allotted space. Thus, when the first bicuspid and first molar are closely approximated, the second bicuspid or premolar commonly comes through the gum internally to the arch.

It is far from uncommon to find the latter tooth twisted upon its axis by the presence of the lingual root of the second temporary molar, wedged between the first permanent molar and the former tooth. In a succeeding figure (Fig. 101) the second bicuspid is completely turned round, so that the lingual has become the labial surface; and in this case the labial root of the temporary tooth has been retained.

In determining upon the course of treatment, we must be guided, in the first place, by the condition of the jaw. If the base is contracted, it may be necessary to remove a tooth; but should the teeth be turned inwards, and their outward movement possible without derangement of the anterior part of the dental arch, we must then adopt a plate, and have recourse to the compressed wood wedges, to jack-screws, an expansion-plate made to bear specially upon certain teeth, or to springs. Either metal or vulcanite may be used in constructing the apparatus, and wedges, if properly proportioned, will serve for its retention without the aid of ligatures or clasps. The movement is very readily effected, being sometimes unintentionally brought about by the very moderate pressure of artificial teeth; but we must not neglect to take into account the antagonism of the opposing teeth. Usually the lingual cusps of the upper close between the outer and inner cusps of the lower teeth, and unless the lower bicuspids are moved outwards contemporaneously with the upper teeth, the normal antagonism will be destroyed. Moreover, there will be a strong counteracting force exercised by the stationary teeth upon those under operation. If the upper teeth, for example, are moved outwards so that the lingual cusps close on the apices of the labial tubercles of the lower teeth, the other teeth will be kept apart until the lingual cusps of the moved teeth slide down either upon the inner or outer surface of the labial cusps of the lower teeth. In those cases in which we find a faulty antagonism our treatment becomes more simple. If, for example, an upper tooth closes externally or internally to its antagonist, our operation will be confined to the malplaced tooth, which, so soon as it approaches its proper position, will be carried onwards in the proper direction by the influence exerted by the antagonising tooth of the lower jaw, in the manner described in connection with misplaced central and lateral incisors.

Irregularity in the position of the crowns of the permanent molars, without the roots participating in the displacement, is of less frequent occurrence than derangement of the more anterior teeth; still, cases sometimes present themselves in which the normal positions are not maintained. Perhaps the most common form of deviation is that in which the second permanent molar on either side is turned inwards towards the median line of the mouth. In a cast given by Mr. Alfred Canton, the three molars are arranged in a triangle, the second being placed internally to the other two molars. In this case the obvious remedy would be the removal of the malplaced tooth. In cases where the first molar leans in towards the palate, the position might, we presume, be changed by the persistent use of compressed wood applied in the manner already described; but we rarely find these teeth out of place without the anterior teeth participating in the derangement, in which case the treatment would become very tedious were we to attempt to reduce to order the whole of the teeth situated anterior to the second permanent molar. In the vast majority of the cases which have come under our notice this treatment has been rendered inadmissible by the coincident contraction of the base of the jaw; and in those in which pressure might have been used, not only must the upper teeth have been operated upon, but the corresponding teeth of the lower jaw also, in order to maintain the proper antagonism.

As malposition of the wisdom-teeth almost invariably involves their removal, whatever may be the position of the roots, the consideration of the whole subject in respect to these teeth will be given in connection with their total displacement.

In treating of those cases of irregularity which admit of mechanical correction, we have confined the description for the most part to the teeth of the upper jaw, under the impression that it would be unnecessary to give a detailed account of the defects of arrangement in the corresponding organs in the mandible. It may, however, be stated generally that the forms of irregularity which occur in the upper may also arise in the lower teeth, and that the treatment suitable for the one will be equally fitted for the other. The construction of the plate, whether metal or vulcanite be used, will of course be modified. We have here to adapt the apparatus to the teeth and the lingual surface of the gums only. Excepting in the foregoing particulars, the methods of operation will be precisely similar to those already described. The vertical position of the lower teeth renders the retention of the compressed wedges of wood particularly easy, and this advantage is still further increased when the teeth so operated upon are inclined either outwards or inwards. Mechanical appliances for the correction of irregularities of the lower teeth are seldom necessary, judicious extraction being all that is required in the majority of cases. This is due partly to the smaller rooted anterior lower teeth more readily availing themselves of any space afforded by extraction; partly to the lower incisors articulating behind the corresponding upper teeth, and so sharing in any improvement in the upper arch; and partly to the more constant pressure-influence of the tongue and lower lip upon the development of the mandible and the arrangement of its teeth.

The consideration of teeth, which are completely misplaced, is deferred till after all those forms of irregularity, admitting of conservative treatment, have been discussed.

Irregularities affecting many teeth.—So far, those irregularities which affect a few only of the teeth have been discussed. From the consideration of these we may pass on to that of irregularities affecting a good many teeth simultaneously, and those in which the maxillæ beyond the actual alveolar border are involved. It is often impossible to draw the line at which we may say that the basal maxilla is irregular, and oftentimes abnormalities which really do not extend beyond the alveolar border appear to do so at first sight.

The late Mr. Oakley Coles proposed a method of measurement which is useful in determining the position and nature of abnormality in the development of the jaws. If the point of a pair of compasses be placed at the margin of the gum on the lingual aspect of the first molars, and the transverse measurement thus obtained pricked upon a piece of paper, and then a measurement be taken by sweeping one leg of the compasses to the interspace between the central incisors, these two distances in a normal jaw will be found to be the same; for those in which the antero-posterior distance is greater he proposes the name of dolichoid, and to those in which it is less the term brachoid jaws (Trans. Odont. Soc., 1880).

It will be found useful, before forming a judgment upon these cases, to try to estimate what the alveolar borders would come

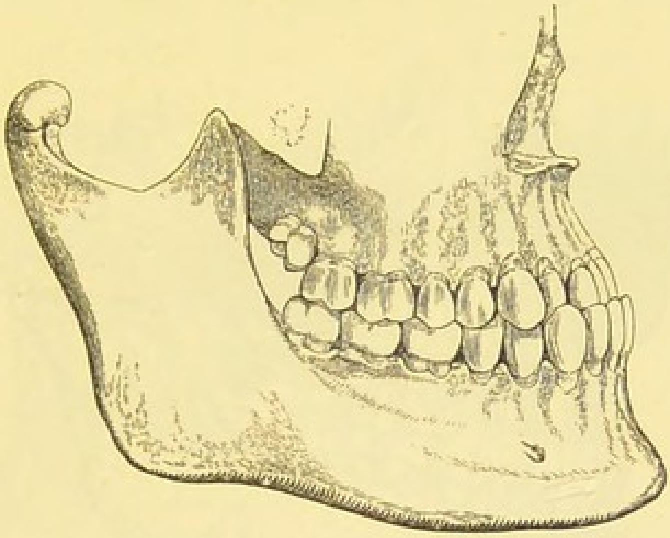


FIG. 88.—Showing the condition of the teeth and jaws in a specimen in which the anterior upper teeth were inverted coincidently with defective size in the superior maxilla.

to were all the teeth removed and the gums allowed to shrink; presented to the mind in this way, a different and more correct conclusion will often be formed from that derived from a mere cursory inspection of the mouth, and it will be found that cases really involving extensive deformity of the whole bone are much more rare than has been supposed.

PROTRUSION OF THE MANDIBULAR TEETH.

One of the simpler forms in which many teeth are involved is that in which the upper anterior teeth, instead of standing out far in front of those of the mandible when the mouth is closed, are directed inwards, and pass behind them. The patient is said to be under-hung. The upper lip is generally short and retreating, while the lower lip and chin hold an unusually forward position.

If the coincident conditions of the jaws be examined, it will be found either that the alveolar ridge of the upper maxilla is unusually small, as shown in the accompanying figure, or that the lower jaw has departed from the normal form. In the specimen from which the illustration is taken, the inferior maxilla does not differ, either in general dimensions or in configuration from the normal specimens; but the upper jaw lacks sufficient development of its alveolar portion. The teeth are placed regularly, but the alveolar line is fully occupied, to the exclusion of the wisdom-teeth; and the second

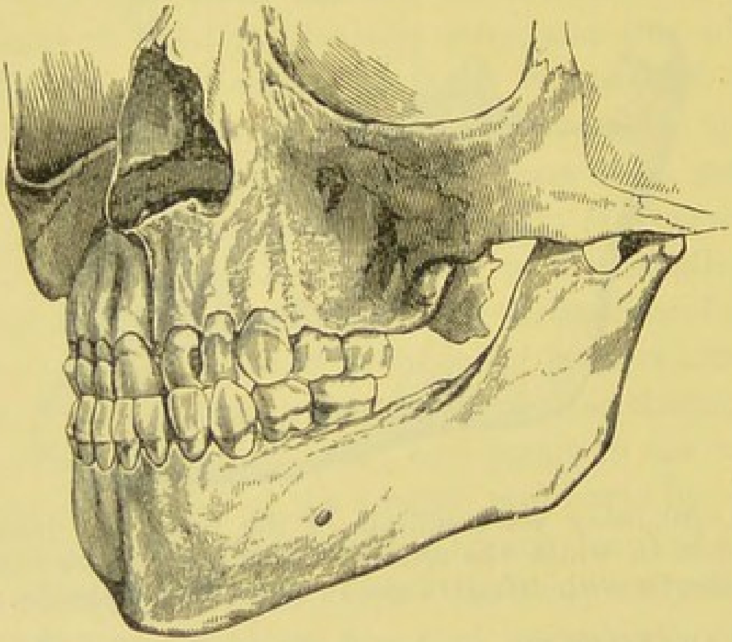


FIG. 89.—Shows inversion of the upper front teeth coincident with unusual development of the lower jaw, the upper maxilla having attained the normal dimensions.

molar closes upon the third molar of the lower jaw in the position usually assigned to the wisdom-tooth, which, from its backward direction, is thrown altogether out of use.

The figure which illustrates the "inversion" of the upper teeth coincident with a well-grown upper jaw, is taken from a specimen in which some temporary teeth are present. In this case we have an excess of growth in the lower jaw, the body of which is unusually long, and is associated with a ramus which has preserved the obliquity characteristic of an earlier age. The line of growth, as indicated by the position of the articular process, is calculated to give great length of jaw at the expense of depth in the posterior portions of the alveolar line.

The cause of this want of proper relationship between the upper and lower jaws and their respective teeth, is in many cases very obscure. In certain families it occurs as an hereditary character. In other cases, the deformity may have been consequent upon the relatively tardy eruption or the inverted position of the upper teeth in infancy.

But whatever may have been the cause, the malposition will be persistent, unless remedied by mechanical interference.

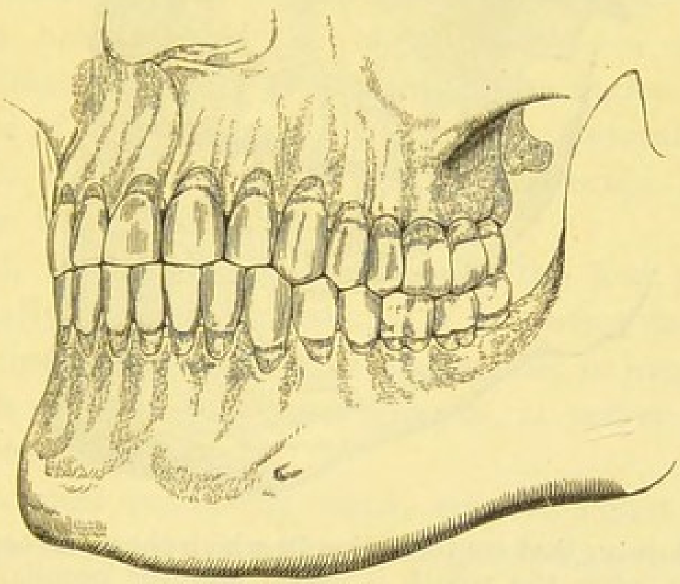


FIG. 90.—Showing the front teeth meeting edge to edge.

The under teeth will present a barrier to the outward movement of the inturned teeth.

For the treatment of such a deformity many of the ordinary appliances will suggest themselves as appropriate, and amongst others the expansion plate in its various developments. But a method adopted by Dr. Kingsley ("Oral Deformities," p. 129) deserves special mention on account of its originality: having such a case to treat, it occurred to him that if all the teeth were simultaneously forced apart they could only move by spreading around a larger arch; he therefore placed india-rubber wedges between all of the upper teeth, having inserted a plate with points carried well in between the necks of the teeth to prevent the wedges from pressing down upon the gums unduly. In the short time of twenty days the whole of the upper teeth had passed outside the lower row, and the treatment of the case was complete. The wedges were introduced from the inner sides of the teeth.

The skull and chin cap may be of considerable value in the treatment of these and similar cases; either by itself or in conjunction with other devices. The insertion of plates with inclined planes have been employed with rapid and satisfactory results in other instances. (Trans. Odont. Soc., May, 1901.)

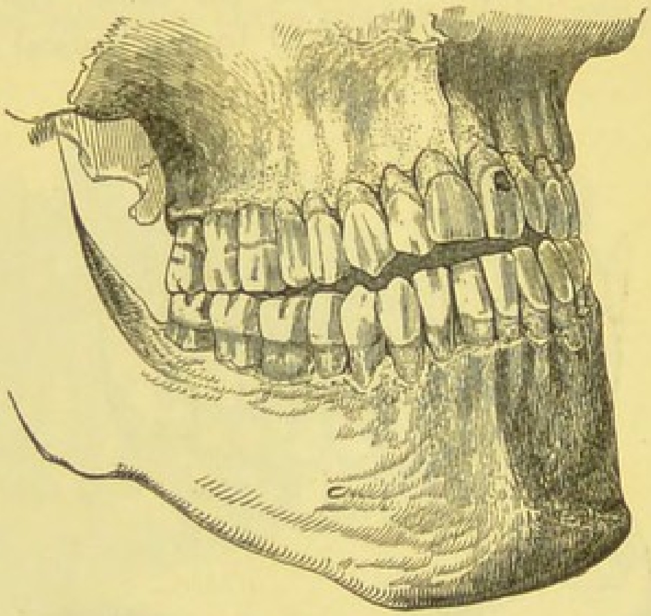


FIG. 91.—Showing that conformation in which the molar teeth only come in contact when the mouth is closed, and the peculiar form of the lower jaw coincident with the imperfect antagonism of the teeth.

In another variety the front teeth meet edge to edge as shown in the figure (Fig. 90). It may be regarded as differing only in degree from those cases in which the upper front teeth are inverted, and as dependent upon similar causes which have operated with less force. If the premolars and molars articulate well, it is better, perhaps, to leave these cases alone.

OPEN BITE.

A form of irregularity involving more or less the whole of the teeth is found associated with an abnormal development of the jaws. In the description of the case alluded to, the molar teeth, on closing the mouth, alone come in contact; while the upper and lower incisors, without being either unduly turned outwards or inwards, stand apart.

In the specimen from which the illustration is taken (Fig. 91), the degree of separation is moderate in amount, as compared with many cases presented to the practitioner; but it affords an opportunity of showing a peculiarity in the conformation of the lower jaw usually coincident with this form of irregularity. It consists in a great development of the anterior part of the jaw in the vertical direction, with a diminished depth in the parts which sustain the molar teeth, associated with an unusual obliquity of the ascending ramus. The line of growth in the latter part has not taken the rectangular direction which characterises the well-formed adult jaw. The anterior part of the alveolar ridge of the upper maxilla has not attained the normal depth—a peculiarity which the illustration does not exhibit in the degree commonly seen in cases of this nature. We have seen several instances in which in the closed mouth the finger could be passed between the front teeth.

The teeth themselves, and especially the first permanent molars, usually present indications of imperfect development of their tissues. The surface of the enamel is irregular, and marked with pits and transverse grooves, is yellow in colour, and readily broken down.

The anatomical conditions which are coincident with this form of irregularity are readily distinguished, but the causes which have destroyed the relations of the several parts of the jaws during development are very obscure. In most instances the patients have been unable without effort to breathe through the nose, and the mouth has consequently been habitually kept open, even during sleep. Possibly the constant traction exercised upon the anterior part of the jaw in keeping the mouth open, may have had some influence in determining the peculiarity of form, and the freedom from the pressure exercised mutually by the antagonistic molar teeth upon each other may have led to their rising higher with their sockets than they do when their conformation is normal.

We have attempted to diminish the amount of deformity in a few cases. In one the patient was a female, twelve years old. The front teeth were separated by a wide interval when the first molars were in contact, and the lips closed with difficulty.

The chin, although retreating, was of unusual depth, and, associated with the unclosed lips, gave a vacant expression to the face. The method of treatment which offered the greatest prospect of success consisted in maintaining a steady upward pressure upon the anterior part of the lower jaw, leaving the antagonising molar teeth to act as a fulcrum. A sheet of gutta percha was moulded to fit the point of the chin, and a cap fitted to the head, and the two were connected by strong bands of caoutchouc—one on each side. The amount of pressure exerted by this contrivance was sufficient to produce tenderness in those teeth which closed upon each other. This source of discomfort passed away of itself in the course of a fortnight, without any modification in the plan of treatment.[1]

At the end of three months the front teeth, which at the time the treatment was adopted were separated by three-eighths of an inch, now came in contact, and the general appearance of the face was greatly improved. The patient was directed to use the apparatus during the night-time for at least six months, and to show herself at the expiration of that period. These instructions were disregarded, and it was only after a lapse of two years that she was again seen. The deformity had returned with the eruption of the second permanent molars, the masticating surfaces of which teeth alone came in contact when the mouth was closed. The treatment which two years before had been attended with a fair amount of success was again adopted ; but either from want of perseverance or from the increased age of the patient, a slight advantage only was gained. Had the patient persevered, the deformity would to a great extent have been overcome. In examples of the form of irregularity under consideration, the most striking and the most important feature is the obliquity at which the ramus is placed with respect to the body of the lower jaw. The line of growth has been almost directly backwards, and the inferior dental canal, instead of being carried upwards in its posterior third, is almost straight from end to end. That form in which the rectangular position has been prematurely assumed, and the ascending ramus below the usual height, has already been adverted to. Here we have

[1] For similar cases see Kingsley's "Oral Deformities," pp. 116 *et seq.*, and "Monthly Review of Dental Surgery," 1874.

a class of cases in which the obliquity peculiar to infancy has been maintained throughout the whole period of growth, and, as a consequence, an alveolar line of unusual length is produced. In the prematurely rectangular jaw we seldom find sufficient space for the normal implantation of the wisdom-tooth ; in the oblique maxilla, on the contrary, there is room even for a fourth molar.

The specimen from which the preceding figure (Fig. 91) has been taken, affords a better opportunity of examining the anatomical relations of the several parts of the jaw than is afforded in the living subject. In this we shall see that had the alveolar portion been developed in accordance with the usual form, while the obliquity of the line of development was preserved, the separation of the front teeth would have been far greater than it is ; but nature, having departed from the normal form in one particular, to a certain extent counter-balances the deformity by a deviation in another direction. Here, the alveolar processes at the back part are unusually shallow, and in the front part of the jaw are unusually deep ; the back teeth are kept down to a low, and the front teeth are raised to a high level. The treatment adopted in the case already cited was in accordance with the indications afforded by the specimen ; the back teeth forming the fulcrum by the aid of which the elastic bands pressed the front part of the jaw upwards, and drew the ascending ramus downwards.

The following case exemplifies the extent to which the form of the jaw may be modified by constant pressure during early life. The patient was a strong healthy young woman, aged 21. Her chin was drawn down towards the sternum by a broad cicatrix, consequent upon a burn received when five years old. The teeth of the lower jaw stood out almost at right angles, and were far in front of those of the upper jaw. The accompanying illustration is taken from a cast made when the patient was in the Middlesex Hospital, and shows accurately the position of the teeth and the form of the alveolar ridge. The lower border of the jaw and the ramus being enclosed by a tense hard cicatrix, their positions and proportions could only be guessed. The accuracy, therefore, of the illustration as respects the hidden parts cannot be depended upon. The injury occurred after the temporary teeth were matured, but prior to the eruption of the permanent organs. Hence the traction exerted by the cicatrix in opposition to the natural action of the jaw, and of the endeavour to keep the face in the natural position, came into operation when the permanent teeth were passing through the gums, and when their alveolar processes were growing up with them. As the development of the permanent alveoli and the backward elongation of the jaw were for the most part effected under the influence of the ever-contracting cicatrix, we shall be justified in assuming that

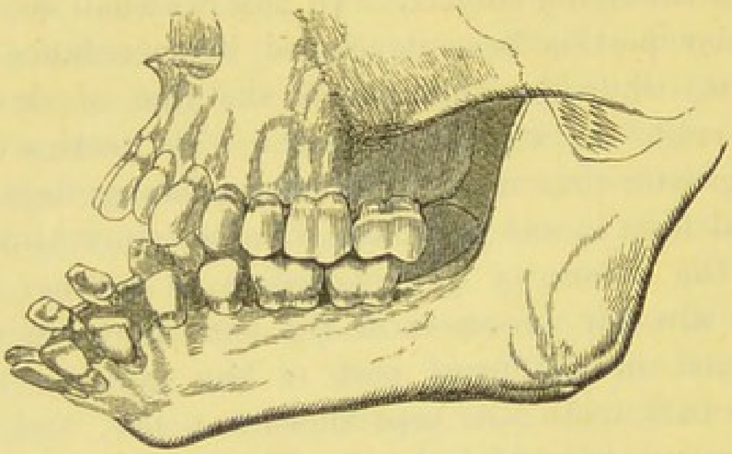


FIG. 92.—Drawing taken from a cast of the upper and lower teeth and gums of a patient, aged twenty-one, who at the age of five years was badly burnt about the neck and chest. The chin was, by the contraction of the cicatrix, gradually drawn down towards the chest, and the alveolar portion of the lower jaw became everted in the manner shown in the figure. The teeth are perfect as regards number, and are tolerably well formed. The outline of the bones has been added by the artist, and hence must not be depended on as faithful representations of the condition of those parts. See Trans. Pathol. Society, 1849–50.

they were originally formed in the everted position shown in the figure, rather than that they were developed in the normal position, and bent outwards and downwards subsequently. But whatever explanation may be adopted as regards the process by which the deformity has been produced, the case offers a very instructive illustration of the amount of change in form that a force incessant in its operation may bring about in the jaw during the period of growth.

In the museum of the Massachusetts General Hospital is a plaster-cast of a similar case, showing the whole face, head, and neck. The deformity of the jaw is very closely like that here figured, and the history of the cause is identical. The patient died from the effects of an operation in which an attempt had been made to replace the cicatrix with skin raised from the chest.

That the upper jaw may easily be distorted by a frequently repeated slight force is exemplified by the results of thumb-sucking, or as recorded in one case, the toe, or the habit of protruding the tongue which some children acquire,—sucking the tongue, if such an expression may be allowed.

It seems probable that the increased obliquity of the ramus in old age, and the progressive protrusion of the lower jaw which is observable in some aged edentulous persons, may be due to a distortion of the bone or of the articulation by the pull of the muscles acting upon it at an angle different from that which existed before the loss of the teeth and consequent closer approximation of the jaws.

A suggestive paper on the subject of open bite, by Mr. J. F. Colyer (Trans. Odont. Soc., Dec., 1896), put forward the view that there was a sort of bending of the lower jaw produced by muscular action. That is to say, that in mouth-breathers the masseter was pulling upwards at its attachment and the depressors of the jaw pulling downwards at the symphysis, with the result of producing a bending of the horizontal ramus. As he points out, the weak bones of rickets often show such bending by muscular action; but it appears to us that there is another and perhaps more probable explanation.

It must be remembered that this bending, and in fact all the phenomena of open bite arise whilst the jaw is growing rapidly, elongating backwards.

It is just as easy to conceive that as rapid elongation is taking place whilst the child is a mouth-breather and the symphysis is being held down by the depressor muscles of the jaws, growth has taken place along a curved line originally; if this be so, it would not be necessary to invoke any bending of bone after it has been formed in order to explain the phenomena of open bite.

To the effects of atmospheric pressure we are inclined to attach but little importance, though Ziem's experiment of producing distortion by keeping one nostril of a young animal blocked for a considerable time is interesting. But for atmospheric pressure to be an adequate factor, we must suppose such an amount of blocking as shall allow a difference of atmospheric pressure to arise and be maintained for a little time, but this is a degree of obstruction in the nasal passages which rarely exists: besides this the obstruction is generally principally at the back in the naso-pharynx, and hence the suck of air passing through the pharynx will tell but little on the nasal cavity of the blocked side.

Schmidt, as quoted by Mr. Baldwin in the Dental Record, vol. ix., p. 147, points out that in mouth-breathers the tongue is depressed, and its tip impinges on the backs of the lower front teeth, and this may act upon a weak or a growing bone.

Mr. Colyer has met with some success in treating cases of open bite by grinding down the points of occlusion of the back teeth until the front teeth met.

This treatment he spreads over some months, and mitigates the tenderness of the ground surfaces by rubbing them with nitrate of silver.

In certain cases a very considerable improvement, both in articulation and appearance, may be effected by the extraction of the four first permanent molars, followed by the grinding down of the more obvious remaining points of occlusion, and by the subsequent wearing of a skull and chin cap.

Dr. Emil Herbst (*Deutschen Zahnärztlichen Wochenschrift*) suggests treating cases of partial open bite, affecting the anterior teeth only, by the following method. A thin gold band is fitted and cemented on to each of the four upper incisors, each band having a small projection in front. To the first permanent lower molars also bands are fitted with hooks attached, suitable for retaining an elastic rubber ring. A Faber's No. 8 rubber ring is fixed to the right lower molar band and stretched over the upper incisors to the left lower molar, in such a manner that the rubber lies above the projections of the upper gold bands. The rubber is supposed to act by first pulling back the upper incisors and then by tending to pull them downwards, this downward pull being increased when the mouth is opened. A retention appliance is constructed by soldering the four upper incisor bands together, and uniting these with bands adjusted to the upper first molars by a gold wire fitted along the lingual surfaces of the teeth. This retention appliance Dr. Herbst advises to be worn for at least six months.

Superior Protrusion.

The front teeth of the upper jaw, including the canines, may deviate from the usual position by projecting forward. The prominence is sometimes sufficient to prevent the lips from closing; hence the teeth are constantly exposed, even when the mouth is shut. The lower lip, instead of lying over the edges of the teeth, passes behind them, while the lower teeth meet the gum behind the necks of the upper teeth. In searching for the proximate cause of this unsightly form of irregularity, we must examine the condition of both the upper and lower jaws, and also the state of antagonism of the upper and lower teeth.

The deformity may result from excessive development of the alveolar processes of the anterior part of the upper jaw; but more commonly we shall find that the molar teeth are unusually short, thereby allowing the incisor teeth of the lower to press unduly upon the inclined lingual surfaces of the teeth of the upper jaw. The upper teeth, yielding to the pressure, are forced outward, and are retained in the malposition by the teeth which have led to displacement. If, in cases resulting from the latter cause, the enquiry be extended to the condition of the lower jaw, it will be found that with the short molar teeth we have a short alveolar range and short ramus. This conformation is probably the primary cause of the mischief. Supposing the line of growth in the ramus to have become nearly rectangular, as regards the body of the jaw, prior to the development of the wisdom-teeth, and the amount of growth in the vertical direction to have been deficient, the molar teeth would be limited in height by the antagonism of the corresponding teeth of the upper jaw. That the length of the molar teeth is influenced by the growth and position of the ramus, a case under treatment satisfactorily demonstrates. In this instance the ramus has preserved the obliquity characteristic of childhood, and occasions the permanent separation of the upper and lower front teeth when the mouth is closed. The patient is upwards of fifteen, and the usual number of teeth are present, but the second permanent molars are the only teeth that come in contact, and these scarcely project above the level of the gums. Here the ramus is sufficient in actual length, but the obliquity renders its length unavailable for the vertical development of the molar teeth. If, then, we have a rectangular ramus of diminished length, with short grinding teeth coincident with well-developed incisors, it is not difficult to see that the upper will be driven outwards by the lower front teeth.

The condition under consideration may also arise from the tardy eruption of the molar teeth leaving the incisors to act for a time upon each other, as they do when from any cause the back teeth are lost. Then, again, the incisors of the lower jaw may attain an unusual height, or they may project in an unusual degree, and produce the mischief. Or the result may be consequent upon a regular linear arrangement of large teeth in a jaw having a small alveolar base, in which case the teeth prior to their eruption will assume an unusual anterior obliquity. In some instances the teeth have been slowly forced outwards by mechanical pressure consequent on a child practising the habit of sucking its thumb.

In anterior protrusion of the teeth there is often some narrowing of the width; thus Mr. Campion (Trans. Odont. Soc., 1895) found that the average width of twenty-six cases of protrusion fell 5·6 mm. below that of normal arches. Dr. Talbot has found that the width of modern arches seems to be diminishing, the early Britons and the Romans having wider arches than their descendants; and Mr. Campion believes that in this narrowing we have at least one of the causes of protrusion, so that it is not merely a deformity of the front teeth. Mr. Campion also found that in a large proportion of his cases there was an abnormal occlusion, some of the lower back teeth biting behind their proper places, and this often occurred in the deciduous dentition also. The mental prominence also is apt to be deficient in development.

It is at all events quite certain that some of the cases have arisen quite independently of any such mechanical cause as thumb-sucking, or force exercised by the lower incisors closing upon the backs of the upper.

Mr. Hepburn is inclined to think that the deformity is largely due to excessive development of the intermaxilla, the canines and teeth behind them showing the normal occlusion, in this respect differing from Mr. Campion; he also holds that with the eruption of the incisors the displacement has reached its maximum, and that with the growth of the bicuspids and molars it will tend to improve, so that he does not advocate early treatment.

Mr. Matheson has succeeded in one case in "jumping" the bite in a week by the use of tiny inclined planes, upon which the lower bicuspids bit; it seems, however, very possible that these cases were merely a return to a normal articulation which had been but recently disturbed by extractions, or by the eruption of teeth in a slightly wrong position. It seems obvious that when a bite has been "jumped" forwards the condyle must be occupying a position too far forward in the articulation, seeing that there is normally no play backwards from its proper seat.

Mr. Constant (Trans. Odont. Soc., Nov., 1900) believes that "the chief and initial mechanical cause is the loss of normal relationship between the length of the rami and the depth of the mandible in the molar region;" that is in all cases of superior protrusion not obviously due to other causes.

Mr. J. F. Colyer regards the fan-shaped uprising of the lower incisors as a cause of superior protrusion. Mr. E. Lloyd-Williams dissents from this view, and says that this fan-shaped arrangement is merely an exact reproduction of the limiting surface of the palatal arch against which the teeth impinge, and that thus the arrangement of the lower incisors is varied by the varying shape of the front portion of the palate, and is the effect, not the cause, of superior protrusion. He also draws attention to five points in connection with every typical case: viz., the apparent prognathous overgrowth of bone in the intermaxillary region, often without crowding; the marked shortening of the body of the mandible; the high level of the incisive portion of the mandible, without elongation of the incisors themselves; the low level of the mandible in the molar region, especially in the neighbourhood of the first molar; and the increased depth of the alveolar portion of the maxilla in the bicuspid and molar region.

No scientific classification of the varieties of this form of irregularity has as yet been made. Mr. E. Lloyd-Williams (Trans. Odont. Soc., Jan., 1900), dealing with the subject from a purely practical point of view, places all cases of protrusion of the front teeth of the maxilla into one of three classes :—

(i.) Simple protrusion of the teeth due to crowding.

(ii.) Dental and alveolar protrusion, with a free bite in front.

(iii.) Dental and alveolar protrusion, with the lower incisors impinging on the gums at the back of the upper incisors.

This classification is a simple and an eminently practical one, embracing as it does every variety of superior protrusion that is likely to be met with in daily practice. It has, moreover, the advantage of tending to simplify somewhat the consideration of the treatment most suitable for the case in hand. Thus a case of simple protrusion of the teeth due to crowding would be almost sure to yield to simple treatment, such as early judicious symmetrical extraction of certain teeth ; whereas a variety similar to the one just mentioned, but complicated by alveolar protrusion, would probably require somewhat lengthy mechanical treatment in addition to early removal of, say, the first bicuspids. In either case we would reasonably expect the result of treatment to be satisfactory and permanent.

Our prognosis would, however, be less favourable in an instance where dental protrusion was complicated not only by alveolar prominence, but also by concomitant mandibular malformation with fan-shaped uprising of the lower incisor teeth.

It is in this latter form of superior protrusion that so great a diversity of opinion exists both as to its causes, its rational treatment, and the age at which that treatment should be commenced.

Some maintain that the best results are obtained by postponing treatment until the second permanent molars have erupted ; any necessary space is then obtained by extraction, the protruding teeth are retracted, and a retention plate worn for some months.

Mr. E. Lloyd-Williams, while agreeing generally with this method of treatment, draws attention to the importance of carefully "raising the bite" in the bicuspid and molar region ; this he does by making a plate covering the posterior teeth, but kept free of the second permanent molars, which are thus allowed to elongate till they articulate with their fellows in the mandible; then the plate is filed away to release the first permanent molars, which in their turn elongate to meet each other; and so on with the bicuspids. Thus by bringing down one pair of teeth at a time, the bite is permanently raised. Finally the anterior teeth are slowly pulled back into a good position and retained there.

On the other hand Mr. J. F. Colyer, with whom many will agree, advocates *early* treatment. He maintains that the eruption of the canines aggravates the protrusion by the pressure which these teeth undoubtedly exert upon the incisors, if allowed to force themselves into position in a full arch. If, in cases where the first permanent molars are saveable teeth, the first premolars are removed before the appearance of the canines, the latter teeth will erupt well backwards towards the second premolars; the pressure of the incisors is thus relieved, with the result that they spread, and can be easily retracted later with a minimum amount of mechanical treatment. If the case be complicated by the fan-shaped uprising of the mandibular incisors, Mr. Colyer, who believes this condition to be also due to crowding, maintains that the most rational treatment is either early extraction of a central lower incisor tooth, or the removal of the first premolars where these teeth have previously been extracted in the maxilla.

The treatment of any form of superior protrusion is apt to be troublesome. It is not difficult to reduce the teeth to a proper position, but it is very difficult to keep them there. In a case which came under treatment some years since, the upper teeth projected outwards, so that it required a great effort to get the upper lip over them, and when the mouth was closed the finger could be laid between the lingual surface of the upper and labial surface of the lower teeth. The habitual position of the under lip was behind the upper front teeth—a habit which in itself no doubt tended to increase the amount of deformity. The arrangement of the teeth, as respects each other, was perfectly uniform and without intervening spaces, while the base of the jaw was normal in size. It was therefore quite obvious that before the teeth could be pressed backward, space must be provided to allow of their movement in that direction. In order to effect this, the two posterior bicuspids were removed; a plate was then fitted to the labial surface of the projecting teeth as far on either side as the canine, and was extended inwards below the edges of the teeth in such a manner as to prevent the under lip from passing behind the upper teeth. A strong band of vulcanised caoutchouc was connected with the plate, and passed round the back of the head. By means of this apparatus the teeth were in the course of six weeks pressed into a very good position. The lips could be closed in the usual manner, and the mouth when seen in profile had lost its objectionable prominence. The patient on leaving for the country was directed to wear the apparatus during the night for six months. After the lapse of eighteen months she returned to town with the mouth just as prominent as it had been before treatment. On inquiry it was found that she wore the plate for a month only, the elastic bands had then given way, and the precautionary measures had from that time been neglected. In the interval the wisdom-teeth of the upper jaw had been cut, and they seemed to have exercised some influence in forcing the teeth into the forward position. But some other cause than this was also in operation, as the teeth, although prominent, were not now, as formerly, in close lateral contact. The wisdom-teeth, from their position, being perfectly useless, were removed, and the treatment already described was renewed, and with the former success. The teeth have now settled down into a position intermediate between that which they held before they were subjected to treatment, and that to which they were at first reduced by the use of the plate.

A similar discouraging result is related by Dr. Kingsley. A case of extreme protrusion was treated by means of external appliances, brought to a tolerably successful result, and finally, partly doubtless owing to neglect on the part of the parents, relapsed to a state more disorderly than that from which it had started.

The tendency to revert to the old state of things is very strong in all cases of protrusion of the teeth, though, with proper care on the part of both parent and practitioner, cases of only moderate protrusion may be brought to a perfectly satisfactory end in a majority of cases. All causes which can tend to upset the gain must be carefully studied and antagonised : such points as the influence of teeth not as yet erupted, the bite of the lower teeth, etc., should be noted, and the patient

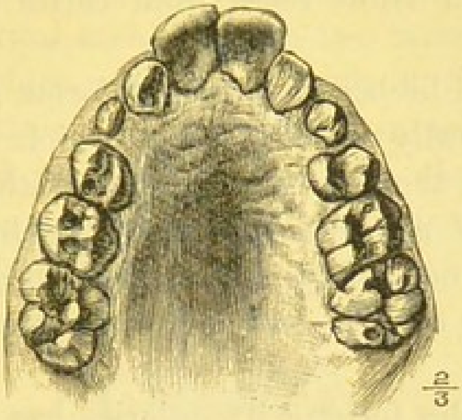


FIG. 93.—Model of maxilla in a case of superior protrusion. The first bicuspids were subsequently extracted. The next figure shows the same case under treatment at a later date.

kept under observation for a long time after the discontinuance of active treatment.

Mr. J. F. Colyer thinks that providing the action of such causes as the lower lip, the lower incisors, and crowding of the upper canines and incisors be overcome, the case will not

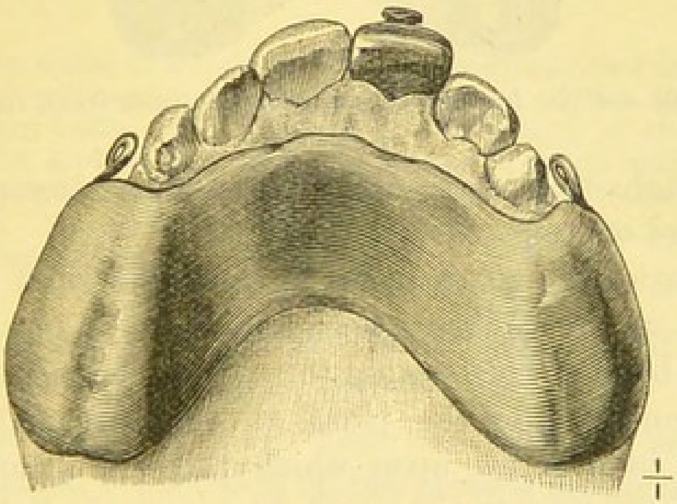


FIG. 94.—Showing appliance for retracting the upper front teeth. An elastic band attached to the eyes on either side is held in correct position by resting in the hook attached to the metal cap on the incisor tooth.

relapse if a retention plate is worn for a sufficiently long period; but that in cases where the crowding of incisors and canines can not be really overcome, a tendency to relapse must be anticipated.

It will often be necessary to draw the lower front teeth also backwards; or their injurious bite may be remedied by grinding down their tips, a course which the comparative immunity of lower front teeth from caries renders free from danger.

The choice will lie between several forms of plates, but one of the most generally useful is one in which a band of rubber dam passes over the fronts of all the teeth, which possesses the advantage of not needing very frequent attention; even this, however, is not always an unmixed good, for patients will at times presume upon it, and neglect to attend at the intervals desired.

In correcting this form of irregularity less rapidity of action

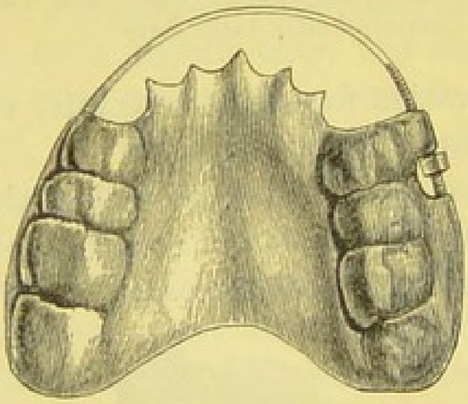


FIG. 95.—Plate for carrying the front upper teeth inwards.

is to be sought than may with advantage be attempted in the treatment of others.

But occasionally more power is desirable than is obtained by the use of the rubber bands, and may be got by a plate carrying a band of gold beaten thin where it crosses the teeth; it is vulcanised into the plate at one end, and the other terminates in a screw upon which there is a nut. This is tightened from time to time, and forms an admirably effective appliance.

Another useful form is a plate similar to that figured above, but carrying from each side strong springy wires which nearly meet in the middle. There is a tendency for the gum behind the teeth to become heaped up and squeezed against the edge of the plate, which should be freely cut away behind the front teeth and not fitted to them as shown in the figure.

Contracted Arch.

A form of irregularity which has attracted much attention is that known as the V-shaped maxilla. The teeth, instead of occupying an elliptical arch, lie upon two more or less straight converging lines, which meet at an angle at the anterior part of the jaw, producing as an almost invariable result an extremely high and vaulted palate. The abnormality is apt to be symmetrical upon the two sides, and, in a few instances,

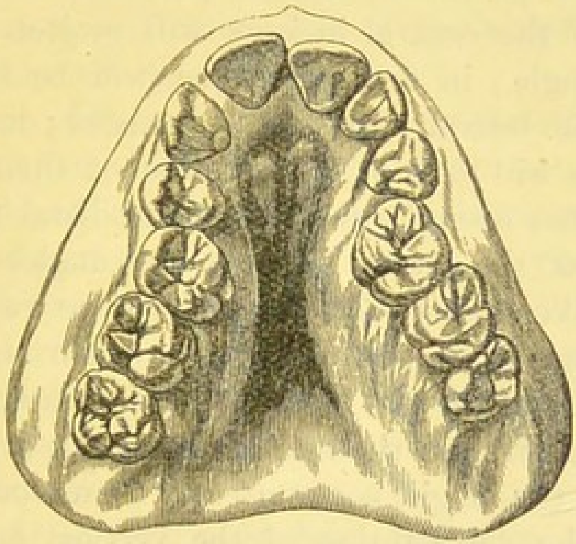


Fig. 96.—Shows a case in which the V-shaped conformation was attended with unusual contraction in the neighbourhood of the bicuspid and first permanent molar teeth. On the left side both of the bicuspids were removed, and in the right the second bicuspid was extracted without any advantage being gained as regards the contracted condition of the palate. We are indebted to the late Mr. Harrison for the use of this interesting specimen.

exists in both upper and lower jaws, although it is more generally confined to the upper alone.

We cannot help noticing that the cases of marked V and saddle-shaped contraction of the maxilla amongst children attending the Regulation Department of the Royal Dental Hospital, appear to have strikingly decreased of recent years. Whether this is the result of early surgical removal of adenoids, enabling those operated on to breathe normally through the nose instead of continuing to be mouth-breathers, we cannot say, although this would seem to be a highly probable explanation.

In its fullest development the V-shaped arch is V-shaped as regards the line of the alveolar border, and also V-shaped as regards the vault of the palate, which runs up to a line like the interior of a roof.

In most cases the lateral width is deficient, and the patients are often mouth-breathers.

Sometimes the arch and the vault of the palate are U-shaped rather than V-shaped, and sometimes there is a sharp bend inwards in the bicuspid region; to this latter some writers attach the term saddle-shaped arch.

Each case will present its special peculiarities. In one, the mesial sides of the central incisors will project forwards and meet at an angle; in another, angles will be formed at the junction of the lateral and central incisors; in a third, the central incisors will form at the junction of their mesial sides an angle directed inwards, and with their distal sides and the median sides of the lateral incisors, two angles directed outwards not unlike an inverted W. The deep vaulted form of the hard palate is sometimes carried to such an extent as to suggest the idea of the two sides of the jaw having been forced towards each other, and the roof of the mouth driven upwards. In other cases the height is not greater than would necessarily result from the substitution of the vertical for the oblique positions of the alveolar portions of the jaw, and it is not uncommon to find that the height, although apparently in excess of the normal elevation, does not really in measurement exceed that of a finely-developed maxilla.

It will not, however, be necessary to enter into all the minor modifications of form presented in cases where this character of deformity prevails. Although numerous examples present themselves in which parentage cannot be adduced as a cause for V-shaped dental arches, yet in many families this peculiar pinched form of the mouth will be found as an hereditary characteristic, traceable back in family portraits for many generations, and shared by the great majority of the members of the families at the present day.

The subject is in need of further investigation, the attempts hitherto made to classify these irregularities and to refer them to various causes being not wholly satisfactory.

With some writers the term saddle-shaped maxilla has no reference to the form of the alveolar borders, but only to the shape of the vault, which is like that of the V-shaped maxilla, but with the apex of the triangle cut off, so that there is a narrow, flat area along the median line.

Dr. Clouston ("Dental Record," 1891) regards the true V-shaped arch as merely deformed, and the U-shaped arch as neurotic. Dr. Talbot ("Etiology of Deformities of Head and Jaws," 1894) disagrees, and regards all these forms as indications of degeneracy, as also are deviations from bilateral symmetry, and regards them all as indications of neurotic temperament. In Dr. Talbot's book will be found a large number of instances of deformities of the maxilla, and of comparative measurements.

The question of the origin of these irregularities has already been touched upon. The subjects of them are often otherwise not well-developed, and are just the children most frequently the subjects of post-nasal growth, so that they are often mouth-breathers. It has been suggested that there is some compression of the bicuspid region caused by the tension of the corners of the lips and cheek when the mouth is carried habitually open, but doubt has been thrown upon this mechanical causation.

It has, however, generally been forgotten that in mouth-breathers the muscular, fleshy tongue which, when the mouth is shut, touches frequently the inner sides of the upper teeth, is held quite away from them when the mouth is carried open and breathing conducted through it, and this is probably a real factor, for what it is worth, whatever may be thought of the cheek and lip theory.

The treatment of these cases is not satisfactory: sometimes they may be expanded with advantage, but it generally happens that the whole face is modelled upon these contracted lines, and that successful expansion would do little more than give to the face an incongruous maxilla.

Total Displacement of Teeth.

Irregularities of the permanent teeth in which both the crowns and the roots are out of the normal position. Transposed teeth come under this head, but as they do not admit of conservative treatment, examples illustrative of this form of departure from the normal arrangement may be given at the conclusion of the present division of the subject.

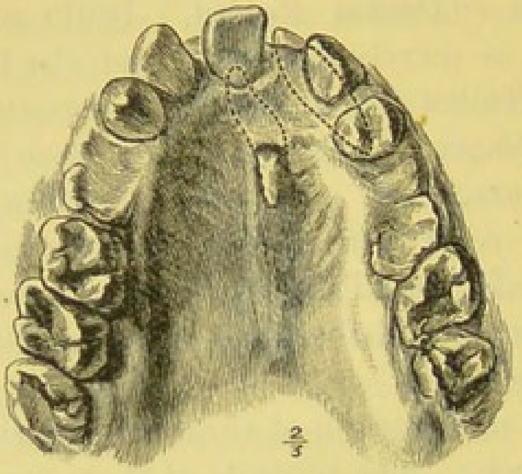


FIG. 97.—The left upper central incisor had erupted high up in the palate, causing an ulcer in the middle line of the tongue. The left canine erupted obliquely over the position of the lateral incisor. The dotted lines show direction of the roots.

The following illustration (Fig. 98) shows the amount to which a **central incisor** may be thrown out of the proper position. Here the cause is sufficiently obvious in the presence of a supernumerary tooth. Cases in which the centrals are completely displaced are, however, comparatively rare. All

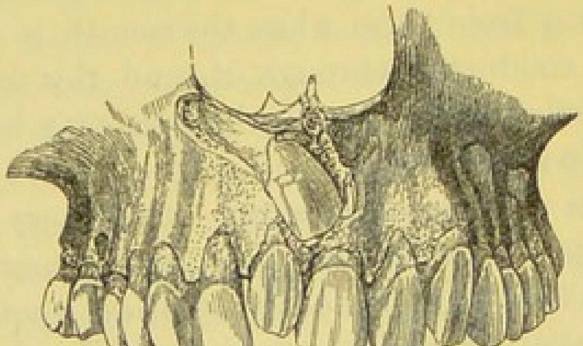


FIG. 98.—Shows the right central incisor with both the crown and root displaced, its normal position being occupied by a supernumerary tooth.

attempts at treatment would in any such case as that which is figured necessarily be useless, supposing the development of the root to have been advanced. Had the supernumerary tooth been removed as soon as it appeared, the incisor would probably have taken its normal position, although even then the displacement during development might have been too great for the operation to have resulted successfully.

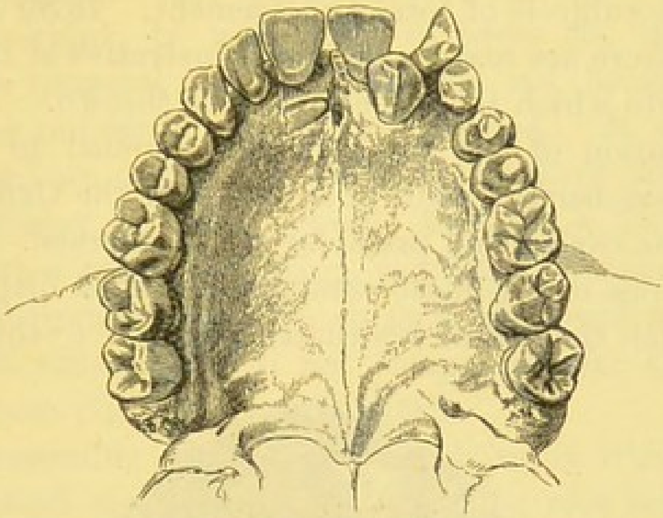


FIG. 99.—Shows the left canine placed behind the dental line, its crown holding a vertical position, and the root, unless greatly curved, equally with the crown, displaced. The lateral incisor has been everted by the canine, while the temporary canine holds the position which should have been occupied by the displaced tooth. The right temporary canine is retained, and the permanent tooth placed horizontally, a portion of the crown only being seen.

We do not remember to have seen any cases in which a **lateral incisor** had been totally displaced, excepting when

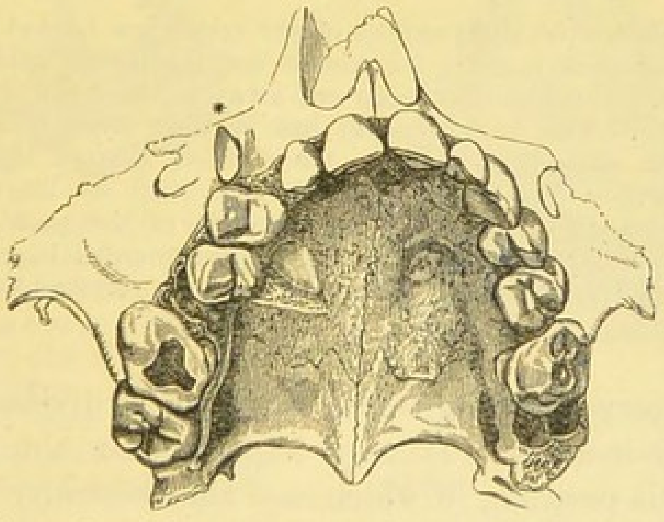


FIG. 100.—Shows the right canine placed transversely in the base of the alveolar tract, the crown being directed towards the cheek, and the root towards the median line of the mouth. The bone has been removed to show the course taken by the root of the displaced tooth.

teeth have been transposed; there is, however, no reason to suppose that they are more exempt than the central teeth from this form of irregularity.

The foregoing observation cannot be applied to the **canine teeth.** They are more frequently than any other description of teeth the subjects of total displacement. In Sir John Tomes' collection there are many examples illustrative of the abnormal positions into which these teeth may be thrown.

Transposition of the teeth is not confined to the human subject, there being a skull of an orang in the Oxford Museum in which the canine and premolar are transposed.

Perhaps one of the most common forms of displacement is that in which the canine is situated posterior to the dental line,

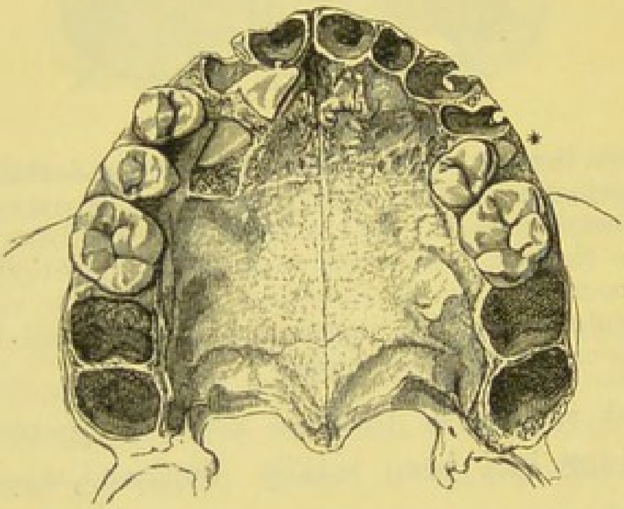


FIG. 101.—Shows the right canine of the upper jaw buried in the base of the alveolar prominence, its course corresponding with that of the latter part. The bone has been cut away to show the direction taken by the tooth. The first bicuspid has become slightly twisted on its axis by the misplaced canine. On the left side of the maxilla the second bicuspid has been twisted round until its lingual surface is directed towards the cheek. The presence of the root of the second temporary molar has probably been instrumental in producing this change from the normal position. This case is referred to on a previous page.

at a point corresponding to the space which divides the central and lateral incisors. It may happen that the crown only occupies this position, in which case the deformity would admit of remedy; but where the root participates equally with the crown, as in the example which forms the subject of Fig. 99, restoration to the normal arrangement, though perhaps not impossible, would be attended with difficulty. The question then arises as to which of the teeth should be removed. The temporary canine, if left, may endure for some years, but if it be extracted we may be unable to force the permanent tooth into its place, and should we succeed, the crown only would be moved; hence the tooth would hold a slanting and probably unsightly position. Our choice would fall upon the canine. It would, we think, be more easy to press the lateral tooth inwards, the terminal portion of its root not being displaced, than to draw outwards into line the canine. In deciding on our treatment we must in no case lose sight of the fact, that although it may be quite possible to force a tooth from an irregular into a regular position, yet that the operation may, under some circumstances, be so prolonged and painful, that the proposed advantage will not compensate for the suffering which its accomplishment would entail.

In the preceding figure a case is shown in which the right canine is placed across the dental arch, the root being directed

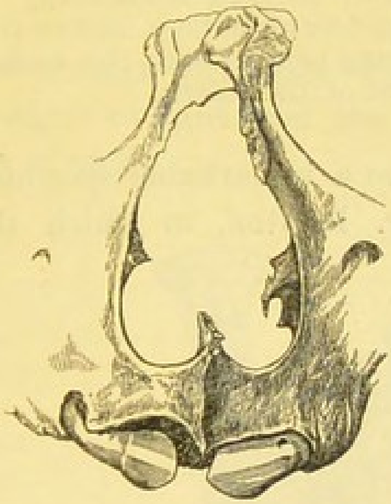


FIG. 102.—Front view of a specimen in which the canines are placed horizontally in a line corresponding with the base of the alveolar processes. They have been exposed to view by the loss of the teeth and subsequent absorption of the entire part.

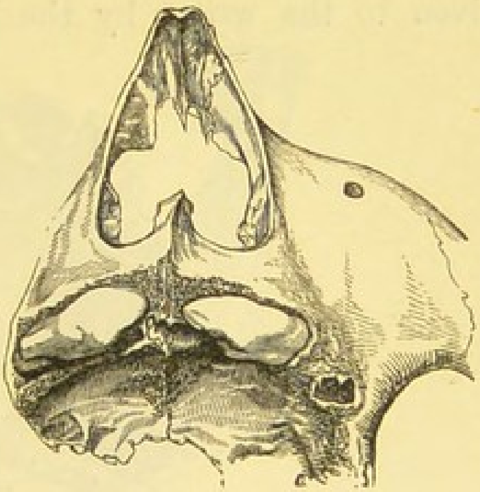


FIG. 103.—Palatal view of the same specimen shown in the preceding figure.

towards the median line of the palate, and the crown towards the cheek. The point of the crown was the only part which was not completely buried in bone. The latter tissue has been cut away for the purpose of showing the course taken by the tooth.

A horizontal position in the base of the alveolar ridge is sometimes taken by the canine, the apex of the crown being exposed to view, or covered only by gum, or embedded deeply in bone.

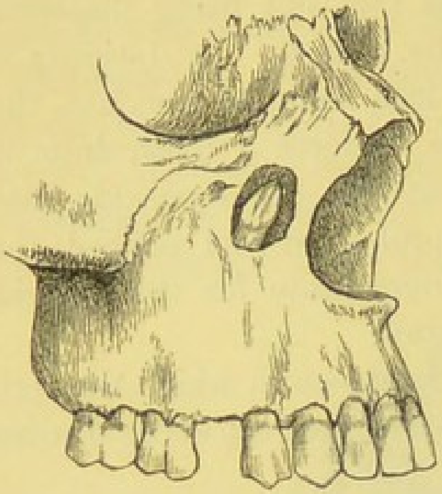


FIG. 104.—Drawn from a specimen in the museum of Massachusetts General Hospital.

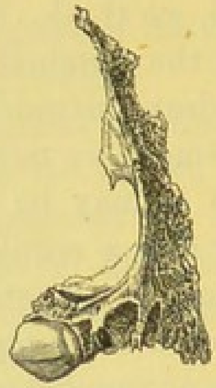


FIG. 105.—Shows a sequestrum from the upper jaw which became detached during an attack of syphilis. It contains a canine tooth situated horizontally in the floor of the nose, its direction being parallel with the median line of the palate.

Figures 102 and 103 are taken from a remarkable specimen given to the writer by the late Dr. Brinton, in which the

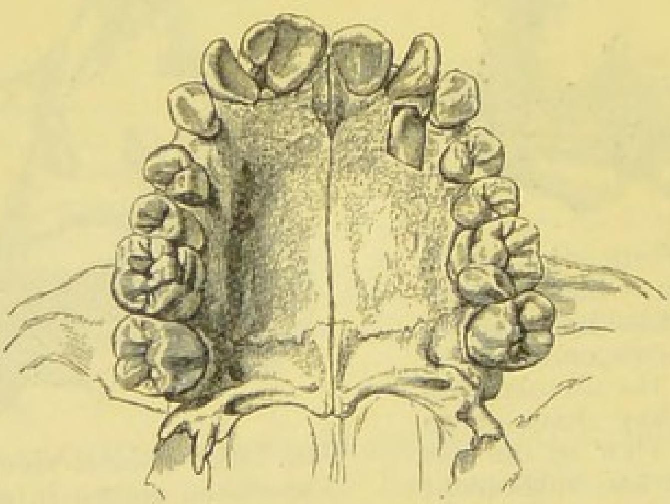


FIG. 106.—From a specimen in which the temporary canines were persistent, and the permanent canines placed horizontally. On the left side a sufficient amount of bone has been removed to show the position of the buried tooth. On the right side the point of the canine may be seen between the lateral and the central incisor. The right temporary lateral incisor has been retained, wedged between the permanent central and lateral teeth.

canines were symmetrically arranged in the horizontal position described in a preceding case.

Teeth so placed may remain without producing inconvenience through a long life, and be discovered only towards its close. When with advancing age the teeth fall out, and

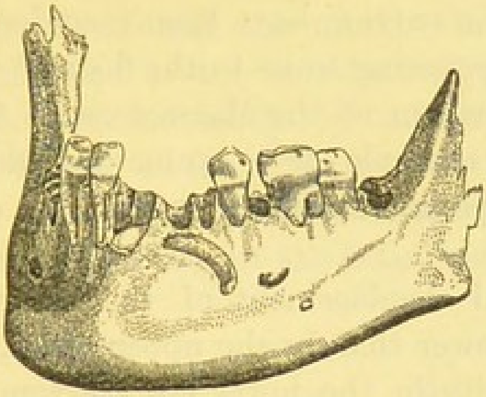


FIG. 107.—Shows an inferior maxilla in which the left canine is placed horizontally in the alveolar border anterior to the dental series. The tooth was exposed to the extent shown in the figure.

the alveolar processes disappear, the long hidden teeth are brought to light, and the patient fancies he is cutting a third set of teeth.

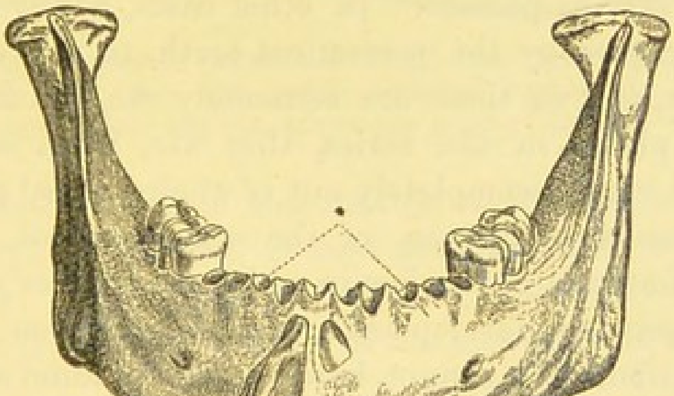


FIG. 108.—Shows a lower maxilla in which the temporary (the sockets of which are shown by the dotted lines) were retained, and the permanent canines developed within the substance of the jaw. The bone has been removed on the one side to show the direction taken by the tooth, which has been twisted on its axis to the extent of a quarter of a turn.

A patient admitted into the Middlesex Hospital under the care of the late Mr. De Morgan, lost a portion of the upper maxilla from syphilis. The dead bone on its coming away was found to contain a canine tooth, which ran under the floor of the nose in a direction parallel with the median line of the palate (Fig. 105). Excepting the absence of the canine, the dental series was normal. Several examples of the canine being found in the antrum have been recorded, in one instance its attachment appearing to be to the floor of the orbit.

And in the museum of the Massachusetts General Hospital at Boston is an example of a canine imbedded in the nasal process of the superior maxilla, with its point directed upwards (Fig. 104).

Although total displacement of the canine teeth is less common in the lower than in the upper series, examples of this form of irregularity in the lower jaw are sometimes met with. Of the two specimens selected for illustration, the one in which the tooth is placed horizontally is the more peculiar. In the second, the temporary canines were retained, and the permanent canines became matured within the substance of the jaw. The retention of the temporary may be adduced as the prevailing cause of total displacement of the permanent canine. In several of the preceding illustrations these members of the temporary set are present. In other cases, however, the arch is fully occupied by the permanent teeth, to the exclusion of the canines, and as these are commonly the last to take their respective places in the series, they are, when so excluded, liable to be turned completely out of their normal position.

The presence of disease, or the occurrence of mechanical injury in that part of the jaw in which the canines are situated when undergoing development, may drive them from their proper position. We cannot, however, call to mind a case which would serve for illustration on this point.

The results entailed by total malposition of the canines are usually unimportant. Tumours arising about the jaw have, however, in a few cases, been found to contain a hidden tooth in their centre, and the teeth so placed have been regarded as the cause of the disease; and in more than one instance, a missing tooth has been removed from the interior of a tumour, and the operation been followed by subsidence of the disease. That teeth imbedded in the substance of the jaw may become a source of irritation, and predispose to disease in the part in which they are situated, can scarcely be doubted.

In the case shown in Fig. 105, it is probable that the presence of the canine not only determined the site of the necrosis, but also the occurrence of the disease, seeing that the loss of the bone was, as regards the alveolar portion of the jaw, limited to the parts immediately around the tooth. In the year 1859 a specimen was exhibited to the members of the Odontological Society, in which a canine tooth lay horizontally on the floor of a large cavity formed in the substance of the lower jaw near its lower border. The history of the case, with the characters presented by the enlargement of the bone, induced the surgeon

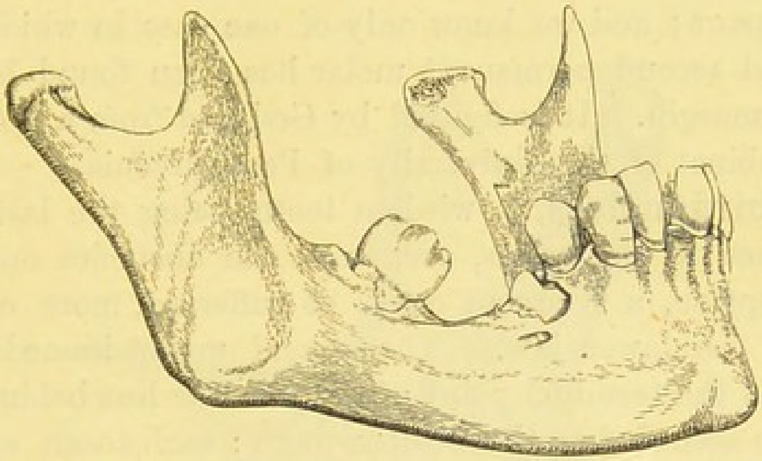


FIG. 109.—Shows a lower maxilla in which the right second bicuspid is placed obliquely, the root being directed backwards. The crown, though exposed, does not rise above the level of the alveolar margin.

to excise that portion of the maxilla in which the disease was situated, and it was the excised portion which was shown at the Society. This case will be found more fully described in the chapter treating on diseases of the jaws induced by misplaced teeth.

Complete irregularity in the position of the **bicuspids** to the extent shown in some of the preceding figures of misplaced teeth, is of very rare occurrence. In the most strongly pronounced case which has come under personal observation, the root of the second bicuspid of the upper jaw passed backwards between the lingual and labial roots of the first molar. In the case illustrated, the direction of the tooth is much the same as in the foregoing case, although situated in the lower jaw. The first molar had been lost, hence the relations between the roots of that and the displaced bicuspid can only be surmised.

Examples in which a bicuspid stands obliquely across the dental line are not uncommon, but in these the displacement is rarely complete; the extremity of the root is usually in the normal position, and the crown, if there were sufficient space in the dental line, could be brought into the normal position. Now and then, however, a bicuspid may be found with the crown directed towards the tongue, and situated below the alveolar margin. Such a case is figured by Goddard.[1]

The **first permanent molar** appearing, as it does, behind the temporary teeth, at a time when the jaw is in a state of active growth, seldom, if ever, becomes the subject of complete displacement; and we know only of one case in which a fully developed second permanent molar has been found below the alveolar margin. It is figured by Goddard from a preparation in the cabinet of the University of Pennsylvania.

The **third molars,** or wisdom teeth, being the last to take their place in the series, are, from the obstacles opposed to their eruption, a frequent cause of suffering, more especially those of the lower jaw. The second molar immediately in front, and the terminal point of the alveolar line behind, bound the space accorded to the wisdom-tooth; each tooth which has no deciduous predecessor is developed beneath the base of the coronoid process in the first instance, and as the coronoid process recedes by absorption on its anterior and deposition on its posterior surfaces, the tooth is enabled to come into its proper position; but if the backward development of the maxillæ has been arrested, the interval will be insufficient for the normal arrangement of the presenting tooth. It would appear to be the exception rather than the rule for the wisdom-teeth, especially of the lower jaw, to take their place among the organs of mastication without producing some amount of suffering at the time of their eruption, and the degree of inconvenience experienced is often sufficiently great to induce the sufferer to apply for professional assistance. In many of the cases which arise in the mandible the teeth can scarcely be said to be displaced. The deviation from the normal conditions is confined to the jaw itself. The tooth takes its natural direction, but the space into which it has to force itself is

1 "The Anatomy and Physiology of the Human Teeth." By Paul B. Goddard. Philadelphia, 1844.

insufficient, consequently the distal side lies close against the anterior surface of the coronoid process, leaving no room for the gum. The latter part, under these circumstances, is pressed upwards, and lies more or less over the masticating surface of the tooth, and is consequently subject to be bruised from time to time by the tooth or teeth of the upper jaw. In this manner inflammation in the gum is set up and maintained. The disease seldom limits itself to the part injured. It more commonly extends to the adjoining parts, involving the soft textures about the ascending ramus, and extending from thence to the fauces. The act of deglutition becomes painful, and the

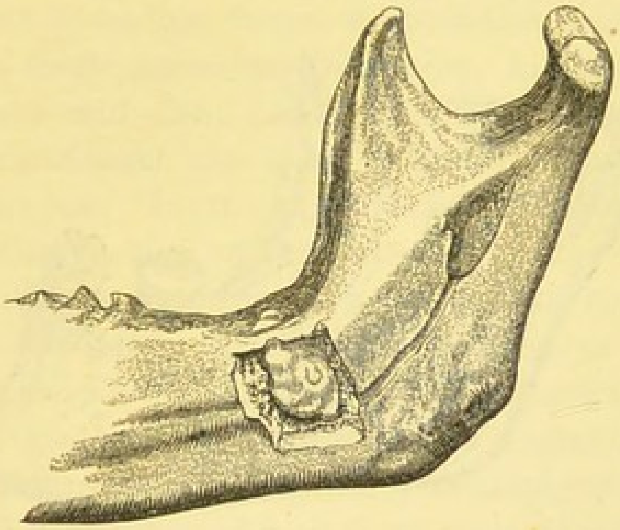


FIG. 110.—From a specimen in which the third molar has been developed below the alveolar margin, with the distal side under the base of the ascending ramus of the lower jaw.

motions of the jaw are restricted. The patient tells you that it is quite impossible for him to open the mouth sufficiently wide for you to make an examination of the tooth which has occasioned his misery. After a time, the overlying gum suppurates, or ulcerates, and the movement of the jaw becomes less constrained.

The patient, however, is extremely cautious in using the teeth until the inflammatory action has subsided, leaving in some cases the gum in a position to be again wounded by the upper teeth ; in other cases leaving the whole of the masticating surface of the tooth perfectly uncovered. If the patient be seen before any great difficulty in opening the mouth has arisen, the tooth should be removed. Indeed, in all cases where the tooth is wedged tightly between the parts already described, this treatment will be the most judicious we can adopt; for should the gum, after the inflammatory symptoms subside, retreat behind the tooth, still the backward position renders the latter useless as an organ of mastication; and should the gum retain its unnatural position, the patient will be liable to repeated attacks of inflammation, until either the gum-covered tooth or its antagonist has been removed.

There may not, however, be sufficient space between the second molar and the ramus for the wisdom-tooth to protrude itself; it then either becomes developed below the alveolar margin, or it comes up partly within the base of the ramus

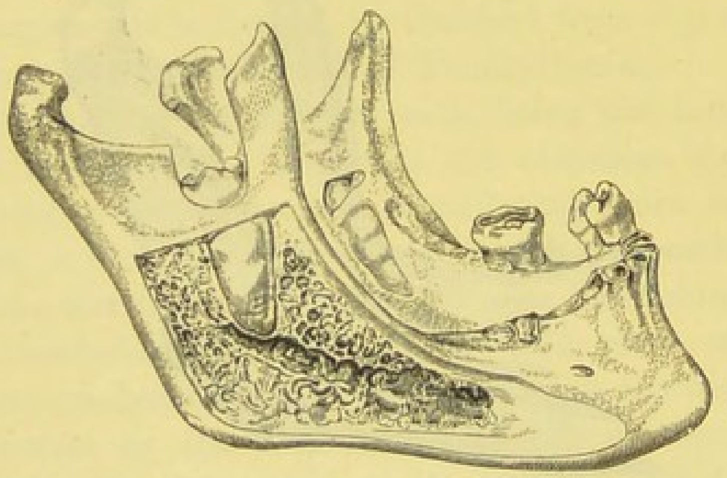


FIG. 111.—Showing the wisdom-teeth imbedded in the rami of the lower jaw. Presented by Sir E. Saunders to the museum of the Odontological Society.

—one half of the crown of the tooth being covered by bone, the other by gum. In either of these cases the patient may or may not be subjected to suffering consequent upon the abnormal position of the tooth, and the absence or presence of mischief will be determined partly by the height to which the tooth rises in the jaw as respects the antagonistic tooth, and partly by the constitutional state of the patient. The same condition of parts which in one person would lead to little or no inconvenience, would in a less healthy subject produce great irritation, and even necrosis, the extent of the disease varying, again, with the susceptibility of the individual. In any case the involved tooth should be extracted so soon as it is found to be a source of irritation. Moreover, a buried wisdom-tooth may remain quiescent for a number of years, and then, even in advanced life, set up violent inflammation.

Two such cases have recently come under observation. In the one, repeated growths of irritable polypi sprouted from the gum over the unerupted tooth, necessitating its removal, which was a matter of great difficulty, and was followed by much exfoliation. In the other, disease of the bone was suspected, but a narrow sinus was found to lead down to a buried tooth. All inflammatory symptoms disappeared after dilatation of the sinus had been accomplished by repeated packing with strips of lint, and the patient's advanced age rendered any more radical proceeding undesirable.

In the two preceding forms of deviation from the normal position the teeth presented themselves in the alveolar line; but cases now and then occur in which, while the vertical position is maintained, the tooth is removed from the alveolar portion of the jaw. In the upper maxilla it may be situated in the posterior portion of the tuberosity, above the level of the alveoli, and in the lower jaw within the ramus. We are indebted to Sir Edwin Saunders for the use of the specimen which forms the subject of the preceding illustration. In this example the wisdom-tooth on either side is situated high up in the ramus, the crown reaching nearly to the level of the sigmoid notch. Although situated in such an unusual position, judging from the state of the bone, it does not appear that they were a source of irritation. There is a total absence of that porous condition indicative of increased vascularity in the parts immediately surrounding the teeth. It is probable that during life the presence of the third molar could not have been detected, and in the absence of disease about the jaw their detection was a matter of no great importance. Still, it is desirable that it should be borne in mind, when disease about the posterior part of the jaws is coincident with the absence of the wisdom-teeth from the usual situation, that the lost teeth may lie buried anywhere in the substance of the bone, and be the exciting cause of mischief.

Mr. F. C. Wallis (Trans. Odont. Soc., 1901) records a case of an inverted unerupted right lower wisdom-tooth in a patient aged 46. The tooth gave rise to severe inflammatory trouble which was diagnosed as necrosis following influenza. It was during an operation for the relief of this condition that the tooth was discovered and removed, the patient's recovery being rapid and completely satisfactory.

Another remarkable case of displacement of the wisdom-tooth, in which it stood (horizontally) close to the sigmoid notch and the condyle, is recorded by Mr. Marshall ("Chicago Med. Journal," 1884).

In the majority of cases, however, the third molars, when misplaced, lose the vertical position. They commonly take an

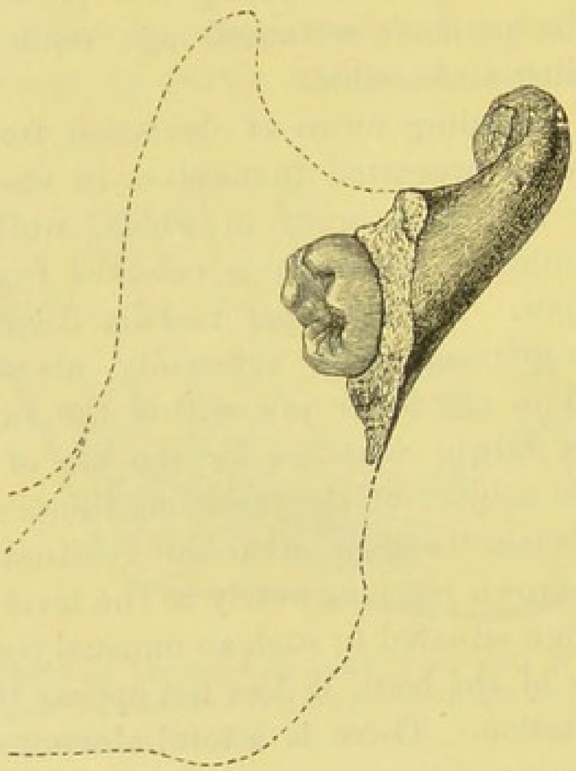


FIG. 112.—Wisdom-tooth buried in the ramus. (After Mr. Marshall.

oblique direction, either forwards, outwards, inwards, or backwards. In the lower jaw the forward direction is by far the most common form of irregularity, the degree varying from a slightly oblique to a perfectly horizontal direction. The succeeding series of figures show various degrees of this form of misplacement.

In the horse teeth have frequently been met with in the temporal region, but no instance of such extreme malposition has been recorded in the human subject.

In endeavouring to trace the causes which have produced this class of irregularities we must recognise two distinct conditions: in the one, the tooth, in pressing forwards, has taken the direction in which the least resistance was offered to its progress; in the other, the malposition has been assumed at a comparatively early period of development, irrespective of

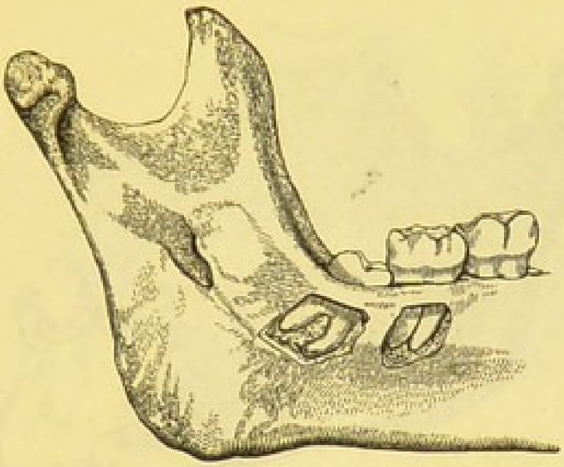


FIG. 113.—View of the inner surface of the left side of the lower jaw, the bone being removed to show the oblique direction of the third molar.

resistance at the time of eruption. In Figs. 113 and 114 the teeth appear to have advanced until the mesial edge or angle of the crowns impinged upon the necks of the anterior molars.

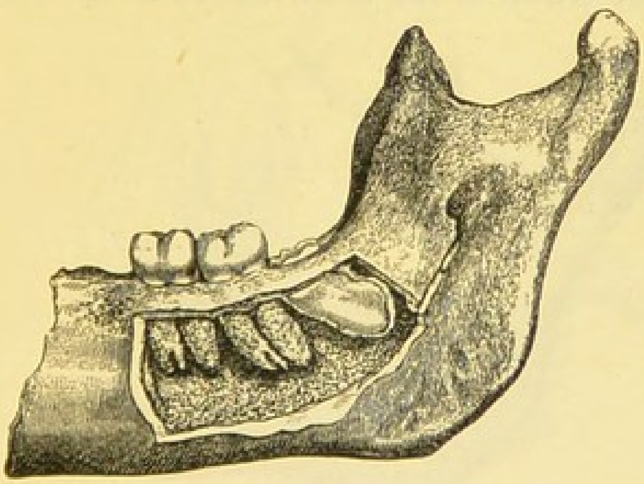


FIG. 114.—View of the right side of the lower jaw, the inner alveolar plate having been partially removed to show the oblique direction of the third molar.

The forward movements of the teeth then became completely arrested. In Figs. 115 and 116 the teeth must have been from the first formed pretty much in the position which they are shown to occupy.

In the upper wisdom-teeth the oblique direction forwards is less frequently assumed. Fig. 117 will, however, illustrate this form of irregularity in the upper maxilla.

In the lower jaw it is not common to find the third molar

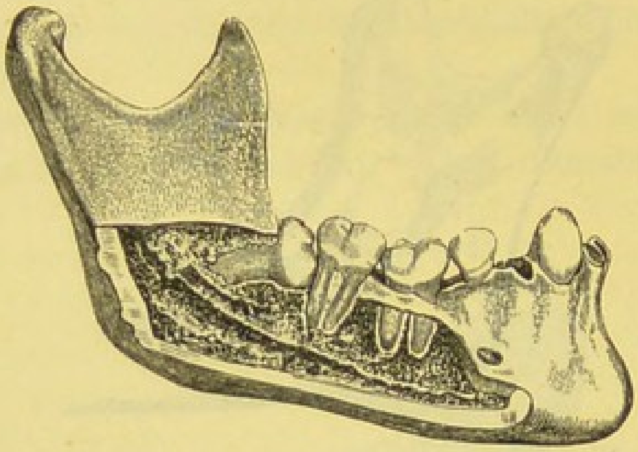


FIG. 115.—Showing the outer surface of the lower jaw, with the third molar placed horizontally, the side of the crown of which rises slightly above the level of the alveolar margin.

directed obliquely outwards, although cases have occurred in which it has assumed that position. In one or two instances we have seen the crown of the tooth buried in the substance of

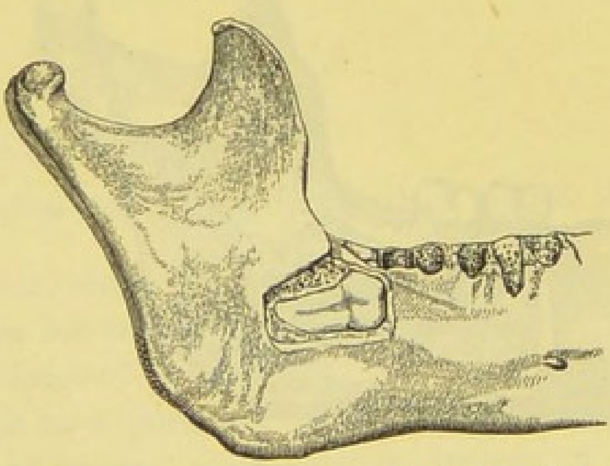


FIG. 116.—Shows a lower jaw in which the wisdom-tooth has taken a horizontal position below the level of the alveolar margin.

the cheek, and so much obscured by the swelling and inflammation of the soft parts around, that its presence was detected with some difficulty.

In the upper jaw, however, the outward direction is more frequently taken. In the accompanying figure (Fig. 118), taken from a specimen now in the museum of the Odontological Society, this form of malposition is shown. A few years since,

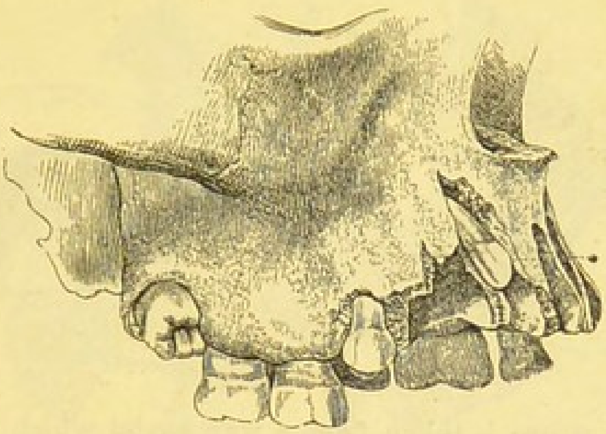


Fig. 117.—Showing an upper jaw, with the third molar directed forward, and impinging upon the second molar. The small tooth situated high up in the anterior part of the jaw, was forced there by the spade of the gravedigger. The artist's accuracy in delineating all parts of the specimen has rendered this explanation necessary.

many practitioners had an opportunity of seeing a case in which the wisdom-tooth pierced the cheek. The crown of the tooth was however, hidden by the whiskers, and appeared to produce no

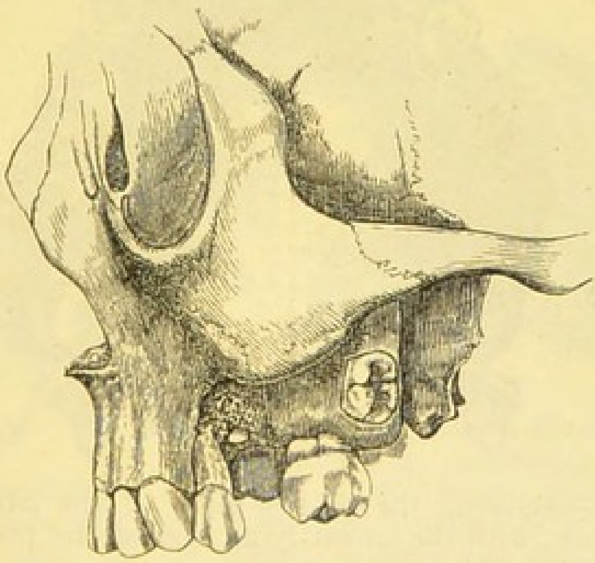


Fig. 118.—Shows the wisdom-tooth of the left side of the upper jaw directed outwards.

inconvenience. Casts of the cheek, with the projecting tooth, were taken, and one of them may be seen in the museum of the College of Surgeons.

A case occurred in the practice of the late Mr. Craigie, in which a lower wisdom-tooth had made its way to the surface and pierced the skin close to the angle of the lower jaw. The

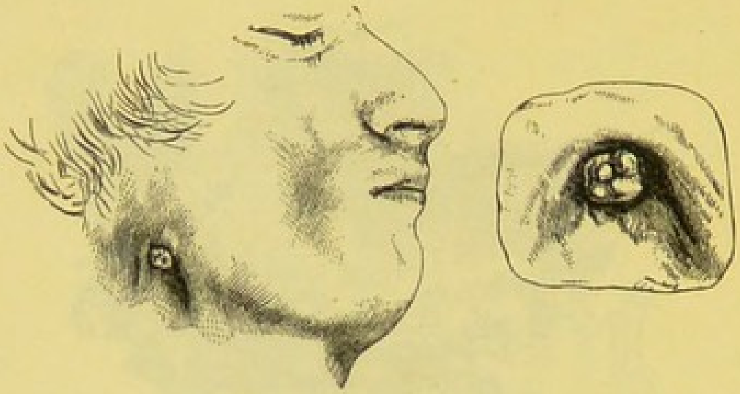


FIG. 119.—The figure is taken from a wax model which is deposited in the museum of the Odontological Society.

crown of the tooth, as is seen in the accompanying figure, was firmly embraced by the puckered skin, which presented the appearance of cicatricial tissue.

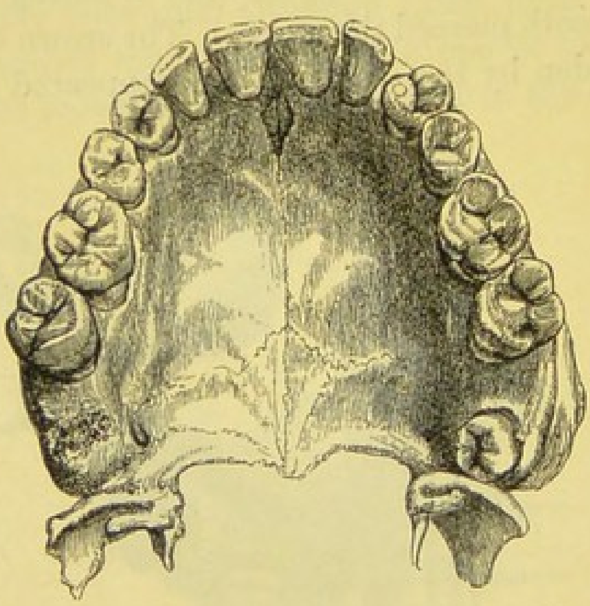


FIG. 120.—Showing the wisdom-tooth of the left side of the upper jaw, with the crown lying against the pterygoid plate of the sphenoid bone.

In this case the tooth was removed, and the opening in the skin closed spontaneously, without necessitating any further surgical interference.

Cases in which the third molar is directed with more or less obliquity inwards are met with in the lower jaw, but in the upper maxilla they are very uncommon. Examples of

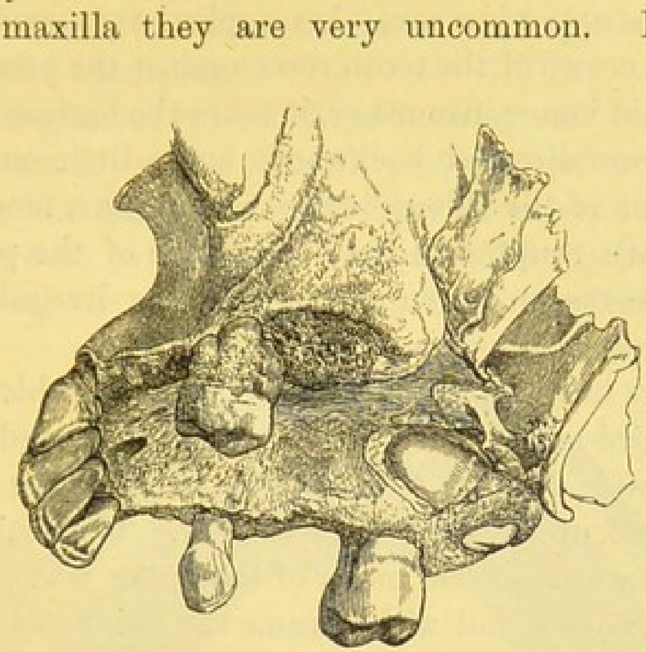


FIG. 121.—Shows the wisdom-tooth of the right side of the upper jaw placed horizontally, and the crown directed backwards and a little outwards. The bone has been removed to show the position of the tooth.

teeth which lean inwards in a slight degree may be seen from time to time, but such hardly call for description in this place.

FIG. 122.—A second molar of the upper jaw, with the wisdom-tooth inverted and embraced within the roots.

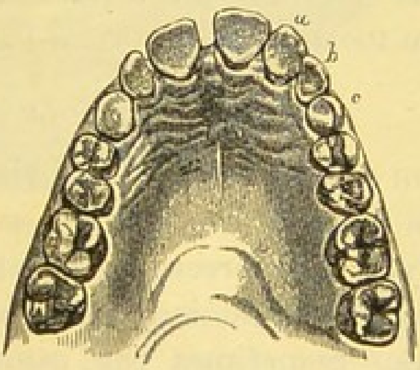


FIG. 123.—Taken from the cast of a mouth in which the canine (*a*) occupies the place of the lateral incisor (*b*). The temporary canine (*c*) is retained, and placed between the lateral incisor and first bicuspid. In all other respects the series is normal.

We do not remember to have seen a case in which a lower wisdom-tooth assumed the horizontal position, with the crown directed backwards towards the posterior border of the ascending ramus of the inferior maxilla ; but of this form of irregularity in the upper jaw several examples have occurred. In one specimen the crown of the tooth rests against the pterygoid plate of the sphenoid bone ; in another, it takes the horizontal position, with the crown directed backwards and a little outwards, and in the museum of the Odontological Society is a model showing a wisdom-tooth erupted in the middle line of the palate.

There is no reason for supposing that the irregular tooth in these instances produced any inconvenience.

A few cases have come under observation, in which the direction of the third molars has been completely reversed. The teeth have been upside down. One example of this rare form of displacement presented the following history. The patient suffered pain from a carious second molar of the upper jaw. The aching tooth was removed, and with it came the third molar, the roots of which were interlocked with those of an inverted wisdom-tooth.

Mr. Vincent Cotterell (Trans. Odont. Soc., Nov., 1900) has recorded a case of an inverted left upper wisdom-tooth removed from a patient aged 36.

And on one occasion, on account of severe neuralgia, for which no other cause was apparent, an upper wisdom-tooth was removed, the crown of which was directed outwards towards the cheek ; after the lapse of two years another wisdom-tooth, nearly normal in position, came down.

Transposition of Permanent Teeth.

From a practical point of view, no great interest is attached to this form of irregularity, as it does not ordinarily admit of remedy. The preceding illustration is taken from a case in which the canine is placed between the central and lateral incisors. Sometimes the canine will be found between the bicuspid teeth. The manner in which transposition may arise will be seen if some of the earlier figures are examined. The position of the canine of the upper jaw is, during the period of development, so much above the adjoining teeth that any irregularity in the growth of the neighbouring parts of the alveolar ridge, or of its contents, may throw it either in front of the lateral or behind the first bicuspid tooth. Even the position of the developing cusp of the canine itself may lead to a similar result. If, for instance, the point be directed either forwards or backwards, the tooth in its descent may lose the proper position, and come either between the incisors or the first and second bicuspids.

While, as a general rule, little or nothing can be done in the way of treatment, yet the possibility of successful transplantation of teeth should, however, be kept in view; thus a case of the kind has been successfully treated by Mr. Spence Bate, and in the Transactions of the New York Odontological Society for

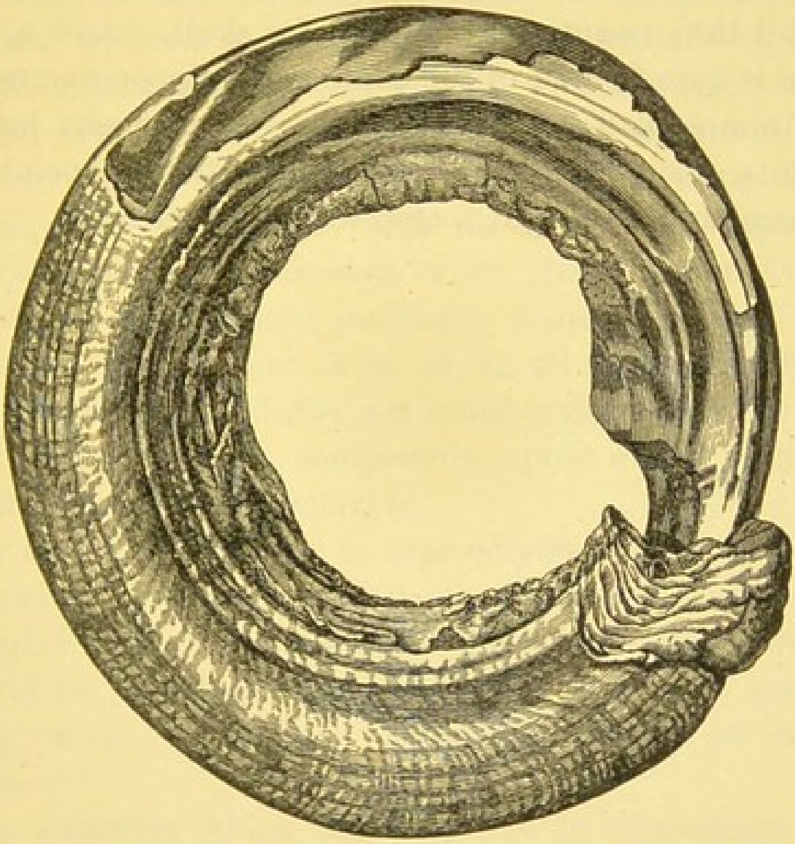


FIG. 124.

1875, a case is described in which the centrals were separated to the extent of five-eighths of an inch, two supernumeraries standing between them. The right central was extracted, and the right supernumerary twisted by immediate torsion. The left supernumerary was extracted, as also the left central, which was transplanted into the supernumerary socket. Two years afterwards the case was doing well.

Mr. Coleman, after consultation with the writer, performed a somewhat similar operation upon a patient in the Dental Hospital; an account of this case will be found in the Odont. Soc. Trans. for 1881.

An abnormal occlusion of teeth may lead to disastrous results by the inequality of wear produced, which may result in the exposure of the pulp cavity. An edge to edge bite may lead to the destruction of incisors, and similar ill-effects may be seen in animals; or the absence of an occluding tooth may lead to the tooth which has no antagonist growing too long, or if it is a tooth of persistent growth, to its growing on till its possession is a distinct detriment to its possessor.

This often happens to the incisors of rodents, which curve round till they re-enter the jaw or the skull. And a striking example is here figured of the canine of a hippopotamus, which, failing to meet and be worn down by its opponent has grown round into a complete circle, re-entered with its point its own pulp chamber, and so put a stop to further growth.

BACTERIOLOGY OF THE MOUTH.

The study of dental caries can hardly at the present day be approached without a knowledge of the bacteriology of the mouth, so that something will be said of those other bacterial forms met with in this situation which have no direct relation to caries of the teeth. Bacteria belong to the group of fungi; they are unicellular plants with an astounding capacity for rapid multiplication by division, when placed under favourable conditions of warmth and moisture, some requiring oxygen, others being independent of it, or, at all events, independent of air, though they probably get some oxygen from the decomposition of the organic compounds upon which they prey; these latter are termed anærobic.

Many bacteria exist only as saprophytes, that is to say, they are nourished upon decomposing animal and vegetable matter or from organic salts and water, and are thus distinguished from the parasites, or those bacteria which can only grow and multiply when in contact with the tissues of a living organism.

Those parasites which can only live in connection with a living host are called obligatory parasites—while others which can also grow as saprophytes are called facultative parasites.

Miller, whose work entitled "Micro-organisms of the Human Mouth," is the standard authority upon this part of the subject, groups the fungi which have a hygienic importance thus :—

1. Fission fungi (bacteria), *Schizomycetes.*
2. Mould or thread fungi, *Hyphomycetes.*
3. Bud fungi (yeasts, &c.), *Blastomycetes.*
4. Animal fungi (Piltzthiere), *Mycetozoa.*

With the last, which are but imperfectly known, we have little concern, and as far as personal investigations show, they have no pathogenic significance.

The group of yeast fungi are not known to cause any disease, with the single exception of thrush—caused by the *Saccharomyces albicans*—the pathogenic yeast found in other conditions in the mouth by Miller he now considers to be probably identical with this organism.

The moulds are not very active in the production of disease in the human body, except with regard to certain skin diseases, although they are the cause of many of the diseases of some lower animals and plants.

The bacteria proper, on the other hand, are a most common cause of disease in man, as they are capable of entering the human body either by the mouth or by other channels, and by their multiplication in the tissues and the production of their specific poisons or toxins of setting up a very large number of serious and fatal diseases.

The bacteria which cause these effects are termed pathogenic, and it seems probable that every infectious disease will be found to be due to some specific organism : of the common diseases now known to be due to these organisms, we may mention anthrax, typhoid fever, tuberculosis, cholera, tetanus and diphtheria.

Recent researches point to the conclusion that the organisms concerned in tuberculosis, diphtheria, and some other diseases have much in common with the moulds, in certain circumstances of growth showing branched and other forms which would prevent them being classified with the bacteria proper.

As the mouth presents all the conditions necessary for this growth in the way of warmth, food, and moisture, it is not to be wondered at that a very large number of different bacteria have been met with in it, and it is more than probable that cleanliness of the mouth, and as near an approach to an aseptic condition as is attainable under the very difficult conditions which it presents, may have very much more effect in the warding off of serious disease than most people at all realise.

The fission fungi are usually described under three principal forms—the rod (bacilli, bacteria), the sphere (micrococci), and the screw (spirillum and spirochæte). Filamentous forms are also found in abundance in the mouth (leptothrix, streptothrix, &c.). Micrococci arranged in pairs are called diplococci ; those arranged in chains, streptococci ; those in clusters, staphylococci ; and those in packets, sarcina.

Whilst dealing with bacteria in general, it must, however, be remembered that, although some are quite distinctive in form, such as the spiral form met with in relapsing fever, yet the majority cannot be discriminated by microscopic examination alone, but their cultural characteristics and their effects upon animals must also be taken into consideration.

Artificial cultivation brings out differences in habits of growth, some organisms liquefying the nutrient gelatine, some coagulating milk, or giving rise to the production of gas in suitable media.

The separation of those forms which cannot be grown upon any known artificial medium is attended with great difficulty.

Miller has obtained and cultivated upwards of a hundred different forms from the human mouth, some pathogenic, some non-pathogenic; amongst others, the pneumococcus, now acknowledged to be the cause of pneumonia, and which is identical with the micrococcus of sputum septicæmia, present in nearly every mouth, the *Staphylococcus pyogenes aureus*, one of the most frequent causes of suppuration, the *Micrococcus tetragenus*, which has been found in tuberculous lungs, and which is speedily fatal to guinea-pigs and mice, and a host of others.

There are, however, some forms which are found very constantly in the mouth, and which may be called the common mouth bacteria.

These are:—*Leptothrix racemosa* (Vicentini), *Leptothrix innominata* (Miller), *Bacillus buccalis maximus* (Miller), *Iodococcus vaginalis* (Miller), *Leptothrix buccalis maxima*, *Spirillum sputigenum*, *Spirochœte dentium*, and *Streptococcus brevis*.

The name leptothrix has been, and still is, somewhat loosely used. Miller proposes to retain it provisionally for those bacteria which grow in threads, but whose life-history is, owing to the present impossibility of cultivating them, imperfectly known, but strictly the term leptothrix should be retained for a division of the higher bacteria distinguished by a basal, non-growing, and an apical, growing end (Lehmann and Neumann).

Leptothrix racemosa. First described by Dr. Vicentini,[1] of Italy. It is found in great abundance in the mouth, occurring in masses in the white substance on and between the teeth.

[1] Vicentini, "Bacteria of the Sputa and Cryptogenic Flora of the Mouth" (London, Ballière). Leon Williams, Dental Cosmos, April, 1899.

It is considered by its discoverer and by others who have worked at it to belong to a higher class than the bacteria, and should probably be classed with the moulds. Examined unstained, it appears to consist of felted masses of club-shaped heads borne on slender filaments which are beaded. The heads consist of rounded bodies (the so-called spores) arranged in six longitudinal rows around the central stem and attached to the stem by stalks or sterigmata.

According to Vicentini, many if not most of the cocci, threads and bacteria found in the mouth are elements of this parent form.

All attempts at cultivation of this organism on artificial media have been unsuccessful.

Leptothrix innominata. This form has not yet been cultivated, and may include other organisms. It is usually seen as felted masses of interlaced threads.

Bacillus buccalis maximus may occur as isolated rods or as threads, but in these latter the individual short rods are conspicuous, and they take on a strong violet colour with iodine; Leber and Rottenstein gave this reaction as characteristic of Leptothrix, but several bacteria of the mouth show it. *B. maximus* is very large, the rods measuring from 2 to 10 μ in length, and from 1 to 1·3 μ in width.

It is the largest of the mouth bacteria, occurring especially in badly kept mouths, and now considered as probably identical with *Leptothrix buccalis maxima.*

Iodococcus vaginatus is very common in unclean mouths; it appears as chains of cells enclosed in a pellucid sheath; the sheath stains but little with iodine, but the cells take a strong violet colour.

Spirillum sputigenum is found but sparingly in clean mouths, but exists in prodigious numbers in those that are badly kept; it is best got from the white deposit at the edges of inflamed gums, whence an almost pure culture may often be obtained. It affects a slightly curved from like a comma, and where several are aggregated together it forms short spirals or S-shapes.

This spirillum is motile, and in hanging drop preparations may be seen in very rapid motion, as first pointed out by the celebrated Dutch microscopist, Leeuwenhoek, in the seventeenth century, in a paper contributed by him to the Royal Society.

It was for a time thought to be identical with Koch's cholera bacillus, but it was shown by Miller to be an entirely different organism, the cholera vibrios being easily cultivated, and the colonies showing very definite and characteristic forms, while the *Spirillum sputigenum* for a long time resisted all attempts at cultivation on artificial media. After many failures Mr. Goadby succeeded in cultivating the spirillum on alkaline potato gelatine, and by this means obtained pure cultures of the organism, in which he found spirillum and spirochæte forms,

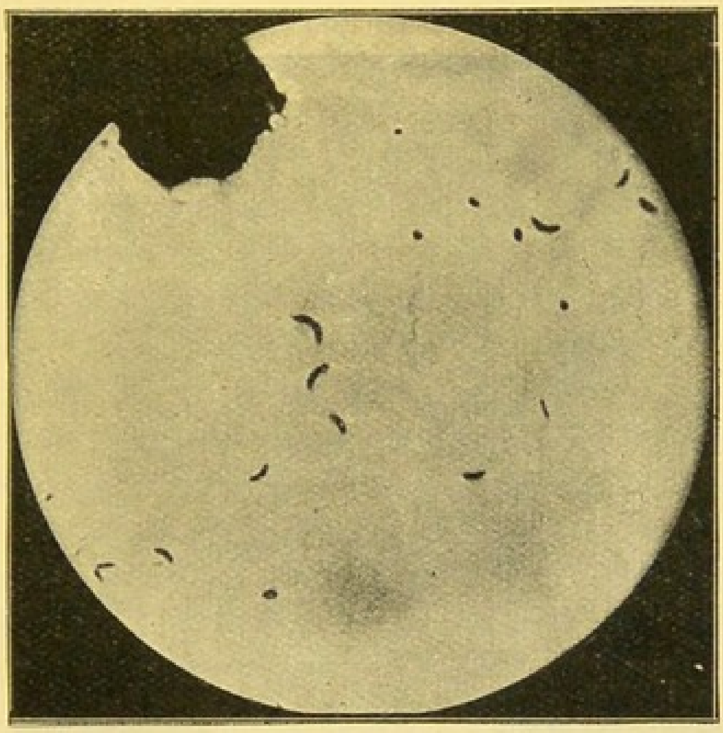


FIG. 125.—Comma form. *Spirillum sputigenum* × 1,000 from healthy mouth (Washbourn and Goadby).

and is of opinion that *Spirillum sputigenum* and *Spirochæte dentium* "are forms of one variety whose cultures differ from other known spirilla, whilst the difficulty of obtaining pure cultivations is due to the reluctance with which the organism takes on a saprophytic existence, and to the restraining influence of other organisms."[1] *Streptococcus brevis* is one of the organisms most commonly present in the mouth, where it is chiefly seen in the form of a diplococcus, and is not pathogenic.

The Finckler-Prior bacillus, also a comma form, perhaps not pathogenic at all, though it was supposed at one time to occur

[1] Goadby, Trans. Odont. Soc., June, 1898.

in European cholera, has also been found in the mouth; this can be easily cultivated, and in cultivation presents well-marked differences from the true cholera bacillus.

There appear to be several other curved forms which occur in the mouth and which take on a spirillum form, but of these not much is known, save that they can be easily cultivated, and so are certainly distinct from the *Spirillum sputigenum*.

The *Spirochœte dentium* does not enter decaying dentine, but occurs, like the last, under the margins of slightly-inflamed

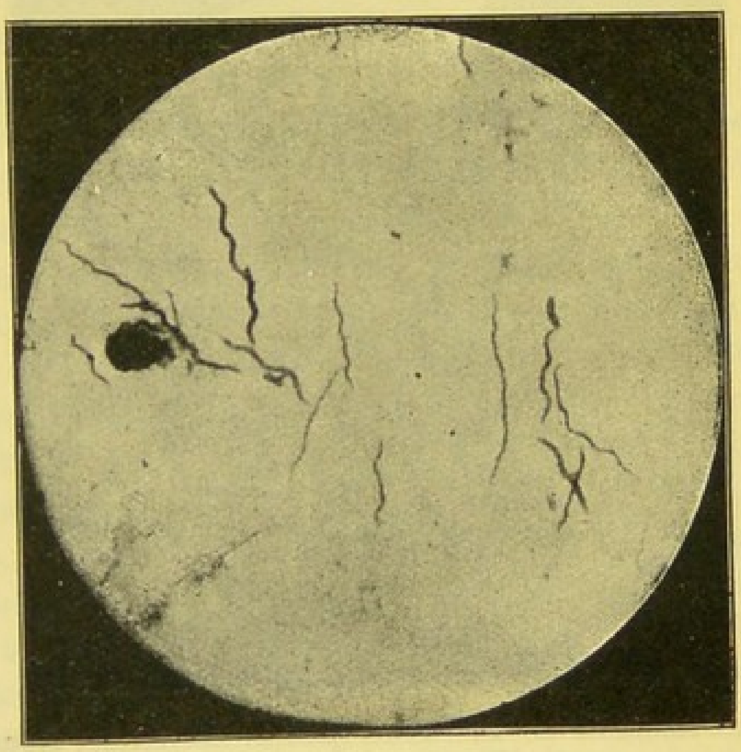


FIG. 126.—*Spirochœte dentium* × 1,000 from healthy mouth (Washbourn and Goadby).

gums; it grows into long spirals, 8—25 μ long, winding irregularly, and of unequal thickness. As mentioned above, it is supposed to be identical with *Spirillum sputigenum* (Goadby). Another very remarkable form has been described by Miller as occurring in a dog affected with pyorrhea, which grows in tufts, and is, for a bacterium, of enormous size; he calls it *Leptothrix gigantea*.

Besides these organisms, there are a vast number of others which are present at times, and which are pathogenic so far at least as animals are concerned. Miller estimated that in one very unclean mouth there were not less than one thousand one hundred and forty millions of organisms.

It may, therefore, be easily understood that human saliva is at times toxic, sometimes very virulently toxic, so that animals inoculated with it die within thirty hours.

We may instance the micrococcus of sputum septicæmia (pneumococcus) and the *Micrococcus tetragenus*, the first of which may be constantly found in the human mouth, and the second in something like twenty-five per cent. of all cases which have been examined with particular reference to this micro-organism. Both are intensely virulent for mice, guinea pigs and rabbits, causing death in from one to three days after inoculation either subcutaneously or in the abdominal cavity. In all, over forty species of micro-organisms have been found in the human mouth, which, inoculated into small animals, produce either local or general disturbances.

It may be regarded as certain that the disastrous results which occasionally ensue after wounds of the mouth in tooth extraction, which in a not inconsiderable number of cases have resulted in the death of the patient, are due to infection with micro-organisms of virulently pathogenic powers which have existed in the mouth. And while we cannot be too careful that our instruments are not the source of the introduction of a poison, yet it is probable that in many cases which have been ascribed to dirty instruments, the organism has really been present in the mouth and has merely been carried deep into the tissues by the operation.

And not only is it *à priori* probable that pathogenic bacteria in the mouth may find their way into the digestive system or into the lungs, but actual proof of this is not wanting.

It has been clearly demonstrated that pathogenic bacteria taken into the stomach at the beginning of a meal may pass on into the small intestines before the contents of the stomach have become sufficiently acid to impair their virulence or vitality in any way.

Investigations made by Hildebrandt, and recently confirmed by Ficker, render it highly probable that in cases of pneumonia the infection does not take place by inhaling the pneumococcus with the air, but that it is brought about by drawing particles of mucus, containing these micro-organisms, into the lungs by forced inspiration, as in sneezing or coughing. It has furthermore been shown that the micro-organisms concerned in the causation of otitis media are the same as may be habitually found in the mouth, and that they obtain access to the middle ear through the eustachian tube.

The staphylococci (aureus and albus), the organisms most commonly found in suppuration, have both been found in the mouth, but with what frequency it is impossible to say, as the statements of different authorities vary on this point. According to some, they are met with in a comparatively small proportion of cases, whereas Black is of opinion that careful search would reveal their presence in every mouth.

And in a case of primary actinomycosis of the lung, Israel found a piece of solid matter, which was sent to Miller for examination, and was proved to be a fragment of dentine with tartar upon it; it was found to contain the ray fungus, so that there is little doubt that this was the carrier of infection.

Baumgarten has also recorded a case in which actinomycosis of the lung was caused by inspiration of the fungus accumulated in the lacunæ of the tonsil.

Streptococci, or cocci which have a tendency to remain united into chains, are of exceedingly common occurrence in the mouth.

Streptococci are frequently pathogenic, that is to say, are the active causes of disease. In scarlet fever they are often found in the tonsil, and may cause general septicæmia or pyæmic infection; erysipelas, abscesses, puerperal fever, purulent peritonitis, ulcerative endocarditis, and many other forms of disease appear to be due to streptococci; and Lingelsheim distinguishes *Streptococcus longus*, which he regards as virulently pathogenic, and *Streptococcus brevis*, which is perhaps not pathogenic at all.

But great differences are to be observed in cultivation and in pathogenic power, even in specimens obtained from the same source, and it remains an open question whether there are these two distinct forms or whether they are due merely to differences in the surroundings. Upon the whole, Messrs. Washbourn and Goadby, who have experimented in this direction, are inclined to Lingelsheim's view, that the *Streptococcus brevis* of the mouth is a distinct form and is not pathogenic; it has never so far been connected with *Streptococcus longus*, which, however, may and does occur in the mouth at times.

They are not inclined, therefore, to the view that there is a pathogenic streptococcus always in the mouth waiting for an opportunity to cause an infection so soon as any accessible tissue is lowered in vitality; but they do not speak very positively on this point.

In the same way, bacteria must be constantly passing into the stomach with food, some chiefly fermentative, others mainly

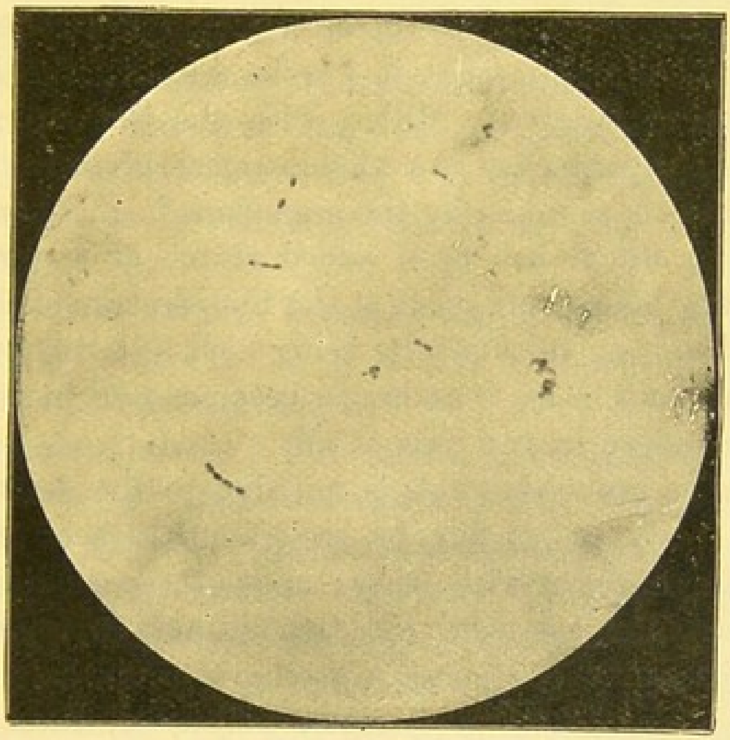


FIG. 127.—*Streptococcus brevis* from healthy mouth; cultivation specimen × 1,000 (Washbourn and Goadby).

putrefactive, though no sharp line can be drawn between these two classes.

Some of these perish in the gastric juice, and some do not; thus it was found that careful sterilising of the food taken reduces to one-thirty-sixth the number of cultivable germs found in the fæces.

The temperature at which bacteria flourish best ranges from about 35° to 38° C., the pathogenic varieties mostly preferring the higher temperatures, so that it will readily be understood how favourable a place the mouth is for their development.

No hard and fast line can be drawn between those which cause what we ordinarily understand as fermentation and those which cause putrefaction, nor indeed can we readily define the difference between the two processes. But all fermentations are dependent upon the presence of bacteria, and those fermentations with which we are most concerned are such as result in the formation of acids by the transformation of carbohydrates into lactic acid, a process which may or may not be accompanied with the evolution of carbonic acid gas.

A large number of bacteria are capable of effecting this transformation, although there is one particular one which has been met with in the mouth, which has so especial a power in this direction that it has been called the *Bacterium acidi lactici* of Hueppe. Miller, with the thoroughness with which he has approached the whole subject, gives the following proofs of the share taken by the organisms in the process.

Saliva, to which has been added starch or sugar, becomes acid in a few hours when kept at the temperature of the mouth. But if it has been sterilised by being kept at a temperature of 212° for an hour or so, it no longer becomes acid in twenty-four hours, nor indeed in any time at all.

In order to prove that this is not due to the destruction of any such body as ptyalin, he took a mixture of starch and saliva and agitated it with ether; under these conditions sugar was formed, but no acid. If carbolic acid was added to a similar mixture till it reached a strength of one-half per cent., the same negative result ensued; neither of these reagents would interfere with the diastatic action of ptyalin.

But a similar mixture, which had been thoroughly sterilised and afterwards infected with a few drops of fresh saliva or a fragment of carious dentine, in twenty-four hours became acid. A drop or two of this solution, added to a fresh sterilised mixture, brought about the same result, and a drop or two of this last served to infect a fresh sterilised mixture, and so on *ad infinitum*.

This clearly proved that the body which brought about the change was something which reproduced itself with great rapidity, and this could only be an organism.

When, instead of pure starch or sugar, a mixture of these with albuminous substances was taken, the result was sometimes an acid and sometimes an alkaline solution.

Out of twenty different bacteria which were experimented with, sixteen gave an acid resultant, and one, which was obtained from a putrid pulp, when cultivated in gelatine gave rise to such copious evolution of gas as to tear the gelatine all to pieces.

Vignal, experimenting with seventeen different mouth bacteria, found that seven of them liquefied coagulated albumen, five others caused it to swell up and become transparent, ten dissolved fibrine, nine dissolved gluten, six dissolved casein, three transformed starch, and nine converted lactose into lactic acid; in fact, the majority had a peptonising action, whilst some were quite independent of free oxygen.

Other fermentations beside this most important one take place. Thus a gummy product, mannite, is sometimes formed, and it is believed by Black that this is the cause of sordes upon the teeth in fevers, and that it may be a cause of stringy saliva.

Butyric acid is of less frequent occurrence; it may be formed as a by-product, but it is not in sufficient quantity to admit of certain recognition.

To recapitulate briefly. The mouth is crowded with micro-organisms, some pathogenic, some not. Of these organisms a large number can cause the fermentation of grape-sugar into lactic acid. A large number also have a peptonising action, *i.e.*, can render soluble albumen, gelatine, fibrine, etc.

There are, therefore, in these micro-organisms all that is requisite to generate acid, and also to subsequently soften and dissolve the decalcified dentine matrix.

And it is highly probable that various pathogenic bacteria may lurk in the mouth, ready to produce their characteristic diseases so soon as they gain an entrance to the tissues they affect.

From what has already been said it will be seen that the difficulty of securing aseptic conditions in the mouth are so great as to, in many cases, render them impossible of attainment, although Dr. Miller has shown that by the assiduous use of antiseptic washes, the use of floss-silk, etc., an approximation can be attained, so that at least the numbers of organisms are vastly diminished.

Mercuric chloride[1] in the strength of 1 to 2,500, was,

[1] The poisonous nature of this drug, of course, precludes its habitual use.

according to his experiments, the most efficacious, Salicylic acid (1 to 300) and Listerine being fairly efficient.

Many surgeons and dentists in operations upon the mouth, in view of the practical impossibility of complete asepsis, are far less careful than they would consider right elsewhere in the body, and indeed pay little regard to asepsis.

But this is not a defensible position. Even if we can only diminish the number of active bacteria which obtain access to a wounded surface, the gain is quite worth the trouble.

And, moreover, if we use instruments and fingers which are possibly septic, we may be the means of introducing some streptococcus or other specially pathogenic organism which was not there beforehand, though swarms of other forms may have been.

Hence, where any material wounding of the tissues is contemplated it is right to cleanse and render as aseptic as possible all the oral cavity with tooth-brush and mouth washes.

In the case of forceps it is easy to thoroughly carbolise the already ordinarily cleansed blades; indeed, there is no objection to using forceps with their blades wet with strong carbolic acid, if only care be taken to avoid the lips. And in the mouth it is possible, at all events for small wounded surfaces, to employ antiseptics in a strength that would be impossible over large surfaces, and so to destroy some at least of the organisms *in situ*, the objection of causing, if not a slight eschar, at all events an excessive amount of exudation, hardly applying here.

Dr. Washbourn and Mr. Goadby (Trans. Odont. Soc., 1896) found that there were many more bacteria in mouths with carious teeth than in healthy mouths. In acute diseases the bacteria were also more numerous. Systematic cleansing with a tooth-brush greatly diminished them, a boy whose mouth abounded in spirilla having got rid of them by simple cleansing with a tooth-brush.

As to the streptococci found in healthy mouths, some appear to be pathogenic (*S. longus*) and, some (the most constantly present) are harmless (*S. brevis*), and these are distinguishable by cultivation. In the discussion which followed this paper, Mr. Mummery quoted a case of Dr. Galippe's in which there was an auto-infection of endocarditis from the mouth. Another instructive case was cited by Dr. Washbourn, in which a boy was taken with severe symptoms of septicæmia and cerebral disturbance after the extraction of a tooth : the case was treated with antistreptococcus serum with the most remarkable and beneficial results, the boy quickly recovering.

A remarkable case which this recalls, one in which a boy quickly died with cerebral symptoms after the extraction of a tooth, occurred at St. Bartholomew's; nothing, however, is known as to the cause of death in this case.

One of the frequent causes of death after surgical operations on the mouth is septic pneumonia, produced by the entrance into the lungs of septic material. The pneumococcus of Fraenkel is constantly in the mouth, and it is very possible that acute lobar pneumonia may be acquired in this way, the bacilli obtaining a lodgment in a lung prepared for their reception by cold, or other lowering conditions.

Sanarelli from numerous experiments concluded that the saliva acts as an antiseptic and destroys a quantity of microbes, but that it is incapable of destroying the mass of microbes in the mouth—though, while it cannot destroy them, it acts as a very bad culture medium for their growth and is capable of attenuating the virulence of many pathogenic microbes, such as that of pneumonia.

These conclusions, however, cannot be altogether accepted. Miller showed that Sanarelli had employed filtered saliva, *i.e.*, saliva deprived of a quantity of nutritive material, such as epithelial débris, mucus, etc.

Hugenschmidt as the result of an investigation carried out in the Pasteur Institute under Prof. Metchnikoff arrived at conclusions totally opposed to those of Sanarelli.

After a great many experiments with many microbes he has never been able to assure himself of the bactericidal properties of the saliva; all he could detect was a certain slowness of growth of certain microbes, but the action was feeble and exceptional. In the great majority of cases, organisms introduced into saliva grew very rapidly, and he also found that, contrary to the opinion of some observers, the sulphocyanide of potassium present in saliva had no effect on the growth of the microbes.

While powerless as an antiseptic the saliva does, however, play an important *rôle* in freeing the mouth of micro-organisms mechanically, saliva washing away the microbes into the pharynx and stomach, preventing the accumulation of food materials to any great extent, and their decomposition by bacteria in the mouth. The saliva also fulfils another function ; it contains diastase and microbial products, these exercising a positive chemiotaxis on the leucocytes. Hugenschmidt introduced into animals small capillary glass tubes containing saliva ; after a certain time these tubes became crowded with leucocytes.

The saliva of the guinea pig introduced in this manner into the peritoneal cavity of other guinea pigs had this effect—the leucocytes crowded into the tubes and inclosed the various bacilli and other foreign bodies which were in the saliva. Metchnikoff considers that the influence of saliva in the attraction of leucocytes should be considered as an important act for the defence of the buccal cavity, and he concludes that it is in consequence of this attraction that wounds in the mouth heal with such rapidity.

Leucocytes are very abundant in the mouth, and the tonsils furnish them in great quantities. Another important point to be remembered is that a continual desquamation and renewal of epithelial cells is going on in the mouth just as it does on the skin, and by this means a great many microbes are constantly being removed from the mouth and carried into the stomach. These epithelial cells in the mouth are loaded with micro-organisms.

The great number of microbes present in the mouth and the struggle for life that takes place among them is another reason for the keeping under of their numbers. By their antagonistic growth the over-multiplication of different species is prevented.

It is also probable that the saliva while incapable of destroying microbes can act on their soluble poisonous products ; in fact this has been found to be the case with the venom of serpents.

Behring has recorded that an ancient tribe in Africa employed saliva as a remedy for snake-bite.

Prof. Miller[1] in his recent investigations on immunity came to the conclusion that mixed human saliva does not possess the

[1] Dental Cosmos, 1903.

power of preventing or retarding the processes of fermentation in the mouth, and that bacterial growth and fermentation take place quite freely in the oral mucus. In persons who are immune to caries he found that the saliva developed rather less acid in a given time in the presence of carbo-hydrates than that of other persons subject to caries, but this difference was not very marked, nor was it uniformly present.

In strongly alkaline saliva as that of the horse, free acids produced by fermentation appear much later than in human saliva.

He found that the conditions seemed to be as favourable for the production of fermentation and caries in a mouth with an alkaline as in one with an acid reaction. When the saliva is alkaline it would appear that the conditions are favourable to the growth of the bacteria (most bacteria growing well in an alkaline medium), the alkali is soon neutralised by the fermentation set up by the actively growing bacteria, and quite as much acid is formed as in a case where the saliva was acid to begin with. Prof. Miller concludes that "the protective powers present in the human mouth are not to be accounted for by any antiseptic action on the part of the saliva, but rather by the phenomena of phagocytosis, by the struggle for existence, and probably by certain forces residing in the soft tissues which have not yet been investigated."

In a recent communication to the Odontological Society (June, 1905), Mr. W. A. Maggs recommended the employment of **antiseptic alveolar plugs** for the after treatment of extraction. These plugs are prepared with hard paraffin and various antiseptics, such as phenol, chinosol, thymol and sulphur, the best results being obtained with hard paraffin and phenol 2 per cent. These plugs are kept ready, moulded to the shapes of the various tooth sockets, and a suitable plug is chosen for the case; they are slightly beaded to assist in their retention, are inserted immediately after the extraction, and allowed to remain for two or three days, when they can be removed by the patient. Their employment is not advised in cases of suppuration around the roots.

In 100 cases in which these plugs were employed, there were ten cases of pain but none of septic sockets. In concluding his paper the author asks if it is necessary or advantageous for the blood clot to fill the socket, and for the saliva to freely bathe

the wound. One would almost imagine from what has been said above with regard to the action of phagocytes in the mouth that it is advantageous, and there might be some fear that by preventing the formation of the blood clot one would rather tend to interfere with nature's method of healing the wound. We know that in healthy mouths the wound after extraction heals very rapidly, and that the contained blood clot is loaded with phagocytes, that the saliva which bathes the wound possesses positive chemiotactic properties attracting phagocytes in great numbers, this chemiotaxis being exerted either by the saliva or by the bacteria contained in it. It seems possible that by the insertion of such a plug not only would the area of the blood clot be greatly diminished, but the antiseptic would prevent the development of the phagocytic action.

A further trial of the method is necessary, however, before we can come to any decision as to the efficacy of this mode of treatment.

Some very interesting results have been obtained by Mr. Goadby (paper at Brit. Med. Assoc. Annual Meeting, 1905), in the **treatment of pyorrhœa with vaccines.**

Certain cases of alveolar pyorrhœa or alveolar osteitis, which were complicated with general symptoms of anæmia, constipation, facial and pectoral acne and general malaise were tested by the method described by Leishman and Wright (Proc. Royal Society, 1902). The serum of the patient and some serum from a normal person having been obtained, a given volume of the serum to be tested and the control serum are individually mixed in a capillary tube with a measured volume of (a) washed white blood corpuscles, and (b) the staphylococcus obtained from the gum margins, a twenty-four hours' cultivation of the coccus being used. The number of cocci taken up by the white corpuscles is counted after half-an-hour's incubation, and the ratio of the number of the organisms in the control to that the test gives what is termed the opsonic or phagocytitic index.

This opsonic index was found to be low in the cases with marked suppuration, which gave a cultivation of the special variety of staphylococci obtained from the gum pus.

A vaccine was accordingly made from the coccus in question and used to inject the patients. The action was watched by noting the opsonic index from time to time. Some amount of reaction occurred in some of the cases, but was not severe. A well-marked negative phase was observed.

Under the influence of the injections the general symptoms cleared up, and the suppuration along the gum margins also diminished, and in several cases disappeared entirely. Parallel cases were treated, some by injection alone, some by injection plus local treatment, and others by local treatment alone. The combined effect of injection and local treatment was the most successful. Several cases of long-standing pyorrhœa were apparently cured, and in all the cases treated a considerable improvement was noted.

One case of chronic antral suppuration was also treated with excellent results.

DEFECTS IN THE STRUCTURE OF TEETH PREDISPOSING TO CARIES.

DEFECTS in the structure of teeth are important as a predisposing cause for the occurrence of dental caries.

These defects may be of two kinds; the dental tissues may be otherwise well formed of good stout material, and yet have defects of form which make vulnerable points, or the whole of the dental tissues may be of such material that they have little power of resistance to adverse influences.

A typically good tooth should be of a white colour, inclining to yellow, its enamel should bear a high polish and be thick, it should not have an appearance of too great or glassy translucency, and should not incline to a greyish or bluish hue.

I may mention that the few patients within my own cognisance who have exceeded the age of ninety have all had typically strong yellowish teeth.

The cusps characteristic of the particular tooth should be well marked, but not excessively long nor over-pronounced, and the grooves and pits should be shallow and closely shut.

The simplest kind of defect is one of form rather than structure, in which pits or fissures exist, which are but an exaggeration of normal forms of the respective teeth.

For instance, a molar tooth may present to the naked eye all the appearances of a well-developed organ, and yet the enamel may be imperfect, and the imperfection may be in such a form as to insure the early injury of the tooth. From the natural depressions which separated the cusps of the molar teeth, minute but deep fissures may be extended through the enamel to within a short distance of the dentine, and they may become larger as they recede from the surface of the tooth. In some cases which I have examined they appear to have been filled with cementum, and very commonly they become the seat of caries, though they not uncommonly occur in lower animals without giving rise to caries.

It will be remembered that the calcification of a molar commences from separate centres for each cusp; the defect under consideration is of the nature of an imperfect coalescence of these centres of calcification, and is in a measure analogous to the production of a hare-lip or a cleft palate.

This may occur in a tooth otherwise very well developed, but it is more common in those of inferior grade.

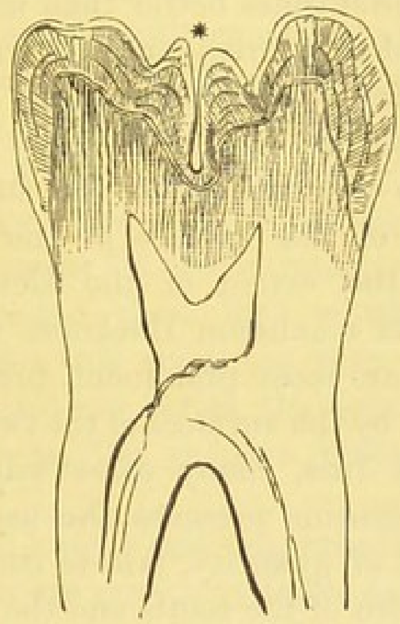


FIG. 128.—Shows a deep fissure, natural size, in the enamel invisible to the naked eye. The section was taken from a first permanent molar of the lower jaw, removed soon after its eruption.

Another form of defect, intermediate between purely local defects of form and general poorness of quality, consists in an irregularity of the surface of the enamel, which may be much pitted or indented everywhere, without relation to the normal pits of the tooth surface, or may show deep transverse grooves, the intervening parts being normal in appearance.

These grooves, somewhat analogous to the marks left upon the nails by periods of illness (see also page 93), have been shown by Dr. Grevers (Trans. Odont. Soc., 1895), to extend obliquely through the whole thickness of the enamel, and, in fact, to correspond to the contour of its outer surface at the date when the defect occurred; Zsigmondy also has arrived at a similar conclusion. The term Hypoplasia has been proposed for this form of defect.

Teeth more widely and generally affected are spoken of as craggy, honeycombed or **Hypoplastic**. In them the enamel is yellowish or brownish, and is less translucent; in extreme cases it is quite dull and relatively soft.

The dentine does not necessarily participate at all in these defects, but well-marked honeycombed teeth are apt to be abnormally rich in interglobular spaces.

Considering these obvious and tangible defects, honeycombed teeth last oftentimes better than might be expected.

It has been stated that irregularity IN THE SURFACE OF THE ENAMEL does not imply a corresponding irregularity in the surface of the dentine; under ordinary circumstances, the elevations and the depressions on the surface of the crown have counterparts on the surface of the subjacent dentine, differing only in the extent of the elevation, because the enamel, attaining its maximum thickness near to those parts of the tooth which are most prominent, breaks the parallelism of the lines formed by the surfaces of the two tissues. Although this is the general rule, many cases will be seen in which the surface of the dentine presents the usual form, while the enamel, from defect of quantity, fails to contribute its share in building up the crown of the tooth, and the cusps of the molars are consequently stunted.

On the other hand, the SURFACE OF THE DENTINE may deviate from the natural conformation; the masticating surfaces of the teeth may be flattened, the cusps being inadequately pronounced, as in syphilitic teeth, or they may be exaggerated. Incisors in which the trilobed edge is very marked, and in which the front surface also shows indications of tripartite arrangement, are generally otherwise of poor quality.

Independently of the quantity, the quality of the tissue may be defective, and consequently unable to resist the influence of agents calculated to injure the tooth.

The fibrous character of the enamel, which in the perfect tissue is somewhat lost by the blending or fusion of the prisms in the process of calcification, may be permanently maintained. Each prism may to too considerable an extent preserve its individuality, a condition which gives an opaque appearance to the tissue, and at the same time greatly impairs its strength. The fibrous character may prevail in certain parts of a tooth, or it may extend through the whole of the enamel. More commonly, however, it will be seen in lines parallel, not with the surface of the enamel or of the dentine, but with the line of growth.

The fusion of the original fibres may, however, be perfect, while the central portions or contents may have fallen short of perfect development. In the place of faintly-marked striation, we may find either parallel series or even minute cavities arranged in single lines which appear to occupy the axes of the prisms, and sometimes coalesce into a fine canal.

In the most perfectly developed enamel, the longitudinal and the transverse markings are regular but comparatively faint, and under a high magnifying power, according to the light, they appear as dark or as light lines, enclosing spaces which are occupied by a material which is a little more dense or opaque than that which forms the lines. Any departure from this condition may be justly regarded as a predisposing cause of caries, the degree of predisposition being proportioned to the relative amount of porosity in the tissue.

Besides these well-known and recognisable defects, there are types of teeth which are especially liable to caries.

No dentist of experience and good power of observation can doubt the existence of these TEETH OF INTRINSICALLY POOR QUALITY, nor can fail to recognise them by the eye, difficult though it may be to precisely describe their characters. They look duller upon the surface, but yet more translucent and glassy; they deviate from the proper yellowish-white hue, and are often undersized. And it is very common for these non-resistant teeth to co-exist in many members of the same family, so that it is common to hear persons speak of the badness of the family teeth. Yet it is not always possible to trace them as the result of heredity, and still less as the result of any tangible form of ill-health in the individual.

It used to be thought, or perhaps it would be better to say assumed, that these teeth were insufficiently impregnated with salts of lime, and all sorts of proposals have been made in the way of supplying the growing child with a fuller supply of lime as food or as medicine, to obviate their occurrence.

Dr. Kingston Barton ("British Medical Journal," September, 1895) found that visible defects in the teeth occurred in hand-fed children with far greater frequency than in breast-fed children; and in one case the occurrence of a well-marked transverse groove seemed traceable to temporary bad feeding with a patent infant food, so that there is some positive evidence in favour of bad feeding affecting the teeth directly. But it would seem that the evil influence takes the form of visible and tangible defects, and not of want of impregnation with lime-salts.

Dr. Galippe ("Recherches sur les propriétés physiques, etc., Société de Biologie," Mai, 1884, summarised in British Dental Association Journal, 1886) has published a series of observations upon the specific gravities of the various teeth, which, according to him, may be taken as representing in a rough way their proportionate richness in inorganic salts, though he does not pretend that it does so with mathematical exactitude.

He finds that the average mean density of the upper teeth is greater than that of the lower teeth, and that the teeth of the right side are a little denser than those of the left—a fact which seems to correspond with a less liability to caries.

The milk-teeth have a lower specific gravity than the permanent, and the roots of teeth than their crowns, and there appear to be differences between the various teeth, which are given in detail in the paper referred to; but these differences do not stand in very close relation to their power of withstanding caries, as the molars have a specific gravity as high as the canines.

He further believes that the density of teeth increases with age, and that they may lose or gain in inorganic constituents after their eruption, contending that they may suffer from constitutional conditions just as bones may, though no proof is offered of this, and it appears highly improbable.

In point of chemical composition the milk-teeth were found to be not only poorer in inorganic constituents, but also to have more of carbonates and less of other salts.

These researches appear to have been overlooked by Dr. Black

(Dental Cosmos, 1895), who has examined a large number of teeth, good and bad, with a view, amongst other things, of ascertaining the relative percentages of lime-salts which the dentine contained, with the result of showing that the differences were quite small, and not, even small as they were, constant in the direction of showing a deficiency in poor teeth. For he found that there was as much difference between different teeth from the same mouth as between good and bad teeth.

As his methods appeared to me to be open to some fallacies, and, moreover, to be quite certainly incapable of accuracy to the decimal points given in his tables, I reinvestigated the subject for myself (British Journal of Dental Science, 1895, and Transactions Odontological Society, February, 1896).

Whilst I feel compelled to reject some of Dr. Black's conclusions, which are based on decimal differences quite beyond the limits of experimental accuracy, yet upon the whole I can confirm his broad results, which are of the very greatest value.

My own investigations brought out the fact that the molars are slightly more highly calcified than the incisors and canines —a result which I find can be deduced also from Dr. Black's figures, though he had not noticed it.

Dr. Black's figures also confirm Dr. Galippe's statement that the specific gravity may be taken as roughly indicating the amount of calcification.

When considering this question of the COMPARATIVE SUSCEPTIBILITY OF DIFFERENT TEETH TO CARIES there appears to be a wide-spread belief that the structure and chemical composition of the teeth have a marked influence upon their liability to caries.

Dr. Black (Dental Cosmos, 1895, p. 417), writes: "Examinations of the density and of the percentage of lime salts, and of the strength of the teeth, that are certainly reasonably accurate, and include a sufficient number upon which to base trustworthy judgment, have shown that neither the density, nor the percentage of lime-salts, nor the strength, is in any degree a factor in predisposing the teeth to caries, or in hindering its inception or progress."

We know that the amount of calcium salts in different teeth is subject to comparatively slight variations. Miller ("Micro-organisms of the Human Mouth," 1890, p. 150), writes: "What is the relation of the lime salts to the glue-giving basis substance? Are they precipitated in the cartilage according to physical laws, or are they held together by means of the organic substance, or do they enter into a chemical union with it? This is a matter of importance for the understanding of certain pathological phenomena exhibited by the teeth. The variations in the amount of salts in the dentine are by no means great enough to explain the variations in hardness. But in the case of chemical union between the organic and inorganic constituents of the tooth we should expect to find dentine hard or soft according as the union is stable or unstable."

The rate at which any calcareous body is acted upon by acids does not depend solely upon the percentage of calcium salts which it contains, but upon the stability of the compounds formed by those salts.

Miller, as the result of experiments upon walrus and other ivories, concludes that "there is a great difference in the rapidity with which different dentines are softened by acids, and that this difference bears a certain relation to the density of the dentine and to the percentage of calcium salts which it contains," but that "these results do not justify the conclusion that the dentine from different human teeth must likewise show similar differences in regard to its susceptibility to the action of weak acids."

It must therefore, we think, be held to be quite established that the difference between teeth of good and of bad quality does not lie in the percentage of lime-salts in the dentine; where it does lie remains a question. It may be in the nature of the organic matrix, in the proportion of water to the organic matter present, in the relative proportion of carbonates and phosphates, or, lastly, it may lie wholly in the enamel.

Dr. Black's research brought out another fact of importance, which is that the mechanical strength (resistance to crushing strain) was adequate in all the dentines to enable gold fillings to be inserted. The enamel he did not investigate; and, after all, this is the first line of defence of the tooth.

In the course of my own investigations I found that, whilst the dentine of an elephant's tusk contains only 57 per cent of lime-salts, the dentine of its molar contains 70 per cent., or nearly the same as human dentine. Yet with this large difference in salts, in respect of hardness, appearance, etc., the two dentines show less divergence than might have been expected; so that it seems a fair inference that one would not expect a small difference in the percentage of salts in the dentine of good or bad human teeth to make any great difference in their physical properties.

Relative Liability of Teeth to Caries.—The different teeth are not equally subject to the attacks of caries; in the first place, the upper are more frequently attacked than the lower—according to Dr. Magitot (*op. cit.*, page 48), in the proportion of 3 : 2; whilst the yet more comprehensive tables of Dr. Hitchcock [1] give the ratio of 1·9 : 1, or very nearly two to one—the first and second lower molars, however, suffering even more frequently than the corresponding upper teeth. There does not appear to be any noteworthy difference between the two sides of the mouth in their relative liability to caries, so that this portion of the tables has been omitted in this place. Dr. Hitchcock (*loc. cit.*) gives the following analysis of 20,000 cases:—

Central incisors	2,189	2,101 upper	88 lower
Lateral incisors	1,954	1,827 upper	127 lower
Canines	1,261	1,058 upper	203 lower
First bicuspids	2,073	1,588 upper	485 lower
Second bicuspids	2,585	1,715 upper	870 lower
First molars	4,499	2,273 upper	2,126 lower
Second molars	3,615	1,675 upper	1,940 lower
Third molars	1,924	899 upper	1,025 lower
Total	20,000	Upper 13,136	Lower 6,864

[1] "Wedl's Pathology of the Teeth." Translated by W. Boardman, M.D., and edited by T. B. Hitchcock, M.D., D.M.D. 1872, p. 399.

Another table, compiled by Dr. Magitot from 10,000 cases gives the following results :—

Central incisors	642	612 upper	30 lower
Lateral incisors	777	747 upper	30 lower
Canine	515	445 upper	70 lower
First bicuspid	1,319	949 upper	370 lower
Second bicuspid	1,310	810 upper	500 lower
First molar	3,350	1,540 upper	1,810 lower
Second molar	1,736	690 upper	1,046 lower
Third molar	360	220 upper	140 lower

Analysis of 2,628 cases of extractions on account of caries, or its consequences. From Lectures on Dental Physiology and Surgery, by J. Tomes, F.R.S. 1848 :—

Central incisors	25
Lateral incisors	62
Canines	36
First bicuspids	227
Second bicuspids	393
First molars	1,090
Second molars	575
Third molars	230

The tables drawn up by other observers, on the whole, correspond with the last two of these ; that drawn up by Dr. Hitchcock differs in some particulars of interest. Thus, in his tables, the carious first molars do not show that great preponderance in numbers over all other teeth which is exemplified in most other tables ; and as his tables embrace fillings as well as extractions, this cannot be attributed to the early attention given by Americans to their teeth.

Dr. Magitot has given an additional 2,000 cases, which combined with his first table, give the following proportions:—

First molars	3,918	1,791 upper 2,127 lower
First bicuspid . . .	1,525	1,104 upper 425 lower
Second bicuspid . . .	1,519	949 upper 570 lower
Second molars . . .	1,011	829 upper 1,282 lower
Lateral incisor . . .	972	939 upper 33 lower
Central incisor . . .	811[1]	779 upper 32 lower
Canine	652	457 upper 95 lower
Third molars	489	282 upper 207 lower

Analysing his table, we get 4,971 carious lower teeth as against 7,029 upper teeth, or, excluding the incisors and canines of both jaws, in consideration of the well-marked immunity of lower incisors and canines, 4,951 carious upper molars and bicuspids, as against 4,611 lower molars and bicuspids. Of these, lower molars furnish us with 3,616, as against 2,902 upper molars, so that the protective effect which helps lower teeth is not efficacious at the back of the mouth, indeed becomes less efficacious as we go backwards from the incisors; this would seem to confirm the idea that it is the secretion of the submaxillary glands that is the protective agency.

A table drawn up by Messrs. Pare and Wallis from the records of extractions at Guy's Hospital gives of 30,012 cases :—

First molars . . .	36·30 per cent., or	10,891
Second molars . .	19·68 ,, ,, ,,	5,904
Second bicuspids . .	13·93 ,, ,, ,,	4,179
First bicuspids . .	10·70 ,, ,, ,,	3,212
Third molars . .	8·76 ,, ,, ,,	2,639
Lateral incisors . .	4 ,, ,, ,,	1,202
Canines	3·66 ,, ,, ,,	1,098
Central incisors . .	2·95 ,, ,, ,,	887

[1] Dr. Magitot's own tables do not add up quite right.

This is in close accord with Sir John Tomes' statistics, which were drawn from only 3,000 cases.

Separating upper from lower teeth, Messrs. Pare and Wallis give :—

Lower first molars . .	18·7	per cent., or	5,632
Upper first molars . .	17·4	,, ,, ,,	5,259
Lower second molars .	11·62	,, ,, ,,	3,489
Upper second bicuspids .	8·33	,, ,, ,,	2,503
Upper second molars .	8·04	,, ,, ,,	2,415
Upper first bicuspids .	7·623	,, ,, ,,	2,288
Lower second bicuspids .	5·58	,, ,, ,,	1,676
Lower third molars .	4·4	,, ,, ,,	1,322
Upper third molars .	4·38	,, ,, ,,	1,317
Upper lateral incisors .	3·37	,, ,, ,,	1,013
Lower first bicuspids .	3·07	,, ,, ,,	924
Upper canines . .	2·86	,, ,, ,,	861
Upper central incisors .	2·51	,, ,, ,,	754
Lower canines . .	·78	,, ,, ,,	237
Lower lateral incisors .	·62	,, ,, ,,	189
Lower central incisors .	·443	,, ,, ,,	133

After puberty the female sex is distinctly more liable to dental caries than the male, though in what proportion the caries occurs remains uncertain for the want of sufficient data; so that different authors arrive at widely different estimates. The patient's age likewise markedly influences the disease; thus, if it has not occurred before the age of five-and-twenty, there is a strong probability, especially in males, of immunity till about the fiftieth year, when, coincidentally with other manifestations of bodily decline, the teeth again become liable to be extensively attacked with caries.

Röse examined the teeth of 6,280 children, the number of boys and girls being about equal, with the result that the percentage of caries in boys was 26, and in girls 26·2.

As to the **prevalence of dental caries among children**, the most trustworthy statistics are those collected by the "School Committee" of the British Dental Association. These show that out of the 10,517 children's mouths inspected there were only about 1,500 which required neither fillings nor extractions, or a little over 14 per cent.; and that in all the others some conditions existed which necessitated special attention, in order to procure, as nearly as possible, a healthy mouth. The following table shows the results in detail :—

Table showing the results of an examination of the mouths of 10,517 *boys and girls in English and Scotch schools, with an average age of about* 12 *years.*

Number of children examined . . .	10,517	
Temporary teeth requiring filling . . .	9,573	18,009
Temporary teeth requiring extraction . .	8,436	
Permanent teeth requiring filling . .	13,017	19,096
Permanent teeth requiring extraction . .	6,079	
Total unsound teeth . . .		37,105
Teeth already extracted		2,174
Sets of teeth free from decay .	1,508 = 14·2 per cent.	

In 86 per cent. of the mouths examined caries was present.

The next table shows the early age at which decay begins, and the rapid increase in the decayed sets with each year of life :

Age period . .	4—6	7—9	10—12	13—14	16—18	Quality.
Number examined .	744	1,716	3,071	2,376	268	8,175
Sound (no decay) .	23·8	14·2	16·1	14·1	6·4	Good.
Defective temporary teeth only . .	67·4	43·3	18·3	5·1	0·1	Uncertain.
Defective permanent teeth, 1—4 . .	8·8	41·5	55·9	51·9	37·3	Fair.
Defective permanent teeth, 5—8 . .	—	1·9	8·5	22·9	32·6	Bad.
Defective permanent teeth, 9 or more .	—	—	1·2	6·0	23·6	Very bad.
	100	100	100	100	100	

These statistics indicate the urgent necessity for treatment in the early years of childhood.

On board the *Exmouth* training ship (480 boys), which is largely recruited from these schools, the average age was fourteen years ; 24 per cent. had perfect teeth, 44·9 per cent. had from one to four permanent teeth carious, 22·9 per cent. had from five to eight, and 5·25 per cent. had more than eight carious permanent teeth.

At the Hanwell Schools (903 children examined) at the age of eight 83 children furnished 127 carious permanent teeth, which, of course, must all have been first molars; at the age of twelve 90 children had 244 carious permanent teeth; the percentage of unsound permanent teeth to the number of children is 53 at the age of six, 271 at the age of twelve, and 300 at the age of fourteen.

In 931 mouths (Feltham, Shibden, Walsall) only about 13 per cent. were returned as "clean," and 42 per cent. as "fairly clean," while 42 per cent. were classified as "dirty," and about 3 per cent. as "foul." The presence of tartar was registered as "little" in over 43 per cent. and "much" in over 9 per cent. of the mouths examined. These 931 cases showed 144 sound dentitions, 307 teeth had been extracted, and 2,864 teeth were carious.

An attempt was made to compare the condition of the teeth in poor and in high-class schools, but in these latter the numbers were not sufficient to be at all conclusive, as only 205 well-to-do children were examined. But these compared by no means favourably with their less fortunately placed brethren.

The data for getting at the relative frequency of caries in the different teeth exist in the case books of the Schools Committee, but, the reports having been made with a different object in view, they are not discoverable in the reports as issued.

A valuable report has recently been issued by Mr. E. Rice Morgan, medical officer to the Swansea Education Committee, in which he gives the result of his examination of the teeth of some of the boys and girls attending five schools in the upper division of the borough. Among 151 boys examined only five, or 3·3 per cent., had no unsound teeth, and of the remaining 146 boys each had on an average 3·7 decayed teeth. Among the 144 girls examined there were six, or 4·1 per cent., with all their teeth sound, while the remaining 138 had on an average 3·2 teeth which were unsound.

Similar investigations have yielded very similar results in America, Germany, and Hungary. The investigations of Unghvari (Hungary) and of Berten (Würzburg) show the percentages of 87·2 and 83. Röse ("On the Decay of Teeth in the National Schools of Germany," "Ash's Quarterly," March and June, 1895), in an extensive investigation in Baden, Thuringia, and Fenchel, showed that caries was present to the amount of 98 and 96 per cent. respectively.

Constitutional Causes Predisposing to Caries.—Various conditions of the system markedly favour the occurrence of caries; thus, the period of pregnancy is especially destructive to the teeth, and it often happens that widespread and rapid destruction occurs in previously healthy teeth during some severe illness. Professor Wedl (*op. cit.*) enumerates dyspepsia, cancer of the stomach, diabetes, scrofula, rachitis, phthisis, and aphthæ as promoting the development of caries. In a case recently under observation almost every tooth was attacked by caries during a severe and protracted attack of rheumatic fever, though up to this time (the patient having reached the age of forty) the teeth had remained sound. And it may be remarked that medicines often get the blame of having done the mischief when the ravages of caries are more truly attributable to the patient's general condition. Thus for example, it is common to see great destruction of the teeth in young anæmic females, and this is often attributed to their having taken large quantities of iron in the form of the muriated tincture. Although, if the mouth be not scrupulously rinsed after the exhibition of acid medicines, the teeth may not improbably be acted upon, yet the constitutional condition which necessitated prolonged treatment with such drugs as iron would greatly predispose to the occurrence of caries.

Acute stomatitis occasionally exercises a most disastrous influence upon the teeth; and all conditions which tend to an unhealthy, congested state of the buccal mucous membrane will have a deleterious influence. It is in this way that dyspepsia and other disorders of the intestinal mucous membrane affect the teeth.

During many acute diseases, notably in fevers, there is great dryness of the mouth from deficient secretion of saliva, while at the same time the buccal mucus and epithelium is constantly shed off, so that sordes accumulate round the teeth. It is easy to see how this state of things will act prejudicially upon the teeth.

Dr. Scanes Spicer (Trans. Odont. Soc., 1890) laid much stress on the influence of mouth health upon the causation of caries, believing that by the drying of the teeth they were deprived of the free bathing in saliva; dryness appears to be the source of much deterioration in long-continued fevers.

Sir B. Richardson mentions that the teeth of fur-dyers, who are much exposed to the fumes of nitric acid, are frequently destroyed.

Whether smoking exercises any preservative influence on the teeth must be doubted; although the impression that it does so is widespread, it is not based on any definite grounds, and there is no difficulty in finding cases of excessive destruction of the teeth in the persons of habitual smokers.

Miller has found that tobacco smoke, and the juice of tobacco of such strength as might be supposed to be frequently present in the mouths of those who chew, are powerful bactericides; but it must be remembered that there are many points to which tobacco smoke will but rarely, if ever, penetrate; whilst in the case of chewing, as a matter of clinical experience, little protection seems to be afforded.

Absence or marked **deficiency of lime** in certain countries appears to be associated with an increased tendency to dental caries, not only in children brought up in such districts, but also in adults whose teeth rapidly deteriorate after a few years' residence. For instance, young adults with comparatively sound teeth will, after a few years spent in Ceylon, return with extensive caries of a somewhat peculiar type. The enamel is but slightly affected, but the dentine is extensively destroyed, dark brown in colour, "dry," and friable.

A somewhat similar effect is noticeable in the teeth of Europeans stationed in the Soudan. Children of European parentage brought up in certain districts of South Africa, such as Natal, have appallingly bad teeth. The natives are in no case similarly affected, and the Zulus, living in a country poor in lime, are a big-boned race possessing remarkably fine teeth. It is perhaps difficult to reconcile these facts, except by remembering that strangers in a land often fail to thrive like the natives do, the latter knowing by instinct how to live and what to eat. The Zulus, for example, are small meat-eaters, and live largely on Indian corn and cereals, ground by hand, and these possibly supply the requisite bone and tooth-forming constituents. The Boers for the most part are said to possess well-formed jaws and sound teeth; but the Transvaal, like the Orange River Colony, is by no means deficient in lime, and Europeans resident in these districts do not apparently suffer dental deterioration in any marked degree.

Dr. C. Röse, of Freiburg, Baden (" On the Decay of Teeth in the National Schools "), remarks, " There is a tremendous preponderance of the well-built, brilliant yellow teeth in the places rich in lime, but in the places poor in lime the whitish-yellow and bluish-grey teeth prevail." His statistics show " that the place in the lime district of Sondershausen with the worst sets of teeth still shows better teeth than the place which shows the best teeth in the district poor in lime." In Thuringia Dr. Röse obtained the following results:—

	Number of children examined.	Percentage of children with caries.	Percentage of all diseased teeth.
Places poor in lime . .	2,973	98	34·9
Places rich in lime . .	2,708	82·8	16·7

Statistics such as the foregoing cannot be disregarded, but it is difficult to reconcile them with the results of Dr. Black's observations on the percentages of lime salts found in various dentines quoted on p. 223.

Certain articles of diet appear to have a directly mischievous action, apparently in direct ratio to their tendency to undergo acid fermentation. Thus it has been found that in children who have been soothed with a " sucking bag " containing sugar and milk the crowns of the upper incisors are rapidly destroyed, though the molars usually escape. Cooks and confectioners are also especially liable to dental caries ; and it is stated by Dr. Magitot (*op. cit.*) that caries is especially prevalent amongst cider-drinking populations.

Miller made experiments with a view of finding out which foods are most injurious to the teeth—starchy, saccharine, albuminous, or fatty. He placed sound natural teeth in a mixture of human saliva and bread or sugar, and kept them in an incubator at body temperature for a prolonged period, with the result that the mixture became strongly acid and the teeth carious, with exactly the same appearance as carious teeth in the mouth. This was due to the fermentation of carbohydrates giving rise to the production of lactic acid, which decalcifies dentine. He found that if sound teeth were placed in a mixture of saliva with albuminous and fatty food from which carbohydrates had been excluded the result was decomposition and a strongly alkaline reaction, but the teeth were not attacked by caries; the alkalinity was due to the decomposition of albumen. Lactic acid alone will not produce caries, and it is to be inferred that the micro-organisms in the saliva and the lactic acid together do the mischief, for Miller has shown that many bacteria found in the mouth can dissolve proteid substances.

We have noticed great and rapid destruction of the teeth in patients who have fed for a considerable period upon a milk diet, but it is of course impossible to say whether this is due to the diet or to the conditions which have necessitated this limitation of the articles of food.

In a series of letters published in "Nature," 1894, attention is drawn to the deterioration in the teeth of some of the occupants of the Scotch islands, amongst whom a change in diet and in luxury has taken place within one or two generations. Coincidently with the abandonment of a hard, outdoor life and the consumption of simple and dry foods requiring much mastication in favour of richer food, more cooked, the consumption of much tea, and the adoption of more sedentary habits, caries, hitherto rare, has become common.

In this connection Dr. Sim Wallace ("Decay in Teeth," p. 85) remarks: "The cause of the present day susceptibility to dental caries is that the natural foodstuffs are to a large extent deprived of their accompanying fibrous parts, and prepared and consumed in a manner which renders them (especially the carbohydrates) liable to lodge and undergo acid fermentation in the mouth; while from the same causes and the induced conditions the acid-producing micro-organisms of the mouth lodge and multiply and augment the rapidity and intensity of the acid fermentation."

Mr. Stanley Colyer ("The Problem of Dental Caries," Dental Record, July, 1904), in an extremely interesting article on the effects of the acid fermentation of carbohydrates upon the teeth, lays great stress upon sugars as a cause of dental caries. He draws attention to the rapidly increasing use of the cheap, rapid acid-producing monosaccharides (glucose, etc.) sugars in commercial food preparation. The polysaccharides (cane sugars) are more resistant to the lactic acid ferment than the monosaccharides, and consequently acid is produced much more rapidly from the latter than the former.

Mr. Warwick Hele (British Dental Journal, 1903) writes: "There can be no doubt about the association of the abuse of sugar with increase of dental caries. Without entering upon the scientific inquiry and explanation, an impartial observer must allow that in the avoidance of the abuse of sugar dental safety lies."

According to Miller, meat-eating races are far more exempt from caries than those which subsist upon mixed foods. Thus, dolichocephalic Ancient Britons presented evidences of caries in only 3 per cent. of the skulls examined (they were probably almost pure meat feeders), whilst brachycephalic Ancient Britons, Romano-Britons, Anglo-Saxons, and Egyptians gave a percentage varying from 15 to 41 per cent. (these were all mixed feeders).

The same thing is indicated by a comparison of the teeth of Esquimaux, North American coast Indians, and New Zealanders, all subsisting upon an almost entirely flesh diet, with other modern races who are mixed feeders. Miller gives an instructive table on this subject.

In the American system of dental surgery, Dr. Black advances the idea that races of men who eat largely acid fruits are less liable than others to caries, whilst those who have subsisted largely on flesh and grain have suffered more than those upon a more vegetarian diet.

Heredity.—Though it has been denied, there is much evidence that the tendency to caries, whether induced by structural deficiencies or perverted functions, is strongly inherited, so strongly, indeed, that sometimes as the several children of the parent successively arrive at a certain age the corresponding teeth will become decayed.

This inherited tendency would appear to often come from one side only; thus, we are acquainted with two families in which the children by a first marriage have conspicuously good teeth, whilst those by a second have equally conspicuously bad ones. In both instances the mothers of the second families had lost all their teeth at a comparatively early age.

On the other hand, it is by no means uncommon to see all the children of parents who have good teeth themselves very seriously affected by caries, so that in a single generation there has been a marked and serious deterioration in respect of teeth. And it would really almost appear as though bad teeth were inherited with more certainty than good teeth.

This inherited predisposition, so strongly marked in families, extends to whole races, and probably is often due to defective developments. On this subject Professor Wedl remarks, "If it be true that geological and climatic conditions, and the means of subsistence which are connected with the same, have such a preponderating influence in respect of the frequency of caries, then it is impossible to explain the fact that foreigners belonging to different races, who are exposed to the same conditions with the native inhabitants, still retain the typical structure of their teeth as well as that of their bodies, and continue to furnish the proportion of dental caries peculiar to their race. This is found to be the case with the isolated Sclavonic races of Austria and the descendants of the Celtic race in France." To this Dr. Hitchcock appends the remark, "As geological, climatic, and social conditions exercise a predominant influence upon the growth and development of the various races mentally as well as physically, it is evident that the development of the dental organs cannot fail to be controlled by the same causes. In this country, which is annually receiving large numbers of foreigners by immigration, the typical traces of race are usually effaced after the lapse of a generation or two, the descendants possessing all the peculiarities, and their teeth apparently being as liable to caries as the teeth of Americans generally."

The prevalence of dental caries in various races, both ancient and modern, has been investigated by Professor Broca and by Dr. Magitot, and subsequently, in greater detail, by the late Mr. Mummery.

Dr. Magitot[1] states in general terms that negro and Arab races are remarkable for the soundness of their teeth, the Caucasian for the contrary, while the Mongolians hold a middle place. Races not indigenous, but freshly imported into a country, appear to suffer in an exalted degree.

[1] "Traité de la Carie Dentaire," 1867, p. 60.

Amongst the anthropological series of the Paris museums he found no example of caries amongst the crania of Mexicans, Peruvians, or Patagonians, nor amongst those of natives of Australia, Madagascar, New Caledonia, etc., and no example of caries amongst the Malay and Javanese crania in the collection of Professor Vrolik. Amongst Egyptian mummies he found a good many examples; among modern nations he notes that the inhabitants of Iceland are almost exempt.

Dr. Black states that as a result of some "hasty" examinations of prehistoric skulls he found caries as prevalent as it is to-day, but he does not himself attach much weight to his observations, as being too few in number for safe generalisation.

To Professor Broca is due the observation that caries was far less frequent amongst the ancient populations of Europe than it is at present, and that the teeth were usually excessively worn down; but that mere wear is of itself insufficient to have prevented the ravages of caries is shown by the fact that the Basque crania (eighty in number) in the Paris museums were alike remarkable for the extent of the wearing down, and also for the tolerably frequent occurrence of caries.

Dr. Magitot[1] observes that in France those regions which are populated by peoples of Celtic descent present a comparative immunity from dental caries.

The late Mr. Mummery[2] subsequently examined and tabulated a very large number of ancient crania with the following results:—Caries was met with in 2·94 per cent. of the Ancient Britons of dolichocephalic type, in 21·87 per cent. of the brachycephalic Britons, in 28·67 among Romano-Britons, in 15·78 of Anglo-Saxons, and in 41·66 of Ancient Egyptians. It would appear from these percentages that the frequency of caries bears a tolerably close relation to the habits of luxury of the several peoples, and it may be added that contracted jaws were met with three times among the Romano-British skulls, a thing quite unknown in savage races.

Amongst modern races, the Esquimaux,[3] North American Indians, Arabs, Africans, New Zealanders, Kaffirs, and Northern Indians were distinguished for having generally sound teeth;

1 *Op. cit.*, p. 65.
2 Transactions of the Odontological Society, new series, vol. ii.
3 The Esquimaux and Samoyedes subsist largely upon raw meat, with the animal's blood saved for consumption as fully as possible.

whilst the Chinese, some American Indians dwelling in cities, Southern Indian tribes, and South Pacific Islanders furnished a large number of examples of caries.

The Hygiene Committee of the British Dental Association found from an examination of the British skulls in the Museum of the Royal College of Surgeons that in skulls of ancient date caries was almost entirely absent, and when present trifling in extent. A circular letter was addressed to certain dental surgeons able to speak from over fifty years' experience, who all agreed that dental caries had increased. Hospital statistics showed that a largely increasing number of patients required to be referred to the dental department. The committee strongly emphasized the importance of instructing children in public elementary schools in the value and care of their teeth.

There appears to be no room for doubt that increased civilisation predisposes to the occurrence of caries, though as yet it is uncertain in what way it does so.

True caries is of very rare occurrence in animals, but when it does arise it is usually in domesticated beasts; thus it is met with in the horse. It has, however, been met with, according to Dr. Magitot, among the anthropoid apes whilst in the feral state. Caution must be exercised in accepting as examples of caries in animals all cases recorded as such, as diseased conditions which have no relation to caries are often recorded under this heading by veterinary surgeons and others not specially familiar with the disease.

The following conclusions seem to be most nearly in accordance with the preceding facts, viz. :—

That caries is an effect of external causes, in which the so-styled vital forces of the individual play no part.

That it is due primarily to the solvent action of acids generated by fermentations occurring in the mouth, micro-organisms playing no small part in the causation of these fermentations.

That, once a breach being made by decalcification, others, or it may be the same organism, take an active share in the further disintegration, partly by a peptonising action upon the organic basis of the tooth, and partly, perhaps, by boring through and breaking up the softened dentine.

Experimental Investigations. — Litmus-paper applied within the cavity of a carious tooth almost invariably gives strongly-marked acid reaction, and thus furnishes evidence of the existence of an agent capable, if unresisted by the vitality of the dentine, of depriving that tissue of its earthy constituents, leaving the collagen to undergo a gradual decomposition favoured by the heat and moisture of the mouth and the action of bacteria.

In examining the circumstances under which the decomposition of the dentine takes place, and under which it is resisted, apart from the influence of vitality, every one must be struck with the power that is exerted by the mere form of the surface involved. Supposing the disease to be situated in a deep fissure, or upon the side of a tooth, against which another tooth is placed, the decomposition will go on with more or less rapidity, the rate being varied in accordance with the condition of the oral fluids. But if the cavity be superficial, and so placed that it is subject to friction during mastication, the progress is usually relatively slow; and if the low walls of such a cavity be removed, the part will become polished by the act of mastication and by the motions of the tongue, and decomposition will be completely arrested quite independently of any power of resistance exercised by vital action. Again, let a tooth be placed under circumstances the opposite of the preceding. For example: take a bicuspid of the upper jaw, the distal surface of which is decayed, and remove the softened dentine; then let dry cotton-wool be forced between the defective tooth and its neighbour, and renewed only once in three or four days. At the end of a fortnight or three weeks it will be found that the surface of the cavity, which was left hard and dense after the first operation, has become soft, and that the softening extends to a considerable depth. Had the cotton, prior to its introduction between the teeth, been dipped into a solution of any resinous gum, such as mastic, the surface of the cavity would have remained unaltered, owing to the exclusion of moisture. But where wool only is used, the secretions of the mouth are not only not excluded, but are held in constant apposition with the exposed dentine by the saturated wool.

Experiments of this character lead to the conclusion that within the mouth *agents are present which, under favouring circumstances, are capable of decalcifying the dental tissues,* and the source of these agents becomes the next question which naturally suggests itself.

The **secretion from the mucous membrane** is perhaps sometimes slightly acid, while the salivary fluid, when normal, is alkaline. Again, the degree of tenacity of the mucus may be increased beyond the normal amount, and may enable it to remain in certain situations unmixed with, and consequently uninfluenced by the alkaline character of, the salivary fluid. The quantity of the mucus may be excessive either from a local or general cause. We not uncommonly find in mouths tenanted by numerous carious teeth the gums thickened and vascular, and covered with a coating of thick adhesive mucus capable of being drawn from the gums in long strings. In a case recently under observation the teeth were rapidly destroyed by caries, and coincident with the destructive process the salivary fluid was scanty in amount. The mouth owed its moisture largely to the secretion of the mucous membrane. The patient complained of great discomfort from the dry and clammy condition of the mouth and throat. The teeth that were first lost decayed in those situations in which we usually expect caries to show itself; but at a later period the whole of the remaining teeth were almost simultaneously attacked near the edge of the gum, producing round each tooth an annular belt of softened tissue. The patient suffered from long-standing dyspeptic symptoms; and among these a vitiated condition of mucus secreted from the surface of the mouth, and a diminished amount of saliva, formed prominent features.

In the foregoing case there could be no doubt that the state of the oral fluids was dependent upon the general condition of the body; but in many cases it is by no means easy to determine how far the disorder of the teeth is dependent upon a general derangement of the system having a coincident existence, or how far the general disturbance of health may be dependent upon the diseased condition of the teeth. Young people are often brought to us in whom, coincidently with the extensive development of caries, we find an abundant flow of saliva, and a free secretion of mucus; but we think the latter is usually in excess, and is found clinging to the teeth, instead of becoming dissolved in the saliva. There may be another explanation for this stringy saliva, namely, the occurrence of mannite fermentation.

Dr. Aug. Lohmann believes that mucin has a decalcifying action upon the enamel of the teeth. He has observed that people whose salivary secretion is abundant, with mucin in large proportion, have a considerable number of carious teeth, and that the process is more rapid when the saliva is decidedly viscid. He has carried on a series of investigations and found that mucin has as strong a decalcifying action as lactic acid. A molar weighing 2·131 gm. suspended in the mucin obtained from the saliva of a girl aged 18, weighed only 2·112 gm. at the end of the thirtieth day. The saliva of pregnant women contains a great proportion of mucin, and is therefore more decalcifying than that of the normal subject. A tooth weighing 2·066 gm. suspended in the saliva of a pregnant woman weighed only 1·777 gm. after thirty days' sojourn in the fluid. An experiment was made with lactic acid in two per cent. solution. A tooth weighing 2·117 gm. was allowed to remain in this solution for thirty days. At the conclusion of the experiment it weighed 2·072 gm. It should be remembered that lactic acid is present in the salivary fluid to the extent of 0·75 per cent.

The effects of the presence of mucin upon the surfaces of teeth and mucous membrane can be neutralised by the action of slightly astringent and antiseptic solutions, or by means of physiological salt solution, which is a solvent for mucin (" Archiv für Zahnheilkunde," June, 1904, and translated in British Dental Journal, 1905).

A disordered state, local or general, of the mucous membrane, must not, however, be regarded as the only source from whence may be produced agents capable of decomposing faulty enamel or dentine. For instance, examples present themselves in which the teeth rapidly decay in mouths free from any increased vascularity, local or general—free from adherent mucus about the teeth, and also from any sign of that fluid being either excessive in quantity or vitiated in quality. Several patients (females) returning after a prolonged residence in India, have presented the foregoing conditions of the mouth. They have been pale, bloodless, and greatly debilitated, though not necessarily greatly attenuated, subjects.

But, after all, the examination of the reaction of the saliva and of the buccal mucus in mouths where caries is rapidly progressive has hitherto disclosed discordant results.

The results of the experiments of Westcott, Allport, Mantegazza, Magitot, and Leber and Rottenstein agree in showing that not only the mineral acids, but also the vegetable acids, even in weak solutions, have the power of dissolving out the lime-salts from a tooth. The various acids, however, act differently on the teeth; thus some attack the enamel almost exclusively, whilst others effect the destruction of the dentine and the cement, leaving the enamel intact. In the experiments of Dr. Magitot ("Traité de la Carie Dentaire," 1867, p. 108) some most instructive results were arrived at. The teeth were submitted to the action of the various reagents for very long periods, in some instances amounting to ten years; and in certain cases the tooth was protected by a layer of wax, save at one point, so that definite cavities were produced.

With solutions of sugar the naked-eye appearances of dental caries were exactly imitated; the destruction was far greater in a solution to which a fragment of animal matter had been added than in the pure sugar solution; whilst in a third experiment, in which some drops of creosote had been added with the view of retarding fermentation, the enamel alone had been destroyed where exposed, and the dentine only very superficially softened. In all of these experiments the solution acquired a distinctly acid reaction. When a greater quantity of creosote was added, no effect whatever was produced on the teeth, and the solution remained neutral; the same negative result followed when the solution was boiled and hermetically sealed whilst still boiling. From these and the numerous similar experiments of other observers, we may fairly come to the conclusion that sugar itself has no power of acting upon the teeth, but that the various fermentation-products which are derived from it are exceedingly potent for evil. M. Mantegazza arrived at confirmatory results in a different manner; the teeth were dried and weighed before and after the experiment, and in this way the actual loss of salts was determined. Under the influence of albuminous ferments, the chief products of the fermentation of sugar will be lactic and butyric acids, together with other derivatives, such as propionic and valeric acids.

Underwood and Milles failed to artificially reproduce all the phenomena of caries, but more recently Miller and, after him, Pound and others have fully succeeded.

Miller has shown that the failure of previous experimenters was due to putrefaction having occurred in the solutions by which an alkaline reaction was established, and that all that is necessary for success is to change the fluid and substitute fresh fluid so often as any putrefaction takes place.

He kept teeth, or portions of teeth, in a mixture of bread and saliva for three months at a temperature of 98°, frequently renewing it.

All the phenomena of caries were reproduced, so that the most practised microscopists were unable to distinguish sections from these teeth from those with natural caries, but the decay so produced was white; when putrefaction was allowed to subsequently occur, all sorts of coloration appeared, as also happened if the pieces were exposed to the air or to the influence of various coloured articles of food.

Miller therefore does not regard the colour, any more than the zone of translucency, as essential phenomena in caries.

As a confirmation of these conclusions, teeth were submitted to the action of lactic acid; in a very weak solution (one part in one thousand) the teeth had undergone no alteration at the end of two years, but in a stronger solution (one per cent.) they were discoloured and soft, and the enamel very friable at the exposed points. As lactic acid is very constantly present in the mouth, either as a fermentation-product formed on the spot, or regurgitated from the stomach in pyrosis or vomiting, it is probable that it is an active agent in dental caries.

It will perhaps be hardly worth while to recount in detail in this place the effects of all the different acids employed in experiments; it may, however, be noted that with butyric acid great discoloration of the softened part was obtained, and that citric and malic acids, both so frequently present in fruit, were found to act very powerfully as decalcifying agents. With respect to the latter, it is generally abundantly present in cider, and some teeth placed in a cider cask disappeared entirely.

Carbonic acid, when present in large quantities (*i.e.*, under pressure), acts as a feeble solvent, but at atmospheric pressure does not act at all. Albumen and other albuminous substances may perhaps help the destruction of teeth by giving rise to fermentation-products such as valeric and butyric acids.

The fermentation-products derived from sugar and from albumen, and citric, malic, and carbonic acids were found to act on the tooth-tissues alike ; whereas alum, oxalic acid, and acid oxalates dissolved the enamel only ; acetic and tartaric acids, and acid tartrates, the dentine and cement only. It has also been found that the chloride and perchloride of iron, as also the sulphate, have a solvent action on the teeth.

Mr. Coleman (Transactions of Odontological Society, 1862) found that the fluid resulting from the addition of fragments of bread and a small quantity of saliva to the water in which the teeth were placed acted very energetically, so that after twenty days flakes of softened dentine could be removed from the surface.

Closely connected with the foregoing considerations is the existence of complete or comparative **immunity** from dental caries. This immunity, as has already been mentioned, is possessed to a very large extent by all animals, even when living under artificial and not favourable conditions; it was possessed to a large extent by almost all ancient races in primitive conditions of life, and is now seen in certain races of mankind and in certain individuals even amongst races very subject to caries. The explanation which has been suggested with regard to general diseases, viz., that immunity may have been acquired by natural selection, *i.e.*, by the weeding out of the more susceptible individuals, does not for various reasons seem to apply to dental caries, and the causes of immunity remain obscure. Bacteria are very abundant in the mouths of many animals, but whether the bacterial flora in their mouths is the same as that in human mouths has not been sufficiently investigated. A few experiments made by Mr. Kenneth Goadby seem to indicate that the bacteria of monkeys' mouths are mostly saprophytic, but much remains to be done in this direction. Miller has devoted much time to the investigation of immunity in man, and the following conclusions are to be drawn from the results of his experiments (Cosmos, 1903, 1904).

1. The mixed human saliva—whether filtered or unfiltered, in its normal state or condensed by evaporation over the water-bath, or at the temperature of the human body—does not possess the power to prevent or retard processes of fermentation and putrefaction.

2. The potassium sulphocyanide in the greatest strength in which it is found in the human mouth does not possess any appreciable antiseptic action.

3. Growths of bacteria and fermentative and putrefactive processes take place in oral mucus quite as readily, if not more so, than in the mixed saliva of the same persons.

4. The saliva of immunes develops in the presence of carbo-hydrates, on an average, a little less acid than that of highly susceptible persons. The difference is, however, not constant, and not sufficiently marked to account for the marked differences of susceptibility.

5. The protective bodies (alexins) of the blood do not, under normal conditions, pass into the saliva in sufficient quantity to be detected by ordinary means.

6. Free acids produced by fermentation make their appearance in strongly alkaline saliva (horse) much later than in human saliva.

7. The struggle for existence probably performs an important *rôle* in protecting the mouth and the organism in general against the invasion of pathogenic micro-organisms.

8. The pronounced hæmolytic or globulicidal action of the saliva is due only to its water, not to its salts, and not to any substance analogous to the alexins of the blood.

9. Phagocytosis appears to play a very important *rôle* in the human mouth.

10. The human saliva apparently does not manifest any antiseptic action towards pathogenic bacteria.

11. The action of the viscidity of the saliva in the causation of dental caries has been somewhat overrated.

12. The quantity of saliva is a factor which should not be overlooked, but is hardly one of primary importance except where the deficiency in the quantity secreted is very marked.

13. There is no fermentable carbo-hydrate *naturally* present in the saliva under normal conditions in sufficient quantity to materially influence the origin and progress of caries.

Miller concludes that "the protective powers present in the human mouth are not to be accounted for by any antiseptic action on the part of the saliva, but rather by the phenomenon of phagocytosis, by the struggle for existence, and probably by certain forces residing in the soft tissues, which have not yet been investigated.

A retrospect. No account of dental caries which did not give some history of the steps by which the present views entertained upon its nature were arrived at would be at all complete, and so it is desirable to give a brief retrospect.

In the first edition of this work Sir John Tomes advocated the view that it was a **chemico-vital** process—that is to say, that while the destructive action was merely chemical, the translucent zone was an evidence of vital reaction; and this view, with the modification that micro-organisms are essential to the process, may be said still to obtain.

Bridgman, in 1861, put forth an ingenious theory that the whole process was due to **electrical** action; but this theory, though ingenious, has not stood the test of further investigation, though it will be necessary to briefly recur to it in discussing the merits of various filling materials. At one time it attracted a good deal of attention and gained not a few adherents.

The idea that dental caries is in some sort an **inflammatory** process, and that the dentine is softened by some sort of proliferation of the living protoplasmic elements which it contains, is an old one, and was held by John Hunter and by various authors from his time onwards; of late years it has been revived by Heitzman and Abbott, as has already been mentioned. According to them, the enlargement of the tubes and the ultimate coalescence of contiguous tubes is due to the increase of the protoplasm which exists in them, and on a finer scale in threads connecting the dentinal tubes at the expense of the matrix; and this protoplasm they believe that they can stain and recognise. But there is no reasonable doubt that what they have seen is really a dense mass of organisms; and if this be so, the whole theory falls to the ground. For it must be noted that they make no mention whatever of these masses of organisms, which any one can so easily see for themselves.

We come next to the **parasitic** theories, which also date back rather farther than we are accustomed to think. Ficinus, in 1847, and Klencke, in 1850, attributed it to organisms, although in detail they fell into errors. Leber and Rottenstein, in 1868, made a further step in the same direction. They regarded the initial softening as due to chemical cause, but held that the breach once made, the leptothrix entered the tubes, multiplied in them, and completed the process of destruction. To them was due the pointing out of the iodine reaction which has since proved very useful, although, as was to be expected in the then state of knowledge of the lower fungoid organisms, their conclusions drawn from it do not now exactly stand, at least, not in the form in which they set them forth.

The next noteworthy contribution to the subject was the important paper of Milles and Underwood in 1881. They called attention to the constant presence of organisms, both rod-shaped bacilli and cocci, in the tubes of the dentine.

They also held that the softening of the dentine was due to acids, but with the significant addition that the generation of these acids was itself due to the organisms which, as they expressed it, "were secreted" by the micro-organisms. They add that "the organic fibrils upon which the organisms feed, and in which they multiply, are the scene of the manufacture of their characteristic acids, which in turn decalcify the matrix and discolour the whole mass."

It will thus be seen that Milles and Underwood bring us very near to the modern theories, but their researches not having been continued, it remained for Miller, in a widely-extended research which is a model of true scientific investigation, to work out the details and to place the theory upon what seems for the present an impregnable basis.

According to his researches, we have, in the first instance, an abundant supply of bacteria always present, even in the most cleanly mouth, but in uncleanly mouths in far greater numbers. A great many of these bacteria have the power of setting up lactic acid fermentation, when sugar is ready formed for them by the transforming action of the ptyalin of the saliva, whilst a good many of them are independent of ptyalin, being themselves able to effect the whole change from starchy compounds.

A decalcification of enamel and subjacent dentine having been effected, these or other bacteria enter the tubes of the dentine, and, acting from thence, effect the solution of the decalcified matrix by a kind of peptonising action.

The **physical signs** which mark the presence of caries are first visible in or through the enamel. But they will vary somewhat in accordance with the character of the surface affected. If the disease arises in a fissure on the masticating surface, or in a depression on the crown of a tooth, a dark-coloured spot will be the first indication of its presence; but if the disease has attacked a surface free from any indentation or fissure, the affected part will lose its translucency, and become opaque and white; subsequently the white may be succeeded by an ash or slate, and finally by a brown colour, more or less deep. If the enamel be examined when in the earlier stages of disease, it will be found that the presence of opacity is accompanied, and no doubt occasioned, by an increased porosity of the tissue, a condition which may sometimes have supervened upon some form of imperfect development.

In fact there is a somewhat close similarity between the appearances presented by enamel affected by the earlier stages of caries, and that which is of imperfect development. In each the prisms are unduly distinct, the spaces between them larger than they should be, and the prisms themselves granular and dotted, and often pigmented.

It would seem also that the solvents which are acting in caries behave very much as dilute acids applied to a section upon a slide behave in attacking certain portions of the prisms before the rest are affected.

The histological changes which occur in caries have been from time to time carefully studied, and although each writer has sought to interpret the appearances to suit his own views, there is a pretty general consensus as to most points of actual fact.

Carious enamel is very much like enamel which has been submitted to slow decalcification, as, for instance, by weak chromic acid ; something like its embryonic condition of granular prisms, adherent to one another ; but it is generally pigmented in a manner that cannot be imitated by any artificial decalcification. In the decay of enamel the micro-organisms never penetrate between the prisms until after these have been softened and loosened by decalcification, so that they appear to be quite unable to act upon normal enamel, except, of course, indirectly by their acid-producing powers.

Subsequently it breaks up, and granular *débris*, in which little trace of enamel structure is to be found, results.

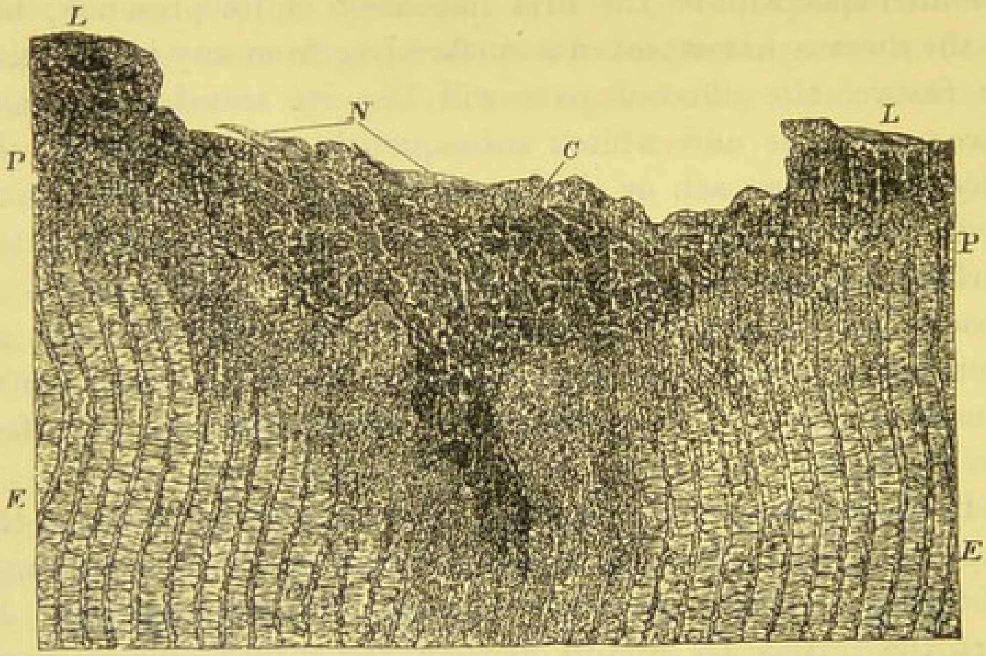


FIG. 129.—Carious enamel, after Dr. Abbott. (Cosmos 1879.)

It has, however, been claimed by Dr. Abbott, working with Prof. Heitzman, that in caries the enamel is not only decalcified, but that the protoplasmic bodies which he erroneously believes to exist in it reassert their individuality. But his protoplasmic bodies are more probably merely masses of micro-organisms.

While we do not agree with Dr. Abbott's views, the accompanying figure approximately represents the appearance of carious enamel, and so is retained here. In it E represents the unaltered enamel, P is a partially decalcified zone, this being the condition which is seen in the familiar white spot.

At C we have fully decalcified matter, which readily takes a stain (according to Dr. Abbott, protoplasmic bodies), and at N flat cells derived from Nasmyth's membrane, which has sunk in. Later observers have noticed bacterial plaques in these situations.

Leon Williams (Dental Cosmos, 1897-8), in the course of his admirable investigations on structural changes in human enamel, refers repeatedly to the appearances and nature of bacterial plaques. In his opinion this thick mass of micro-organisms is always present on the surface of carious enamel, and the approximal surface of a human tooth is usually covered with a thick growth of similar nature. He writes (Dental Cosmos, p. 97) : "The thick mass of micro-organisms is more easily raised from the surface of the enamel at this stage (just after the complete destruction of Nasmyth's membrane has been effected) than at any other. Pressure upon the cover glass in mounting the specimen will nearly always cause such a separation." He believes that "the so-called granular layer of decaying enamel, which has been so often described, is simply a mass of micro-organisms," and that the acid product of the bacteria dissolves out the cement substance between the rods, which are eventually either entirely dissolved or thrown out and washed away.

Miller (Cosmos, 1903) is of opinion that bacterial plaques are essential neither to the beginning nor to the progress of caries, nor does their presence necessarily result in the production of caries. It is possible that they may intensify processes of decomposition in particles of food clinging to the surfaces of the teeth.

When the disease is established in a fissure the enamel to a great extent escapes, and the indications of its presence are not strongly pronounced until a very considerable amount of destruction has been produced. The disease extends into the dentine, penetrating to a considerable depth in the direction of the tubes, and spreading laterally under the enamel without affecting its outer surface ; with the softening of the dentine the inner surface of the enamel becomes softened from within, until the tooth at that point is so much reduced in strength that the enamel breaks in, and suddenly reveals a large and scarcely suspected cavity.

Carious Dentine.—The most conspicuous change in the dentine is that it has become softened in various degrees: it may be but little altered in density, or it may be of horny consistency, or it may be like soft cheese, or even more friable. No sharp line of demarcation between healthy tissue and that which is already carious exists, either to the sight or the touch. It becomes darkened in colour, the depth of the discoloration standing in something like inverse ratio to the rapidity of progress of the disease. There is also an increase in tenderness, which may be great or slight, this standing in direct relation to the rate of progress. "White" decay and "brown" decay are processes not differing in kind, but only in degree and in rapidity of destruction, and it is probable that some part at least of the discoloration is due to accident, *i.e.*, to staining of the absorbent decalcified dentine by food introduced into the mouth, although this will not account for all the phenomena observed, and perhaps Miller is right in ascribing it to chromogenic bacteria, which produce all sorts of colours in artificial cultures.

If a tooth in which caries is progressing slowly, and in which the disease is limited in extent, be divided, the relations of the diseased to the healthy parts may be examined, and it will be in the direction of the dentinal tubes that the disease will be found to have made the greatest progress. Supposing the disease to have commenced upon the masticating surface of a molar tooth, it will commonly be found that the mass of diseased tissue, when limited in amount, presents the shape of a short cone, the apex of which is directed towards the pulp-cavity, and the base towards the enamel.

The section will show that the destructive agent, having gained access to the dentine through an opening in the enamel, has spread, to a certain extent, upon the peripheral surface of the tissue, through the terminal branches of the tubes, and thus formed the base of the cone; but that it has spread to a greater length in the course of the trunks of the involved tubes, following their convergent course towards the pulp-cavity, and thus produced the apex of the cone. But if an example be taken in which the disease has assumed the spreading character, the conical form of the disorganised part will be less strongly, if at all, pronounced. In certain cases, indeed, the whole of the masticating surface of a molar tooth is lost before the disease has advanced to a sufficient depth in the direction of the pulp-cavity to expose its vascular contents. In some teeth, particularly in those described as "honeycombed teeth," the disease, after the enamel has been destroyed and the dentine reduced in thickness, becomes in certain cases arrested. The exposed tissue assumes a polished surface, deep brown colour, and acquires a density which enables the crown, though deprived of enamel, to serve the purpose of mastication with scarcely less efficiency than an uninjured tooth.

Coincidently with structural changes in the dentine a certain amount of uneasiness exists and directs attention to the presence of the disease. It rarely happens that the presence of caries in its earlier stages is altogether unattended by some uneasiness in the affected tooth. The amount is often very slight—so slight, that the condition will be noticed only by those who are in the habit of devoting considerable care to the preservation of the teeth; on the other hand, there are many who immediately recognise the presence of disease by the discomfort it occasions, and in exceptional cases the patients describe the affected teeth as giving them a considerable amount of pain long before the disease has progressed to an extent capable of directly involving the pulp. Toothache of this description must be distinguished from that which is consequent upon inflammation of the pulp, whether resulting from exposure produced by caries, or arising from any other cause; and the distinctions may be made by observing the characters of the pain. There is an absence of throbbing, and a less degree of intensity as compared with that occasioned by inflammation of the pulp. Contact with hot or cold fluids does not usually produce any very unpleasant effect.

The seat of pain appears to be mainly in the peripheral portion of the dentine, and after the vitality in this part of the tooth has been destroyed, the sensation of discomfort in great part passes away.

But no doubt there are cases in which the presence of caries is unattended with any feeling even of discomfort, for we find those in whom the pulp becomes exposed and disappears without a moment's toothache.

Of the **microscopical appearance** presented by carious dentine, much more is to be said.

One of the first and the most obvious changes observed is, the enlargement of the dentinal tubes, which become dilated to many times their original dimensions; and the surroundings of the enlarged tubes having undergone some change, perhaps of the nature of a partial decalcification, we get the so-called "pipe-stem" appearance.

Under the microscope the section looks as though it might have been built up of multitudes of tobacco-pipe stems, united by an intervening substance. Such is the condition when disorganisation has advanced up to a certain point; at a later period polygonal areas, five or six-sided, appear with but little intervening substance, the exact nature of these changes being still a matter of uncertainty.

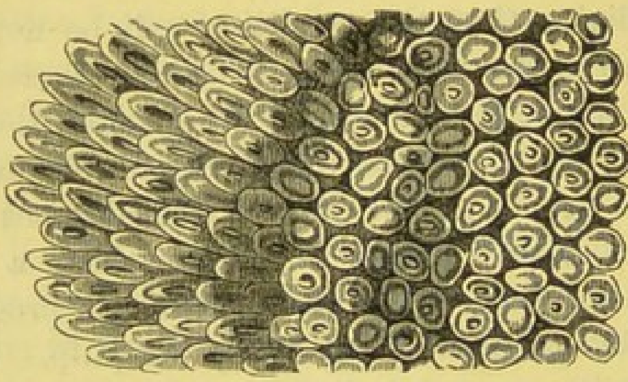


FIG. 130.—A section from dentine softened by caries.

The first chemical change consists in the removal of the lime-salts from the collagen, leaving the dentine of a consistence capable of being readily cut with a sharp knife, when it will be found to exhibit the structural characters just described. Miller has found that a piece of carious dentine cut out with a spoon excavator was decalcified to such an extent that it had lost twelve-thirteenths of its lime-salts, whilst of its organic matter only two-fifths had disappeared. This area of decalcification goes well in advance of the invasion by micro-organisms. The question naturally suggests itself, may not these appearances be nothing more than a certain stage in progressive decomposition, due to a solvent fluid obtaining access to the tissue through the tubes, and the outline of each rod be indicative only of the depth to which the fluid has permeated?

As a matter of fact, the connecting material is the first, and the walls of the tubes the last, to become disintegrated; and this, prior to the discovery by Neumann of the very indestructible nature of the dentinal sheaths, seemed to answer the question in the negative. Knowing, however, as we now do, what great powers of resistance the walls of the canals possess, this explanation of the tobacco-pipe appearance is rendered far more probable. Occasional exceptions to this sequence of disorganisation, will, however, be found in teeth which are

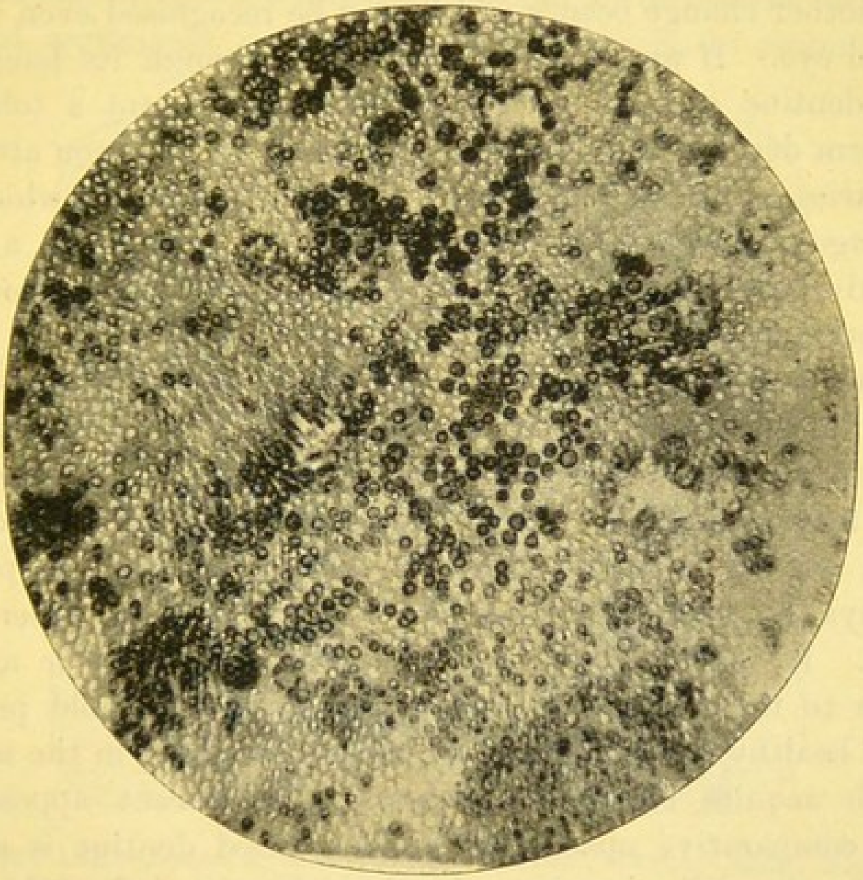


FIG. 131.—From a micro-photograph of carious dentine (cross-section), taken by Mr. Mummery, which shows the "tobacco-pipe" appearance well.

destroyed with great rapidity. In them the tubes will appear to have become enlarged in an altogether irregular manner, and the distinction of the tubular and intertubular parts of the tissues will be but faintly pronounced, and indeed may be altogether wanting. But supposing a section from a carious tooth in which the destruction has been gradual be taken, the following conditions may be observed: commencing at the part where the dentine presents pretty nearly its natural appearance, we then pass to a point where the appearances depicted on the preceding page are seen; still further on, this condition becomes yet more strongly marked, and at the extreme edge, supposing the section to have extended to the surface of the cavity, the process of disintegration may be seen.

If the dentinal sheaths of carious dentine be isolated by the application of strong acids, they will often be found to present varicosities and globular swellings.[1]

Another change occurs which may be recognised even by the naked eye. If we divide a sound tooth through its long axis, the dentine exposed by the section will present a tolerably uniform degree of opacity; but if the tooth has been attacked by caries, in addition to the discoloration of the part which has undergone chemical change, we shall generally find a comparatively translucent zone removed a short distance from and surrounding the disorganising mass.

This region of increased transparency, almost always to be found between the advancing caries and the pulp-cavity, does not invariably present the regular form above depicted; it may form a cone, the apex of which is directed towards the pulp, and the base towards the caries, or it may be present as hyaline stripes and spots having no very determined form. It corresponds in naked-eye and microscopic appearances to the dentine of the roots of the teeth of old persons, or of healthy stumps which have remained long in the mouth, which acquire this peculiar horny, translucent appearance. The comparative opacity of healthy dried dentine is simply due to the difference between the refractive index of the air contained in the tubes and that of the matrix, and any cause which tends to bring these more near to one another will increase the transparency of the tissue.

Thus the tissue might be rendered more transparent either by the obliteration of the canals by calcification of their contents, or by the decalcification of the matrix, which, by lowering its refractive index, would bring it more nearly into accord with that of the air in the tubes.

The true nature of this transparent zone acquires additional

[1] Excellent figures are given of these beaded, elongated bodies, in Heider and Wedl's "Atlas zur Pathologie der Zähne," part iii., pp. 792, 793; and they are further described in Wedl's "Pathologie der Zähne."

interest from the fact that it is the last remaining evidence of supposed vital action, and it alone has not been imitated in artificial caries; the other appearances have all been shown to be due to purely external causes, so that this alone remains to be discussed.

In the first edition of this work it was stated that the translucency was due to the exclusion of air from the tubes by the calcification of the fibrils.

In favour of the view that the dentinal fibrils become calcified, several arguments may be adduced. One is its *primâ facie*

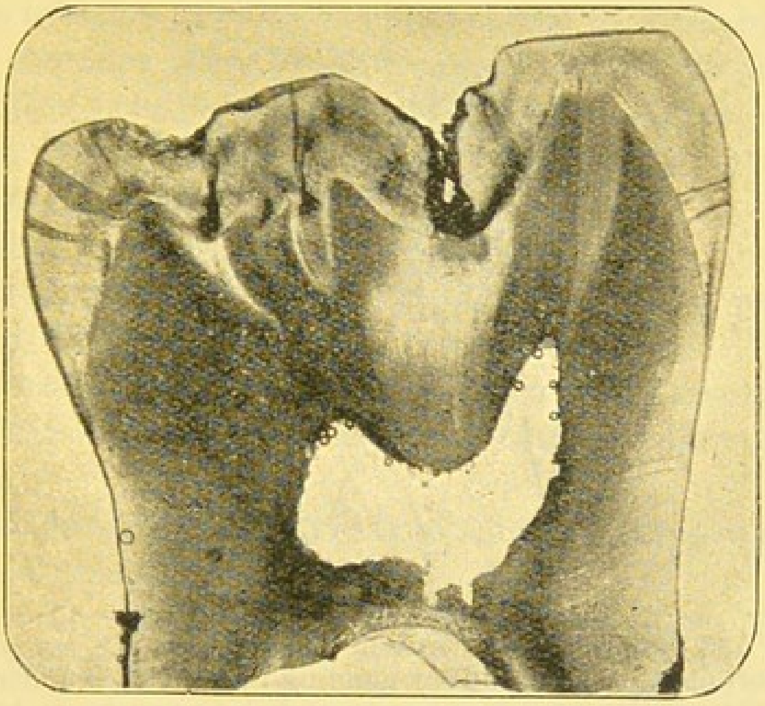


FIG. 132.—Zones of transparency (Miller, Trans. Odont. Soc., 1895) where the enamel is much worn, but no caries appears to exist.

probability; we know that slow progressive calcification does go on in the tubes long after the apparent completion of the dentine, and seeing that the irritation of caries does unquestionably cause calcification to start afresh in the pulp, it seems very natural to suppose that it would have the same effect in the dentinal tubes.

Again, there is the resemblance in the appearance of the translucent zone to that of the roots of old teeth, which are supposed to be more rich in lime-salts than ordinary healthy dentine.

Dr. Magitot ("Recherches sur la Carie des Dents," Paris, 1871, p. 511) believes that the dentinal fibrils do become obliterated by calcification, and regards it as an indication of resistance to the progress of the disease.

Professor Wedl, however, although he attributes the increased transparency to the absolute exclusion of air from the tubes, speaks of the calcification of the fibrils as "noch problematische" ("Pathologie der Zähne," p. 334); and by treating dried sections from the horny-looking roots of the teeth of old persons with carmine, he found that they retained the power of imbibition, the colouring matter thoroughly

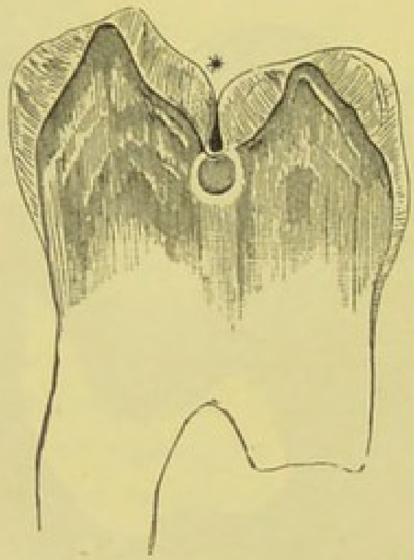


FIG. 133.—Shows a transparent zone of dentine, removed a short distance from and surrounding that which is undergoing decomposition consequent upon caries.

permeating the tubes, though they appeared to be impervious to air. MM. Leber and Rottenstein also deny the existence of calcification in the fibrils, attributing the transparency to the disappearance of calcareous salts, and stating that the translucent tissue is distinctly less hard than the surrounding dentine (*op. cit.*, p. 39).

According to Miller, chemical analysis gives 71·9 as the proportion of ash in healthy dentine, and 72·1 per cent. for the translucent zone. But this difference is a very slight one, and can hardly be held to be conclusive; moreover, if the tubes are filled up, organic matter as well as lime-salt will have doubtless been added, so that analysis, except of larger quantities than are obtainable, can hardly be expected to finally solve the question.

Mr. F. J. Bennett (Transactions Odont. Society, 1895) has published some observations upon the zone of transparency in cases of partly arrested caries. He found the "pipe-stem" appearance in sections transverse to the tubes, and concludes that it is therefore an area of decalcification; he believes that he has recognised it also in teeth mounted on plates. In discussing the paper, Mr. Mummery was inclined to attribute the tobacco-pipe appearance to the fact that the section was taken from a region of decalcification in advance of the micro-organism invasion, such as has been shown to exist by Miller. Later in the same year, Dr. Miller contributed a paper on the same subject, pointing out that Walkhoff and Baume had both found the opposite results, namely, contraction or obliteration of the tubuli.

Dr. Miller points out that—

1. If it is decalcification, it ought to be easy to produce it artificially, whereas it never has been so produced.

2. That decaicification advances in a fairly regular line, whereas the transparent zone often runs in deeply (compare Fig. 132).

3. That decalcification spreads rapidly sideways—not only in direction of tubes.

4. That he has failed to find it in dead teeth (worn as artificial teeth).

5. That it occurs under worn enamel without caries.

6. That chemical analysis has given no confirmation to the decalcification view. [The difference of one per cent. found would be utterly insufficient to account for transparency.—C. S. T.]

7. That dentine ever so little decalcified takes stains readily; the transparent zone stains with more difficulty than the surrounding parts.

On the whole then it remains unexplained; the evidences for decalcification and for calcification are alike weak, that against decalcification somewhat the stronger.

Mr. Charters White has found, in specimens in which the dentinal tubes are permeated with coloured collodion, that the tubules of the zone of transparency are only very partially permeable, the coloured collodion entering up to a certain point and there terminating abruptly; a very few of the tubes, however, carry it through.

This, so far as it goes, is in favour of a calcification theory.

Whether or not the transparent zone occurs in dead teeth worn as artificial substitutes is a matter still in dispute; it certainly has never been produced in artificial caries, but it is asserted by Wedl that all the appearances of dental caries may be seen in natural teeth which have been worn upon plates, viz.: the thickening and varicose swelling of the dentinal tubes, the granular condition of the fibrils, the dark pigmentation, and also the *clear, translucent zone* (Wedl, *op. cit.*, pp. 320 and 334).

Owing to the almost entire abandonment of the use of human teeth as artificial substitutes, I have not been able to get a sufficient number of examples of caries occurring in them to enable me to speak very certainly on this point; but, judging from those which I have seen, I was formerly inclined to think that the transparent zone is as constant in them as in living teeth; though Dr. Magitot (*op. cit.*, p. 511) is of the contrary opinion, and considers that this clear zone constitutes the only difference between caries as occurring to living teeth and others; and in face of Miller's more extensive researches, my own impression that it does occur is of small value.

Dr. Miller has examined the sixty most suitable specimens from some three hundred teeth which had been worn upon plates and showed decay. In only one was there a transparent zone, and this was so situated that it was impossible to ascertain whether it had not been formed prior to the employment of the tooth as an artificial substitute.

Globular masses of calcareous salts may sometimes be found in the dentinal tubes near to a carious cavity, but inasmuch as they are met with in dead teeth as well as in living ones, they are probably to be explained as depositions from solutions of salts, and not as evidences of vital action. Indeed, even if it were conclusively shown that the dentinal fibrils became obliterated by calcification, this would not amount to absolute proof of vital action; for albumen out of the body is able to form combinations with calcareous salts which have a definite structure, and it would be conceivable that the same thing might happen in a dentinal tube.

An appearance seemingly indicative of consolidation of the fibrils may be found by taking a tooth in which the progress of decay has been slow, leaving the disorganising dentine of a deep brown colour, and comparatively firm in texture. If we cut with a sharp knife a thin section in the direction taken by the dentinal tubes from the discoloured portion (if the tooth be well selected), the disconnected rods will be seen broken abruptly into short lengths. Sometimes they are present in

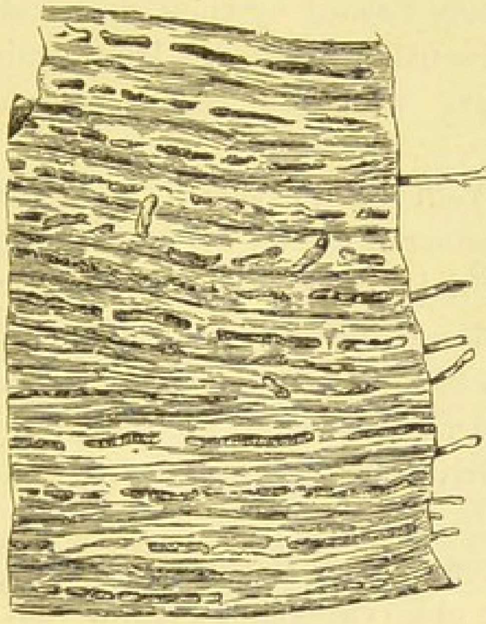


FIG. 134.—A section in a plane with the tubes, from carious dentine. These rods may be portions of consolidated fibrils, or they may be bits of the sheaths of Neumann, or they may be mere casts of the enlarged tubules.

great numbers scattered over the specimens, many lying within the tubes, others upon the surface, and occasionally they may be seen with one end projecting from the edge of the section and the other within the tube.

Miller mentions that they occur in artificial caries, and that they dissolve and disappear in weak acid: hence they can hardly be pieces of Neumann's sheaths, but are probably casts in lime-salts of the tubes.

In a paper descriptive of the histology of dental caries (Dental Cosmos, March, 1879), Dr. F. Abbott states that at a certain distance from the decay the canaliculi look enlarged, and each contains the dentinal fibril. Nearer to the line of decay we meet with moderately enlarged canaliculi, the centres of which are occupied by protoplasm, stainable by carmine. One step further on the canaliculi are double or treble their original size, and they are filled with yellow protoplasm exhibiting the net-like arrangement of living matter; whilst ultimately these enlarged canaliculi coalesce, and large spaces filled with the same material occur with but traces of basis-substance intervening. It will be noticed that the main peculiarity of Dr. Abbott's account lies in the fact that he claims a high vitality for the contents of the enlarged tubules and the spaces ultimately formed by their coalescence; but to this we shall have presently to recur. Here again, as in the case of enamel, he has probably had micro-organisms under observation.

Professor C. Wedl states that in a transverse section a greater or less number of canals are seen whose limiting walls (the so-called dentinal sheaths) describe moderately large circles, and whose cavities are filled by a mass, in some places homogeneous, in others of molecular appearance, which forms convex projections beyond the surface of the section; but he does not lay down any positive statement as to what the nature of this material may be.

Leber and Rottenstein ("Recherches sur la Carie Dentaire," 1868) took up the observations of Ficinus that a cryptogam, to which the name of leptothrix was given, was very constantly present in carious dentine, and pointed out that it was to be found not only on the surface, but that it penetrates far into the dentinal tubes, and that it is a chief agent in their enlargement and the softening of the surrounding matrix. They found that the contents of the enlarged tubes were characteristically stained by iodine.

Later, Messrs. Underwood and Milles (Trans. Internat. Med. Congress, 1881) showed that in the enlarged canals, and even in some which show but little enlargement, micrococci and oval and rod-shaped bacteria are to be found. They penetrate at first in Indian file, accumulate, and choke up the channels; and when the matrix is disappearing, and neighbouring channels coalesce into irregular spaces, the whole tissue becomes a mass of conglomerated organisms.

Thus what is for Dr. Abbott reticulate protoplasm is for Messrs. Underwood and Milles a mass of organisms.

Sections cut from apparently healthy tissues beyond the sphere of visible decay show here and there a narrow line of micrococci or bacteria, like an advanced guard; and these

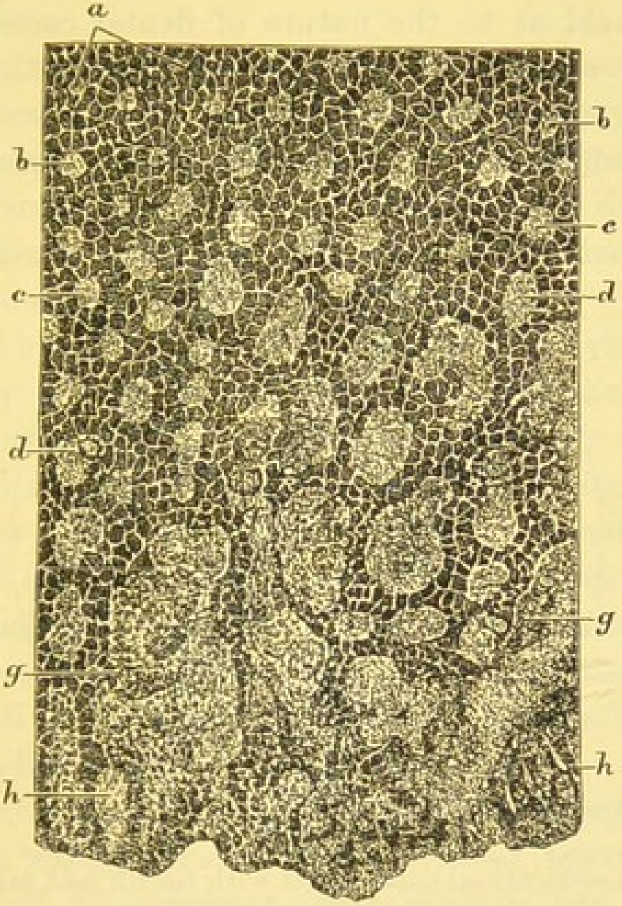


FIG. 135.—Carious dentine (after Abbott). *a*, healthy tissue; *b*, dentinal fibrils; *c*, dentinal fibrils slightly enlarged; *d*, dentinal fibrils further enlarged; *g*, large protoplasmic masses. This figure is retained as historical, rather than as accurately representing the appearances.

percolate far into tissue which the naked eye would pronounce quite unaffected.

Dr. Miller's conclusions differ in some respects from those of Messrs. Underwood and Milles; for he holds that large areas of softened dentine exist which contain no organisms, which, therefore, are not co-extensive with the decalcification. He also holds that the various changes found subsequently to softening are caused by the invasion of micro-organisms. Moreover, he and others have been successful in producing an artificial caries which, under the microscope, cannot be distinguished from the real disease; whilst Messrs. Underwood and Milles had failed to reproduce the exact effect, owing to the condition of their experiment having allowed of putrefactive changes taking place.

Such being a brief history of appearances described, we may proceed to the consideration of the **pathology** of the condition. The views held as to the nature of dental caries may be, for the sake of convenience, grouped under the three following heads:—

Those which regard it as a real "disease," a vital phenomenon,

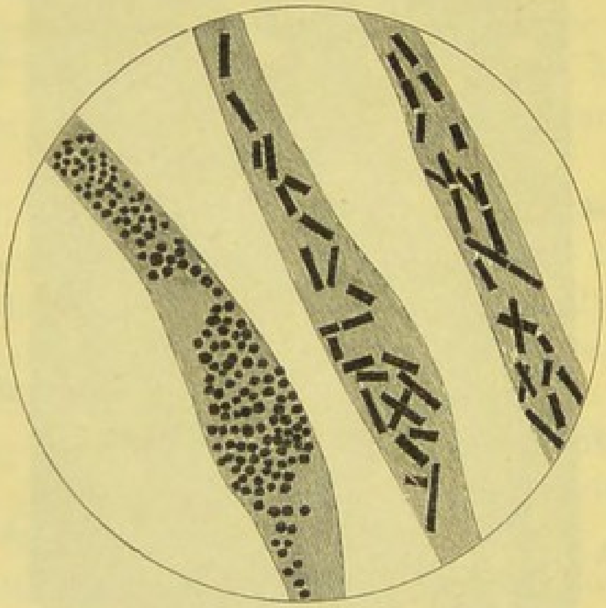


FIG. 136.—Dentinal tubes filled with bacilli and micrococci, after Underwood and Milles.

strictly comparable to morbid conditions of other more highly organised parts of the body.

Those which regard it, in the main, as the effect of mere chemical action, but also consider that some very constant appearances are only explicable on the hypothesis of vital reaction.

Those which regard it as wholly and entirely the effect of chemical action, in no degree modified by the connection of the tooth with the living body.

It was at one time very generally supposed that dental caries was an inflammatory affection, a true "disease" of the dentine, and the name "Odontitis," was given to this supposed disease. Amongst the older writers, Hunter, Cuvier, Fox, T. Bell, and others held this opinion, and it has of late years been revived by Neumann, Hertz, and Dr. F. Abbott.

In support of this idea, the occurrence of so-called *caries interna* was adduced; but if there be any one thing certain about caries, it is that it always starts from the surface, and cannot occur at any spot devoid of communication with the exterior.

Neumann believes that in the varicose swellings of the dentinal tubes evidences of cell proliferation may be seen, and he hence draws comparisons with inflammatory and ulcerative affections of soft parts. Wedl ("Pathologie der Zähne," p. 333) strongly dissents from this view, and thinks that the appearances may be easily otherwise explained.

And Dr. Abbott considers that "caries of a living tooth is an inflammatory process, which, beginning as a chemical process, in turn reduces the tissues of the tooth into embryonic or medullary elements, evidently the same as during the development of the tooth have shared in its formation; and its development and intensity are in direct proportion to the amount of living matter which they contain, as compared with other tissues. The medullary elements, owing to want of nutrition and to continuous irritation, become necrosed, and the seat of a living growth of organisms."

Dr. Abbott bases his belief in the inflammatory proliferation of the plasm which permeates the dentine upon the appearance described at a former page; and, as has already been hinted, these same appearances have been under the observations of, and have been otherwise interpreted by, other observers. And although Dr. Abbott has employed high powers and very careful methods of preparing his specimens, we think that his interpretation of the appearances he has seen and figured is beyond all question wrong. And supposing an inflammatory action in the living contents of the dentine to be an important factor in the phenomena, it may be asked, How is it that this, once started, never goes on after the carious cavity has been excavated and filled, and that with materials which, by their conductivity or other cause, not infrequently actually induce an inflammation in the pulp? It might be thought that a comparison of caries as occurring in a dead and a living tooth would at once set the question at rest, but unfortunately there is difference of opinion as to the appearances there presented.

Dr. Abbott gives no figures and no detailed description of any cases of caries occurring in teeth worn as blocks or as artificial teeth, save of a very slight degree of caries in a piece of hippopotamus tooth. In this he notes that there was no enlargement of its dentinal tubes; but this might well be the case in many a specimen of equally slight caries in a living tooth, and, moreover, it is but a single observation. He gives it as his opinion that in "dead and artificial teeth caries is a chemical process assisted only by the decomposition of the glue-giving basis substance of dentine and cement."

Hertz ("Virchow's Archiv," Bd. xli.), on comparing sections of carious teeth with those from teeth softened by acid fluids, came to the conclusion that there were real differences, mainly consisting in swelling and fatty degeneration of the dentinal fibres, which pointed to the existence of some vital action; but he does not describe the condition of extraneous teeth softened by the fluids of the mouth.

On the whole, then, it may be said that the notion of caries having any relation to inflammation of the living portion of the dentine has met with but few adherents, whilst on the other hand, in support of the theory that most, if not all, the phenomena of caries may be produced by chemical action, without the intervention of vital forces other than extraneous ones, *i.e.*, the growth of bacteria, a great and conclusive body of evidence has been brought together. In the first place, it always starts from the surface; it may be in a fissure, or at some point where the tissues are defective, but it never occurs at any place which is not exposed to external influences.

Again, the use of litmus-paper proves that in many places in the mouth an acid reaction exists; and experiments performed out of the mouth have conclusively shown that most dilute acids, vegetable as well as mineral, have the power of speedily decalcifying dentine and enamel (p. 243, 244).

In some mouths the hippopotamus ivory formerly used for artificial teeth was very rapidly attacked. Thus Dr. Magitot ("Traité de la Carie Dentaire," 1867, p. 102) mentions the case of a lady in whom these plates could only be worn for six or eight months; at the end of that time they were translucent and amber-like in appearance, flexible and spongy to the touch, and very offensive; in places actual dark walled cavities were formed. The gums were tumid and spongy, and a considerable number of softened stumps remained in the mouth. When the crowns of human teeth are inserted into the mouth, either upon a plate, or pivoted on old stumps, they often become carious; such teeth are especially prone to be attacked on the surface which is in contact with the gum, though it is not unusual for interstitial cavities to be formed in them. Nevertheless, some writers have denied the identity of the destructive process in these artificial substitutes with that which occurs in living teeth; and others, whilst admitting their substantial similarity, believe that differences may be found.

The appearances which have been supposed to indicate vital action in caries are mainly two: the "tobacco-pipe" structure apparent on transverse sections (see p. 254), which looks like great thickening of the tubes of the canals, and the obliteration of the tubes between the caries and the pulp-cavity, which gives rise to the appearance of a clear translucent zone.

Neumann ("Archiv für Klin. Chirurgie," Bd. vi.) believed that the apparent thickening of the walls of the tubes is a real thickening of the dentinal sheaths at the expense of the matrix, and that the fibres participate in the process, the canal ultimately becoming obliterated. He believed that in a single instance he saw calcification of the fibrils.

But Leber and Rottenstein ("Recherches sur la Carie Dentaire," Paris, 1868) have given figures, drawn from a human tooth which had become carious whilst worn as an artificial tooth, in which the dilatation of the canals and the thickening of their apparent walls are exceedingly well seen; so that these two characters, at all events, are produced purely by causes external to the tooth, and having nothing whatever to do with its vitality.

Wedl also ("Pathologie der Zähne," p. 326) gives a description, illustrated by figures, of the microscopic appearances met with in caries occurring in teeth worn thus, which put it beyond all doubt that the process is identical with that which occurs in a tooth connected with living parts. The tubes are beaded, and have pearl-like rows of globules in them, and when isolated by decalcification and boiling are seen to have the varicose swellings so characteristic of caries.

Seeing that the characters of caries, in its destructive processes at least, have been repeatedly met with in human teeth worn as artificial substitutes, and also in hippopotamus ivory placed under similar circumstances, it must be admitted that there is at present a balance of evidence in favour of the view that caries—in so far as it is a process of disintegration—has no relation whatever to the connection of the tooth with the living body. It is, however, equally a fact of every-day observation that the pulp is, so to speak, sensible of the approach of caries towards it, and that secondary dentine is in consequence deposited on that wall of the pulp-cavity which is threatened by the advance of the disease. So far, then, there is an attempt to bar the progress of the disease ; or, to speak more accurately, the stimulus of irritation transmitted to the pulp starts afresh the process of calcification in that organ.

As the irritation set up by caries is thus capable of inducing calcification in the pulp, it was not unnatural to suppose that it might have a similar effect on the contents of the dentinal tubes ; and it may be that this is to be seen in the translucent zone of the surrounding caries.

Those whose daily clinical experience brings under their notice caries occurring in the same mouth in teeth with and without living pulps, will surely find it impossible to believe that there are under their eyes two diseases in their very essence different : that the caries of the living tooth is an internal inflammatory change, and that the caries of the dead tooth is an effect of external chemical and physical causes alone. But we have never seen this difficulty fairly faced by any of the advocates of the "vital" theory.

The occurrence of **organisms** in decaying dentine has already been repeatedly alluded to ; their presence is best brought out by staining in aniline dyes, many of which answer the purpose well, gentian, violet, orange rubin, and fuchsin giving excellent results. They may be used in many ways, of which Gram's method of overstaining, placing in a dilute solution of iodine in iodide of potassium, and then decolorising in absolute alcohol, being amongst the best. Such stained preparations show a mass of deeply-coloured bacteria upon the free surface of the softening dentine. Near the surface most of the tubes are enlarged and filled with bacteria, whilst deeper in they are found to have penetrated along the line of the tubes to varying depths.

The invasion of the tubes is more generally by micrococci, which show no tendency to run into chains, and sometimes are to be seen in single file. The rod-forms (bacilli) are,

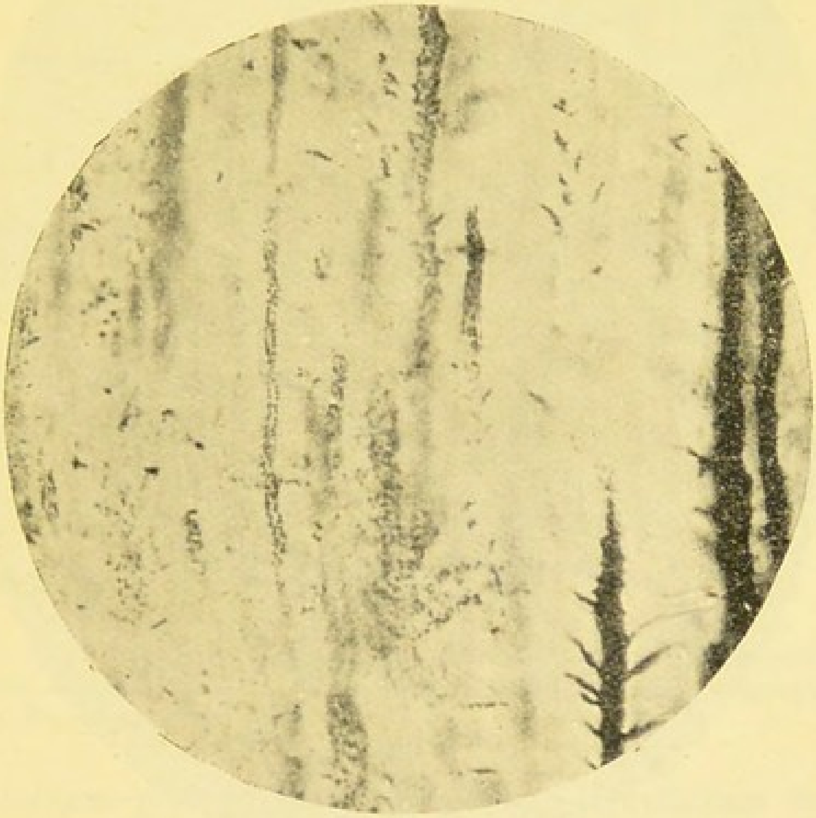


Fig. 137.—Carious dentine showing invasion of the tubes by micrococci. To the right the tubes are greatly enlarged, and cocci have entered the finer branches of the tubes. Photographed by Mr. Mummery.

however, not uncommon, and are shown in the following figure.

The interglobular spaces are often another line of advance, though occasionally they will be found to be somewhat remarkably free. As Miller well points out, the line of invasion is irregular towards the pulp, but it is often sharply bounded laterally.

Upon the free surface is a great mixture of bacterial forms, consisting of masses of micrococci, rod-shaped bacilli, and leptothrix threads, whilst in the deeper portions we find micrococci to greatly predominate, though here and there an infection of bacilli unmixed with micrococci is to be found, and now and again the leptothrix will be found to be the principal bacterium present, even deep in the dentine.

In the further advance of caries, here and there larger irregular spaces are found filled with bacteria (the so-called liquefaction foci of Miller), and leptothrix forms abound.

FIG. 138.—Carious dentine showing invasion along the tubes by bacilli. Micro-photograph by Mr. Mummery.

Inasmuch as in an aseptic flask nothing happened, Underwood and Milles, finding the bacteria to penetrate beyond the apparent line of mischief, attributed to them a primary *rôle* in the matter; but Miller, finding that it is impossible to produce a direct infection of one piece of dentine from another, holds that they cannot *per se* initiate the characteristic changes of caries, but that they do so in the indirect manner already sketched out.

A precisely similar invasion takes place in artificial caries. Figure 140, drawn from a specimen of artificial caries prepared by Mr. Pound and presented to the author by Mr. Sewell, shows well an invasion of micrococci along dentinal tubes and their branches.

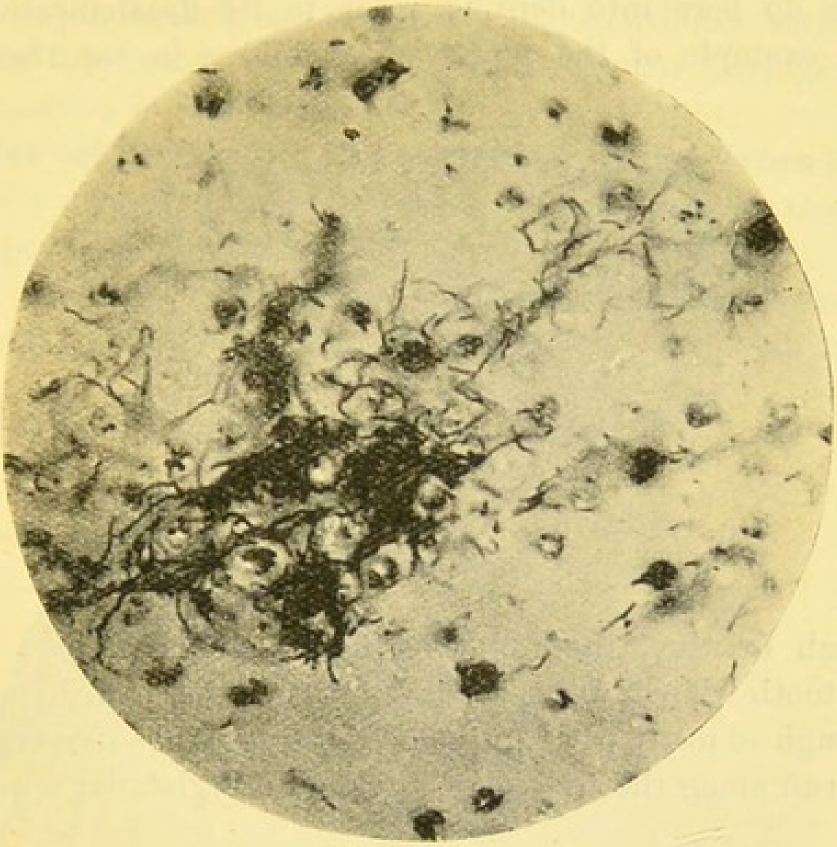


FIG. 139.—Cross section of carious dentine showing liquefaction foci and masses of leptothrix filaments. Photographed by Mr. Mummery.

The tobacco-pipe appearance and the liquefaction foci are also to be seen in artificial caries.

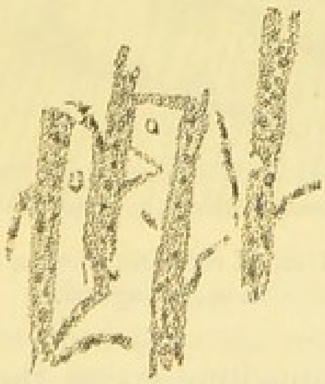


FIG. 140.—Micrococci of artificial caries, drawn under a Zeiss 3mm. apochromatic objective.

The following figure, 141, drawn under a Zeiss 3mm. apochromatic, shows both of these points. The dark points in the middle of the "pipes" are shown by the staining to be bacteria.

Although it is not claimed that the bacteria of the mouth do bore into dentine prior to its decalcification, yet as an example of the power of organisms to eat their way

FIG. 141.—Artificial caries. "Tobacco pipes" and liquefaction foci.

through dentine, the following figure, drawn from a section of a tooth which was picked up in a churchyard, is given. Although in many parts of the specimen the invading organisms have run along the tubes and into the interglobular spaces, yet

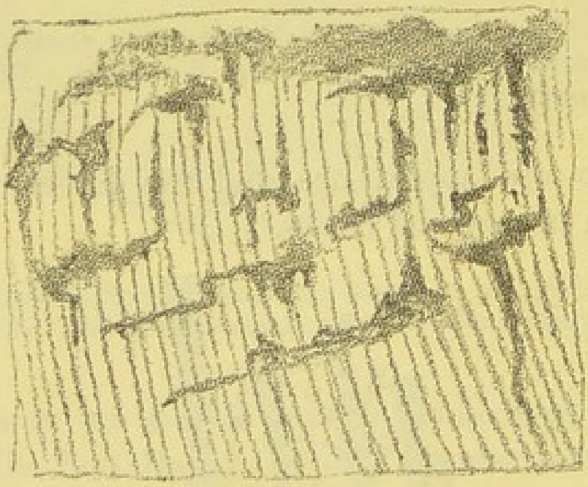


FIG. 142.—Section of dentine from a tooth picked up in a graveyard.

they are capable of tunnelling across the solid matrix at right angles to the tubes, and indeed in any direction.

The specimen (described and illustrated more fully by micro-photographs in the Trans. Odont. Soc., 1892, C.S.T.) is only given here as an illustration of the boring powers of this particular organism, which probably does not occur in the living subject. From the appearance of its workings it would seem to belong to the mould fungi, and is possibly the *Saccharomyces mycoderma*, to which Miller attributes borings in a natural front tooth worn on a plate. Similar borings have been observed in fossil teeth.[1]

Caries originating in the cementum is rare ; when it does occur the micro-organisms appear to invade it along the lines of Sharpey's fibres (Fig. 143).

The bacteria of dental caries.—The researches of Miller and Vignal, Galippe, Goadby, and others point to the

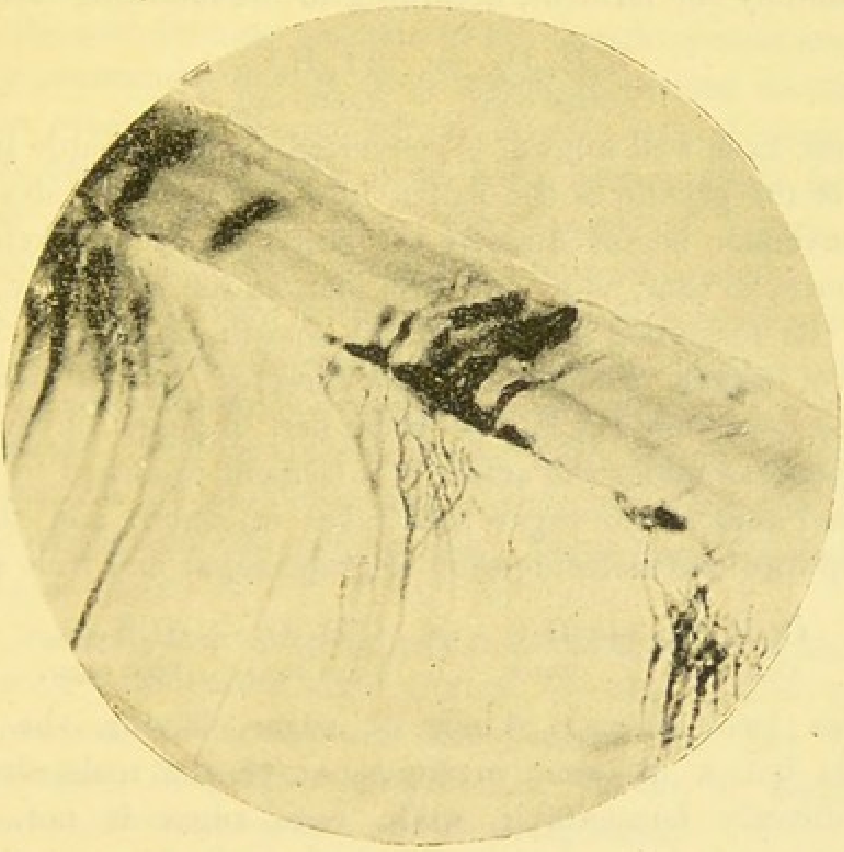


FIG. 143.—Caries of cementum, showing lines of invasion of organisms. Photographed by Mr. Mummery, from a scrap by Prof. Miller.

fact that there is no especial bacterium of dental caries. Many of the bacteria obtained from the mouth in pure culture have been found to set up fermentation with the carbohydrates, which results in an *acid* reaction, and these bacteria are thus capable of producing the decalcification of the tooth tissues which characterises the first stage of caries.

1 "On the Teeth of Creodonts," C. S. Tomes, Proc. Zool. Soc. 1906.

At the same time, most of these organisms bring about putrefactive changes in albuminous substances, which result in an *alkaline* reaction.

Most of the bacteria found in the mouth, then, possess this double action—*i.e.*, of producing acid fermentation in solutions of carbohydrates and alkaline fermentation in solutions of albuminous substances. One and the same bacterium can give rise to either reaction. The acid produced by the action of mouth bacteria on carbohydrates has been shown to be, in most cases, *lactic acid.*

A molecule of grape sugar in the mouth is converted into lactic acid by the ferment, according to the following formula :

$$\underset{\text{Grape sugar}}{C_6H_{12}O_6} = \underset{\text{Lactic acid.}}{2\ C_3H_6O_3}$$

Starch, as is well known, is converted in the mouth by the action of the ptyalin of the saliva into dextrine and dextrose. The conversion begins directly the starchy food is taken into the mouth, so that, as a matter of fact, starch as readily gives rise to the formation of acid in the mouth as sugar. Those kinds of sugar which are not directly fermentable—for instance, cane sugar $C_{12}H_{22}O_{11}$—must first undergo a hydrolytic decomposition under the action of a ferment produced by many bacteria ; that is, the sugar first takes up water, and then is split up into one molecule each of grape sugar and fruit sugar.

$$\underset{\text{Cane sugar}}{C_{12}H_{22}O_{11}} + \underset{\text{Water}}{H_2O} = \underset{\text{Grape sugar}}{C_6H_{12}O_6} + \underset{\text{Fruit sugar.}}{C_6H_{12}O_6}$$

These two different kinds of sugar, having the same formula but a different arrangement of the molecules, are both directly fermentable, while cane sugar is not. The ferment which brings about this hydrolytic decomposition is called invertive, because it inverts or changes the plane of polarisation, which, in the case of cane sugar, is to the right ; in that of the mixture of grape and fruit sugar, to the left. Other acids are probably also produced in the mixed fermentations going on in the human mouth, although we are not able to say just what they are ; probably small quantities of formic, butyric and other acids may be produced. The whole process going on in the mixture of foods we take being of a very complicated nature, large quantities of gas are often produced, which itself is evidence of the fact that the fermentation is not always of the nature of a simple division of one molecule of sugar into two of lactic acid.

Many organisms found in the mouth produce an enzyme or peptonising substance, which is capable of digesting the gelatinous residue of the dentine after it has undergone decalcification by acids, so that in this second stage of the process of decay, as in the first, there is no one especial organism engaged.

Many acid-producing organisms have been separated from the mouth; some are aerobes, some anaerobes, and some are facultative aerobes.

Of the acid-forming bacteria in the mouth certain are found pretty constantly in the deep layers of carious dentine and certain others in the superficial layers; but of those which liquefy decalcified dentine none have been isolated from the deeper layers, though from the superficial layers of the decalcified dentine many forms have been separated.

Of the acid formers in the deep layers *Streptococcus brevis* is largely found by Mr. Goadby, who also finds in this situation *Bacillus necrodentalis* and *Staphylococcus albus.*

With the acid producers in the deep layers Mr. Goadby classifies the *Sarcina lutea*, *aurantiacus*, and *albus*, the *Streptococcus brevis*, and the two pyogenic organisms, *Staphylococcus areus* and *albus.*

Of those forms which liquefy decalcified dentine, the same authority enumerates three forms of the potato bacillus (*mesentericus ruber*, *vulgatus* and *fuscus*), the hay bacillus (*B. subtilis*), *B. gingivæ pyogenes*, *B. furvus*, *B. liquifaciens fluorescens*, *Proteus zenkeri*, and *B. plexiformis.*[1]

It seems also that a decomposed pulp may give origin to acids capable of softening the dentine. Thus MM. Leber and Rottenstein (*op. cit.*, p. 11) mention a case in which three incisors became deeply discoloured without any breach of surface; this condition had supervened after a blow. On drilling into the teeth, the entire dentine of the crown was found to be utterly decomposed and softened. M. Sheller also reports two similar cases.

[1] Goadby, "Mycology of the Mouth."

It is, perhaps, from observations on such teeth as these that the idea of "central" or "internal" caries has sprung; but the condition has little, or nothing, in common with true caries.

To summarise, we find that in dental caries the initial stage is one of decalcification. This is due to the formation of acid products, mainly of lactic acid, and production of acid is caused by fermentations of carbo-hydrates which are set up by the presence of micro-organisms having this power.

Decalcification having been effected, perhaps the same, perhaps other, organisms enter the softened tissue, mainly along the lines of the dentinal tubes, and there exercise a solvent peptonising action upon the organic tissue of the matrix.

The translucent zone, when it exists, is non-essential. Perhaps it is a vital action in the nature of a filling up of the tubes by calcification. All the other phenomena of caries can be artificially reproduced.

Some writers have thought that Nasmyth's membrane is a frequent site of caries, adducing the greenish discoloration on the necks of the teeth in young people as a carious disintegration of this membrane, whilst others, with perhaps more probability, think that the membrane is a protection.

That it is permeable to fluids is proved by its ready detachment under the action of acids, but its resistant nature renders it more likely than not to be useful as a protection, and the green stain on the teeth of children is paralleled by similar discoloration in the teeth of some animals—moreover it often spontaneously disappears.

TREATMENT OF CARIES.

THE great prophylactic against caries is cleanliness, as is well exemplified by the rarity of its occurrence upon smooth and fully exposed spots.

An experiment of Miller's, of great significance, determined the amount of acid produced by two equal infections, the one prior to, the other after, the careful cleansing of the mouth with tooth-brush, floss-silk, and tooth-pick, the amount of acid produced by the latter being often as low as one-fourth of that by the former, while after the use of strong antiseptics the amount may be reduced almost to nil. "There is no known solution, alkaline or antiseptic, applicable in the human mouth, which will penetrate between the teeth, or to the bottom of fissures and cavities when these are filled with food, in sufficient quantity to have any appreciable effect. Therefore before all antiseptics or alkaline washes come the tooth-brush, tooth-pick, and floss-silk."

There is no doubt that a vast amount of dental caries might be prevented or at least controlled by thorough, systematic, and regular brushing and cleansing of the teeth. The fact is that the average person knows neither when nor how to use a tooth-brush to the best advantage, nor what shape and kind of brush is likely to be the most efficient. It is obviously the duty of the dentist to give this instruction, whenever the desirability of so doing is indicated, and especially to endeavour to persuade his child-patients to take a real interest in the care of their teeth.

By many, a slightly curved tooth-brush will be found most effective, but if a perfectly straight one is preferred it should be small to be efficient. The bristles should be moderately stiff and only just sufficiently long to admit of free flexibility; those at the end of the brush may with advantage be grouped, as it were, into a projecting bunch, an arrangement which facilitates the removal of food débris from between and behind the teeth. The outer surfaces of the teeth should be brushed vertically up and down as well as horizontally, and the lingual and biting surfaces should receive at least an equal amount of attention.

The teeth should be cleansed after each meal, but the time of all others when it is most essential that they should be thoroughly brushed is the last thing at night, and it is of extreme importance that no food be taken after this is done.

It is chiefly by the fermentation of carbo-hydrate foods that acids are produced during the hours of sleep, and these remaining undisturbed in fissures and between the teeth, tend by repetition to dissolve away the protecting enamel, to say nothing of the irritation of the gums and general insanitary condition of the mouth produced by the lodgment of food particles.

Well brushed healthy gums are firm to the touch, and their margins cling closely to the necks of the teeth; they are of a pale coral colour and do not readily bleed. It is therefore a mistake to regard pale firm gums as an indication of anæmia.

Before brushing can be expected to produce the best results, it is of course necessary to thoroughly scale the teeth, being particularly careful to remove any rings of tartar that may have formed under the gum margins. A little finely powdered sulphate of copper gently passed under these irritated gum margins will rapidly produce a healthy condition, which can then be maintained by efficient brushing. A quill tooth-pick is the safest means of removing masses of food débris lodged between the teeth; metal or wood tooth-picks should be avoided. The habitual passing of waxed dental silk between the teeth may in careless hands be productive of as much harm as good, and can only be confidently recommended to intelligent persons with sound or moderately sound teeth.

At the same time antiseptics used as washes, or incorporated in a tooth soap, all act in the right direction, and should be used in addition to the most scrupulous cleanliness.

Mercuric chloride is so very disagreeable, and also so poisonous, that it is hardly available for free use in the mouth, although Miller found it to be the most efficacious, as by its use in the proportion of 1 to 2,500 almost complete sterilisation was attainable.

Salicylic acid in the proportion of 1 to 300 appears, according to Miller, both efficacious and free from action on the teeth (though Hollaender says that he has often seen enamel attacked by it), as are listerine, borobenzoic acid, eucalyptus oil, winter-green oil, etc. The essential oils, though all antiseptic in varying degrees, are not very active; of these oil of peppermint, oil of cinnamon, and oil of cassia are among the best.

After making a number of experiments, Miller gives the following formulæ for antiseptic mouth washes :—

R. Thymol, gr. iij.;
Benzoic acid, gr. xlv.;
Tincture of eucalyptus, ℥ss.;
Oil of winter-green or }
Oil of peppermint } gr. xxv.;
Alcohol (100), ℥iij.;

and

Thymol, gr. iij.;
Benzoic acid, gr. xlv.;
Mercuric chloride, gr. vij.;
Tincture of eucalyptus, ʒss.;
Oil of winter-green, gr. xxv.;
Alcohol, ℥iij.

These are intended to be used with water in quantity sufficient to produce decided cloudiness.

Other agreeable and useful formulæ are given by Hollaender ("Handbuch d. Zahnartzlichen Heilmittellehre," 1890, Leipzig).

R. Thymol, gr. 5;
Acid carbolici, ♏ 10;
Tinct. anisi, ʒijs.;
Ol. menth. pip. ♏ 15;
Sp. vini. rect. ad. ℥j.

This may be coloured with a little cochineal and used in the proportion of ten drops in a wineglass of water.

R. Acid salicyl, gr. 3;
Ol. menth. pip. ♏ 15;
Sp. vini. rect. ʒij.;
Aq. dest. ℥j.

A tooth-powder ought to be non-gritty, and should contain a cleansing agent, an antacid, an antiseptic, with just sufficient pure soap to produce a slight lather in use. Tulloch's

"Ivradent," which contains amongst other ingredients chlorate of potash, phenol, bicarbonate of soda, carbonate of magnesia, precipitated chalk, with a sufficiency of essential oils, astringents, and pure neutral soap, is a scientifically compounded and excellent tooth-powder.

In some respects tooth soaps are to be preferred to powders, and an excellent one has been introduced under the name of Cook's Hygienic Tooth Soap. This contains as antiseptics saccharine and tincture of benzoin, and is agreeable to use as well as being fairly antiseptic; it is based upon Miller's experiments.

In the treatment of simple caries three methods are employed. The removal of the diseased, together with the surrounding healthy tissue, to such an extent as to leave a perfectly smooth surface, constitutes one method; another is the impregnation of the softened area with a salt, such as argentic nitrate, and a third is the removal of the diseased tissue, and the substitution of some indestructible material for the lost part, which constitutes the ordinary method of treatment. In either case the diseased part must be removed, or, at all events, such portions of it as have been softened by the abstraction of the lime-salts.

In selecting between these operations, we must be guided in the first place by the depth to which the disease has penetrated, and by the situation in which it is established. If the disorganisation has not extended into the dentine to a depth which greatly exceeds the thickness of the enamel, and either the median or distal surface of a tooth (especially of a front tooth) be the part attacked, the operation of **excision** may be performed with advantage. But if the teeth are irregularly placed, the advantages of this method of treatment may be either increased or diminished by the peculiarity of the case. Teeth when crowded together will be improved by the operation if they have been attacked with disease on the lateral surfaces, but when a separation exists already, the widening of the aperture by the file will produce an unsightly appearance, without offering any advantage over filling the cavity.

The operation of filing is not confined to the simple removal of the affected portion of a tooth by the file. Not only must the diseased part be cut away, but it must be removed with such other portions of the surrounding parts of the tooth as will enable the operator to leave a perfectly smooth surface, and one which can readily be reached when the teeth are cleaned. But nowadays, though the file remains the best instrument in some cases, it has been to a large extent displaced by corundum discs, and emery cloth discs used in the engine. The use of the file or other coarse cutting instrument completed, the rough surface left by that instrument has next to be removed, and a smooth and polished one, free from angles or depressions, substituted. In the production of this surface pumice powder may be used after the file is abandoned, and subsequently chalk, applied by means of a strip of linen, or a piece of wood cut into a suitable shape.

The mesial or distal side of a front tooth is the situation in which the file is most commonly applied, and the operation will leave the dentine exposed to a greater or less extent. Now, if the rough or grained surface left by the file be allowed to remain, and be so situated that the food in mastication, or the tongue in its constant motion over the part, fails to remedy by friction the defective operation, we shall soon find the exposed dentine extremely sensitive, discoloured and softened. Examples used to be sufficiently numerous in which a dividing file had been passed between two sound front teeth for the purpose of relieving lateral pressure. The division so produced had closed up, and the part placed beyond the influence of friction. In the course of a comparatively short time, each tooth, the enamel of which had been cut through, was attacked by decay; a cavity results, less favourable for plugging than would have arisen had the operation of filing been omitted.

Nature sometimes performs for herself an operation which is analogous to filing when properly performed, both as regards its physical peculiarity and its results. The walls of a broad but shallow cavity produced by caries break down, the softened tissues are exposed to friction and rubbed away, till at last the hard dentine is reached; this becomes brightly polished, and endures for an indefinite time unaltered.

The file only has been spoken of, but enamel chisels, diamond, and other discs, are frequently used in conjunction with, or in preference to, the file. With these instruments the diseased part may, in most cases, be removed much more rapidly, and with less inconvenience to the patient.

And the comfort of the patient is not the only advantage possessed by these more modern appliances, for with the file it is often difficult or impossible to avoid removing much of the labial surface of the tooth, which so far as the ultimate results of the operation go, might have been allowed to remain, and the absence of which must prove very disfiguring. Thus, it need hardly be said that, in operating upon an upper incisor, the anterior surface of the tooth should be as little encroached upon as possible, the removal of the enamel and dentine being confined to the interstitial and lingual surfaces. Supposing the contiguous surfaces of two teeth to be affected, the interval between them produced by the operation should be wedge-shaped, the edge of the wedge being directed towards the lip, and the base towards the tongue.

If the bicuspids or molar teeth were subjected to a similar operation, the edge of the wedge-shaped interval would be directed towards the gums, and the base on a line with the masticating surface of the teeth; the separation would also be wider towards the tongue than towards the lips.

A very useful form of enamel chisel has been recommended by Dr. Arthur for the cutting down of teeth with the object of leaving a smooth and well-shaped surface. It consists of a thin flat blade of hardened steel, the edge of which has been ground off square. Thus the cutting or scraping edge is a right angle, and it will be found very efficient in removing dense enamel; it may be made of very various shapes, its peculiarity being that as the edge is a right angle, it can only be conveniently sharpened when the blade is thin; it may be left almost or quite hard without danger of chipping, if the quality of steel be good.

The results of cutting away superficial decay in such a manner as to leave a polished and thoroughly exposed surface are often exceedingly satisfactory; the difficulty, however, lies in the selection of cases, for it is at times attended with the most disastrous results. It is often possible to recognise cases of caries in which, although the diseased part might be excised, this would be injudicious. Again, when we find associated with caries a thickened and vascular condition of the gums generally, and more especially of those parts which pass between the teeth, together with an exudation of the thick ropy mucus to which we have already referred, the operation of excision will be attended with very doubtful success. If we thus treated a small cavity, it is probable that in a short time another, equal in extent to the dentine exposed, would take its place.

Yet it was proposed by Dr. Arthur[1] to very greatly extend the applicability of this operation, and to use it not merely as a remedy, but as a preventive against the attacks of caries; and his views, with certain differences, have been endorsed by Dr. Bonwill (Dental Cosmos, August, 1879). Starting with the assumption that in certain individuals decay of the teeth is perfectly certain to occur, and that these individuals may be, with but little chance of error, recognised by the dentist, he proposes to cut away sound teeth soon after their eruption, in such a manner that they may be isolated from one another. Where doubt exists as to the necessity of such a procedure, he advocates separating the incisors from one another as soon as they take their places, and carefully examining their proximal surfaces; he states his conviction that if the smallest indication of caries is detected on their proximal surfaces before the twelfth year, the molar and bicuspid teeth are perfectly certain to be attacked. To quote his own words, "What I propose is the separation of teeth closely in contact, which are of such frail character, and are exposed to such destructive influences, that their decay is inevitable, or has already occurred."

Although it is probably true that the treatment of caries by excision and subsequent polishing of the surface might be practised with advantage more frequently than it is, yet it may be doubted whether there is much evidence in favour of so bold a plan of treatment as this. In the first place, it is undoubtedly true that there are some mouths of which the dentist may confidently predict that almost all the teeth will successively decay; but are not these exactly the cases in which every point of exposure of the dentine made by the file, or enamel cutter, becomes a starting-point for caries? And, on the other hand, are not those favourable instances in which caries has never recurred after its first excision, almost always to be found in mouths where the strong early tendency to caries which prompted the operation has ceased to exist,

[1] "Treatment and Prevention of Decay of the Teeth." R. Arthur, M.D. Philadelphia, 1871.

though in such a case it will have done some good service in tiding over a period of danger?

Then, too, it is admitted by Dr. Arthur that the operation may have to be repeated over and over again, and that constant care and attention is required on the part of patients. But, as has very truly been remarked by a critic, had all this polishing with tape, etc., been carried out by the patient without any operation having been performed, interstitial caries would probably have never occurred, and it is exceedingly difficult to secure such a degree of attention in any patient, much more so in one of early age.

If the separation be carried right through down to the gum the teeth are very prone to shift their position and close up again, necessitating repetitions of the operation, and involving great loss of tooth substance; even if they do not, the inevitable exposure of the gum at the bottom of the wedge-shaped spaces will lead to its being kept in a state of irritation by food forced down upon it.

They can only be kept from closing together by leaving a shoulder of limited area close to the edge of the gum, and caries is very apt to occur in the neighbourhood of these points of contact.

The treatment by free excision has been sometimes resorted to in those cases where teeth of obviously delicate structure are attacked in every interspace shortly after their eruption. It is within the experience of almost every practitioner that there are cases in which, after endless pain and trouble, the teeth are nearly all lost at a very early age, and the operation of filling, no matter how well conducted, ends in utter failure. Excision also may fail, probably will, but it offers a chance for the preservation of the teeth.

A higher degree of success is attainable with front teeth than with others, as their shape lends itself to the formation of a good self-cleaning interval, without the leaving of an awkward shoulder at the gum.

Still the treatment by excision does not grow in favour, but on the contrary few now practise it, and it stands in danger perhaps of undue neglect. Our own impression about it is that there are just a few cases in which it fills a useful place, but that more harm is likely to be done by its adoption in a case not quite suitable, than would result from the adoption of filling in a case well suited for excision, so that filling is almost always the safer practice.

Another means of arresting caries may be touched upon here. Where the necks of teeth are superficially softening all along the periphery of the gum, so as to render it impossible to file them, at all events without the sacrifice of a large amount of as yet sound tissue, a free application of **nitrate of silver** will often succeed in arresting the attack. The softened tissue becomes quite black and slowly wears away, leaving, if the treatment have been successful, a polished mahogany-brown surface on which caries does not recur. Many teeth may be saved by this means which would probably have been lost had any other form of treatment been adopted, but it is hardly admissible in the front of the mouth where the teeth are much seen ; zinc chloride, which does not stain, is of some value in the latter position.

The operation of filling is divided into two distinct stages—the first of which is confined to the removal of the disorganised tissues and the production of a cavity of suitable shape ; the second consisting in the introduction of the material used for making the filling. For the present the **preparation of the cavity** for the reception of the filling must receive attention, and upon the proper performance of this the ultimate success of the operation will in great part depend.

In the treatment of a case, one point for decision will be the extent to which the diseased dentine can be removed. The general rule is to cut out the disorganised tissue, until the walls of the cavity present the colour of healthy dentine ; but there are exceptions to this rule. In the first place, the dentine may have become to a certain extent discoloured, and yet have retained its normal hardness. Again, the discoloration, and even softening, may have advanced so far into the tooth that the removal of the whole would endanger the exposure of the pulp where this is not desirable. If the pulp be exposed during the operation, the loss of the tooth is to some extent endangered ; consequently it is better that a layer of discoloured dentine should be allowed to remain for the protection of the pulp, than to run the risk of sacrificing the tooth. Supposing that the walls near the orifice are strong and sound, it does not appear that the retention of a little slightly-softened dentine at the bottom of the cavity interferes seriously with the durability of the filling. This slightly-softened dentine almost invariably becomes quite hard under the influence of a lining of oxyphosphate cement mixed with oil of cloves or a trace of thymol. Mr. Cass Grayston recommends the sealing in of a paste of tannin, carbolic acid, and oil of cloves, and this is certainly a very effective application for the purpose in view. The presence of any softened tissue at or near the orifice of the cavity must, however, be carefully guarded against, for the neglect of this precaution would be followed by the extension of the disease.

An exposed edge of disorganised dentine will allow solvent fluids to pass through it to the sound tissue, rapidly or otherwise, as the surface exposed is relatively great or small, and spreading from a single point at the circumference of a plug, the decay will by degrees encircle it with a softened and porous layer. The retention of softened dentine, even in the bottom of a cavity, should, if possible, be avoided; but if it be allowed to remain both in the bottom and on the side of a cavity, the operation of filling will be attended with but temporary advantage.

After decay and softened dentine have been removed, the cavity almost invariably requires additional shaping for retention. Possibly the cavity has already been extended for purposes of access, and frequently a cavity easy of access must be extended for prevention of subsequent decay. This extension for prevention of caries is an important practical point to bear in mind, especially when dealing with interstitial decay in premolars and molars. For instance, in approximal cavities, what we mean by extension for prevention is the cutting away of lateral tooth-walls until the line of junction of filling and cavity-margin is free from contact with the next tooth, and easy of access for cleansing by the tooth-brush, or even by the movements of the mouth. Some would carry the method further by invariably extending the cervical margin or floor well under the gum level, but this latter proceeding appears to us to be driving a sound principle too far. It is extremely important to remove all trace of softened tooth substance from a cervical margin, but quite unnecessary as a rule to cut beyond sound tissue; moreover, it is unwise to put the endurance of a good patient to the test in order to secure quite a problematical advantage.

The first step of the operation is not, as we have said, completed on the removal of the softened tissue, for the resulting cavity would seldom present a form favourable for the retention of the filling. When the disease has penetrated to a short distance only, the removal of the decayed part would leave a mere concavity, the sloping sides of which would favour the escape of the filling when pressed upon one side only. It consequently becomes necessary, after the disorganised matter has been taken away, to proceed with the excision of more or less of the healthy tissue, until a cavity of suitable form has been produced. A cylindrical hole may be regarded as presenting the most advantageous form for the reception of a filling, but it is in a comparatively limited number of cases only that this regular figure can be obtained. A certain degree of approximation can, however, be generally reached, and the nearer the approximation the greater will be the facility with which the operation of filling is performed, and the greater also will be the chance of producing a durable filling.

When the disease has advanced to a greater extent than it is assumed to have done in the preceding example, the removal of the softened tissue will often leave a large cavity, the orifice of which is considerably contracted, owing to the enamel, and perhaps a thin layer of the subjacent dentine, having resisted the influence of the destructive agents more successfully than the more deeply-seated tissue. It might be thought that the overhanging of the sides of the orifice would favour the retention of a filling, and the assumption would perhaps be justified if it were practicable to introduce a perfectly solid filling in a cavity so shaped. Unfortunately it is extremely difficult either to thoroughly excavate or to force a filling under a projecting ledge. The filling may have a very satisfactory appearance when finished, but in a comparatively short time evidence of failure will be discovered. That portion of the tooth which overhangs the filling if imperfectly supported from within will break down, moisture will find its way around the edge of the filling, decay will be re-established, and if the operation is not repeated, the tooth will be lost.

In order to avoid unfavourable results arising from the foregoing cause, the overhanging edges must be cut away, if not sufficiently to produce rectilinear walls, yet to reduce the angles to moderately curved surfaces. The walls of a cavity may bulge outwards or inwards, but anything approaching to receding angles or sharp corners must be avoided, when preparing a cavity for an all-gold filling.

In the case of other fillings too, weak overhanging enamel must be freely removed in the course of preparation of any cavity, except perhaps where it is desirable for appearance sake to leave a thin enamel wall on the labial surface of an incisor tooth. Considerable difference of opinion exists, however, as to what extent overhanging enamel should be cut away in occlusal or partially occlusal cavities in molars or premolars; all agree that the obviously weak portion must be removed, but whereas many operators are in favour of cutting away all enamel unsupported by dentine, others feel justified in leaving sound enamel which, when thoroughly supported by an oxyphosphate cement lining, is likely to withstand the strain and stress of mastication. We are inclined to think that in the majority of cases the latter is the wiser plan, but those who practise it with success have no doubt realised the importance of devoting unusual care to the removal of softened dentine from under all overhanging enamel margins. For this purpose sharp excavators of various shapes are the only efficient instruments; no engine bur can possibly reach these recesses. It may be here mentioned that the cavity margin should never pass through the summit of a cusp; if both slopes of a distinct cusp cannot be left, it is wiser to remove practically the whole enamel cusp, grinding it down with a stone if necessary, so that the force of the bite may be received solely upon the filling.

When the cavity is very shallow, the general rule with respect to the sides being parallel may be deviated from with advantage. It will be well to make the bottom comparatively flat and the sides rectilinear, or divergent from without inwards. It may happen, however, that this form cannot, owing to the condition of the tooth, be produced; that the convergence will be from without inwards, giving the outline of an inverted cone. To render a cavity so shaped capable of retaining a filling, one or two shallow grooves should be cut around the circumference of sufficient depth to hold the material firmly in its place when forced into them in the operation of filling.

The strength of the walls of a cavity is a very important subject. It is useless to leave a portion of a tooth standing which a trifling degree of force will at any time break down, and thus expose the filling; and it is worse than useless to leave that which will give way during the operation of filling, and thus perhaps endanger the whole tooth. An unwillingness to interfere with the appearance of a tooth not uncommonly induces the operator to attempt the preservation of a part which eventually gives way, and necessitates the performance of a second operation under circumstances less favourable than those obtained on the first occasion, and the tooth is left in a more unsightly condition than it would have been had the fragile portion been freely cut away in the first instance. The absolute strength required will vary with the position which the tooth occupies in the mouth. In a molar tooth, which has to sustain the full force of mastication, the walls of the cavity must be composed of enamel and dentine, with a considerable thickness of the latter; whereas, in front teeth a much thinner layer will be found sufficient. Indeed, in incisor teeth the enamel alone, if the extent be limited, is sometimes sufficiently strong, when supported, to endure for many years. The colour of the filling may show through at the point where the dentine is entirely absent, and yet there may be sufficient strength in the enamel for the maintenance of the plug and of its own structure.

There is yet another point in the formation of a cavity to which attention may be advantageously directed.

The character of the margin of the orifice is scarcely less important than the shape of the cavity itself. As a general rule, the plugs which are surrounded by enamel are more durable than those inserted in cavities the margins of which are partly formed by dentine or cementum. It is consequently desirable to preserve, if possible, the enamel, and to remove the dentine at the margin of the orifice in such a manner as to allow the filling to come in contact with the enamel, so that the dentine may be wholly covered over and protected. Where the circumference of a plug is bounded by strong enamel, as on the masticating surface of a molar tooth, the undulating character of what we may call the top of the wall, is unimportant; but should dentine form a part of the whole of the boundary, as it may do when the disease is situated on the mesial or distal side of a tooth, it will be necessary to reduce the orifice to a flat and smooth surface.

There are a variety of other considerations which come into play in determining the amount of tissue which shall be cut away; one is the nature of the filling material which is to be inserted; for instance, if it is purposed to use gutta-percha, the chief failing of which is its softness under wear, it is well to leave all the enamel which can possibly be allowed to remain, for there is little difficulty in filling under deep undercuts, and the plug will last much longer from being more protected by enamel.

But were we about to use gold, the retention of similar rather thin edges would be quite bad practice, for reasons partly detailed above. Again, a gold filling being tough, can itself afford to have thin edges which run out over the enamel, and it is often advisable to bevel outwards the margins of the cavity so that the gold may overlie it; but had amalgam been selected the margins should be left quite square, as its brittleness would render any thin edge certain to speedily break off and leave a dangerous crevice round the plug; moreover, feather edges are never watertight in amalgam fillings.

Another point for consideration in shaping the cavity is the relation of the tooth to its neighbours: if, for instance, we are filling two contiguous cavities, it will be far better that filling shall touch filling, instead of enamel touching enamel, so that it will be sometimes well to cut away more than would otherwise be necessary simply for the sake of removing the junction of the filling and the enamel from contact with the next tooth, and bringing it to a point where it will be fully exposed to the cleansing action of the tongue. But this will have to be again discussed in connection with contour filling, so that it will be sufficient to merely allude to it here.

Then again it is desirable that the lines of cleavage of the enamel prisms be borne in mind, and the margins be so shaped that no half fibres remain; *i.e.*, that the edge shall be composed of enamel fibres the ends of which are solidly supported by dentine.

It is hardly possible to enter at any length into the very various forms of **instruments** which have been devised to prepare cavities for the reception of the filling materials, but a few words may be said as to the chief groups into which they may be divided.

For the removal of enamel, which is in a large proportion of cases the first step to be taken in order to get access to the cavity, enamel chisels of different sizes are employed ; these should be made of the finest steel, and the temper left very nearly hard. This necessitates that the edges shall not be thin, or they would fly, and so enamel chisels should have an edge formed at a somewhat obtuse angle; indeed, Dr. Arthur's pattern consists of a thin blade, the edge of which is ground quite square, *i.e.*, the edge is a right angle. Such a chisel does not cut, nor can it advantageously be used to cleave off large pieces of enamel, but it works admirably when applied so as to pare or scrape away from the surface of the tooth substance, and may, for example, be used to make V-shaped separations between the backs of front teeth.

In the use of those enamel cutters which are brought to an obtuse-angled edge, the lie of the enamel prisms at that particular part of the tooth should be kept in mind, and the instrument, if possible, be so applied as to cleave off successive layers ; it will be found of advantage to scratch the surface along the line of the intended cut before putting pressure upon the instrument, so as to cleave off the piece attacked.

Figures of a few of the most popular forms of enamel chisels are appended, but no two operators will affect precisely the same forms.

Dentine is removed by means of excavators, instruments of almost endless variety of form ; figures of a few are here given, and it may be mentioned that the so-called spoon-shape will be found to be of all others the one which is capable of the widest application.

There is, however, one property which should be possessed by all, whatever the shape or size of the instrument. It should be made of good steel, and kept perfectly sharp. A blunt instrument tends to prolong an operation which is always disagreeable and sometimes very painful. With a perfectly sharp excavator the softened tissue is quickly removed, and with a comparatively slight amount of discomfort. A few rapid and well-directed strokes of the blade, and the softened tissue is cut away, and although a proper form has yet to be given to the cavity, the subsequent steps of the operation are seldom productive of as much discomfort as attended the removal of the softened tissue. In the removal of softened dentine from a tender tooth, the excavator should be used in such a manner as always to *cut*, and not *scrape*; this is a point which can hardly be too strongly insisted on, though it is very often neglected. As a rule less pain will be caused if the dentine is cut in a direction away from the pulp.

So far as any general rule can be laid down, sharp excavators should be used for removing the greatly softened dentine, and the engine used for altering the resultant cavity into a good form.

The introduction of the dental engine has in no small degree rendered obsolete the old-fashioned rose head, which cut by a

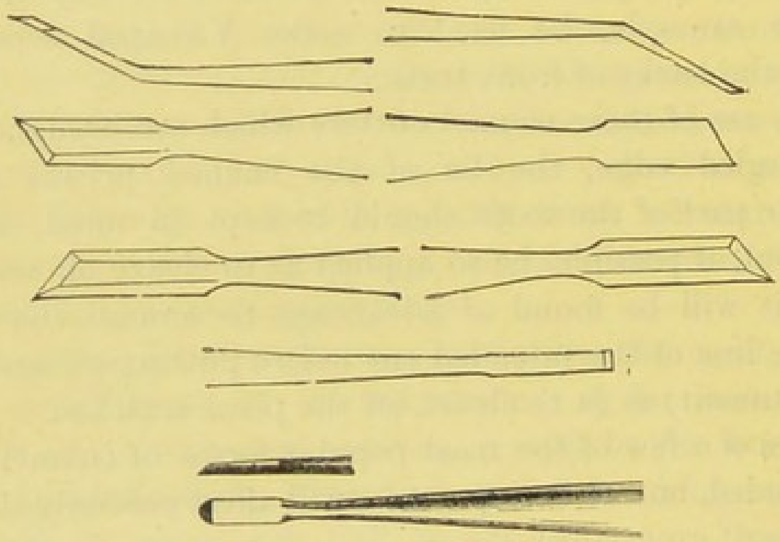


FIG. 144.—Enamel chisels.

slow revolving movement; but even now for certain purposes it holds its own as superior to the more modern instrument. A well cut rose head, with coarser teeth than would be appropriate in an engine burr, and left of very hard temper, will cut enamel in a way that cannot be attained by a rapidly revolving tool, and will moreover keep its edge long, while the other will not; so that a few rose heads of fine quality and temper will always be found useful.

Hypersensitive Dentine.—Cases are not infrequently met with in which the carious dentine possesses such an exalted degree of sensibility that its removal cannot be borne, and the patient flinches from the slightest touch of any instrument.

A minute quantity of arsenic placed in the cavity, and retained for a few hours, will render the part absolutely insensible to pain. The objection, however, to such a course is the difficulty of limiting the action of the arsenic to the surface on which it is applied. It may find its way to the pulp, and occasion the death of that organ—a condition speedily followed by discoloration of the whole crown of the tooth, and very probably by the supervention of alveolar abscess. Thus Dr. Kingsbury relates an instance in which arsenic had been used for the purpose of obtunding the sensibility of dentine, and had caused the

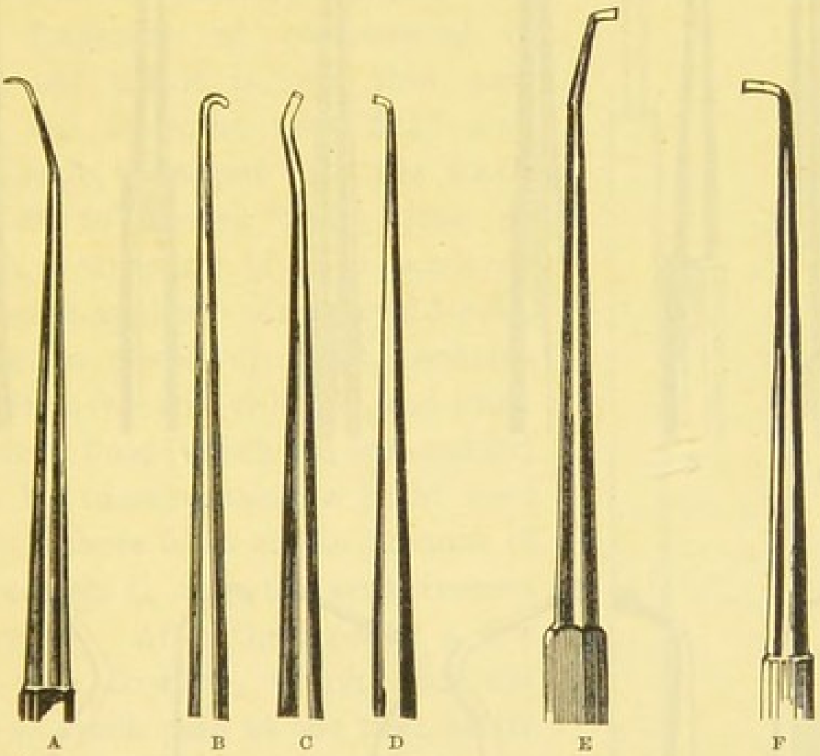
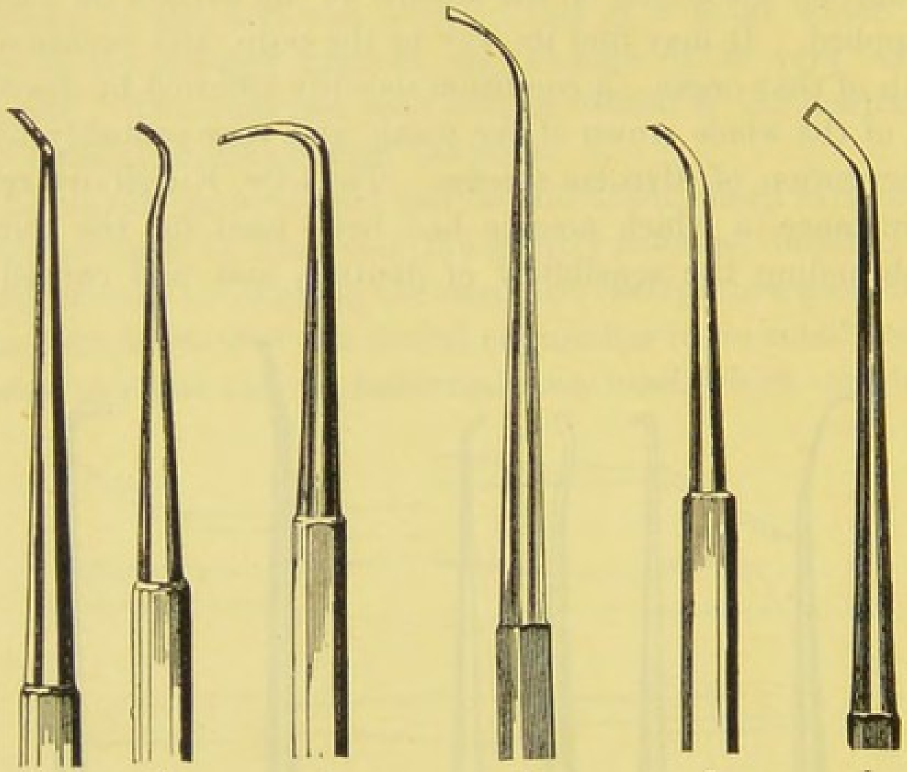


FIG. 145.—Excavators.

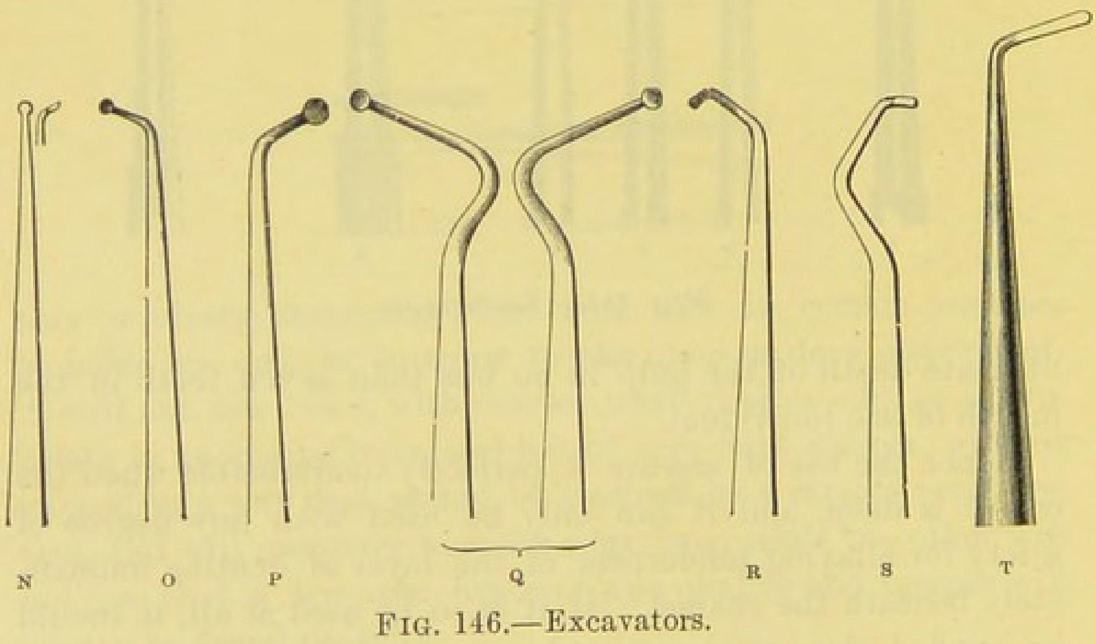
ultimate death of the pulp in no less than seven teeth in the mouth of one individual.

Hence the use of arsenic is perfectly inadmissible when the cavity is deep, and it can only be used with any degree of safety for allaying tenderness of the layer of dentine immediately beneath the enamel. If it is to be used at all, it should be applied *dry*, or very nearly so, to avoid the risk of its reaching the deeper portions of the tooth, and the cavity carefully sealed, preferably by a temporary filling of gutta-percha. But as there are other agents which are capable of reducing the sensitiveness of dentine, its use is to be strongly deprecated;

though it must be admitted that it is the most efficient and most certain in its action of all the remedies proposed for the purpose.



G H I J K L



N O P Q R S T

FIG. 146.—Excavators.

Next to arsenic, in point of efficacy, comes zinc chloride; a small fragment of the partially deliquesced salt, or a piece of wool dipped in the solution produced by allowing the salt to deliquesce, will if held in the cavity for a few minutes, greatly reduce the sensitiveness of the dentine. The application of the zinc chloride often causes severe burning or aching pain for a few minutes, but after this has passed away, little tenderness remains. Although the application is painful and less efficacious than that of arsenious acid, it is to be preferred, inasmuch as there is little danger of causing the death of the pulp. The following method of using the zinc chloride is convenient, and yields satisfactory results. A small fragment of cotton-wool is teased out till it is very thin, and mixed up in some very fluid zinc oxychloride, then put into the tooth and left to harden there, just as though a dressing of gum sandarac were being applied. Zinc oxychloride, even when mixed up thick, contains some little free zinc chloride, and when used very fluid (which we are enabled to do by incorporating a little wool with it), there is an ample amount of the free salt to allay the sensitiveness of dentine. After the lapse of a few days, this dressing, which does not cause so much pain at the time of its application as that of the pure salt, is removed, and the tooth is then usually tolerably insensitive to the touch of an instrument.

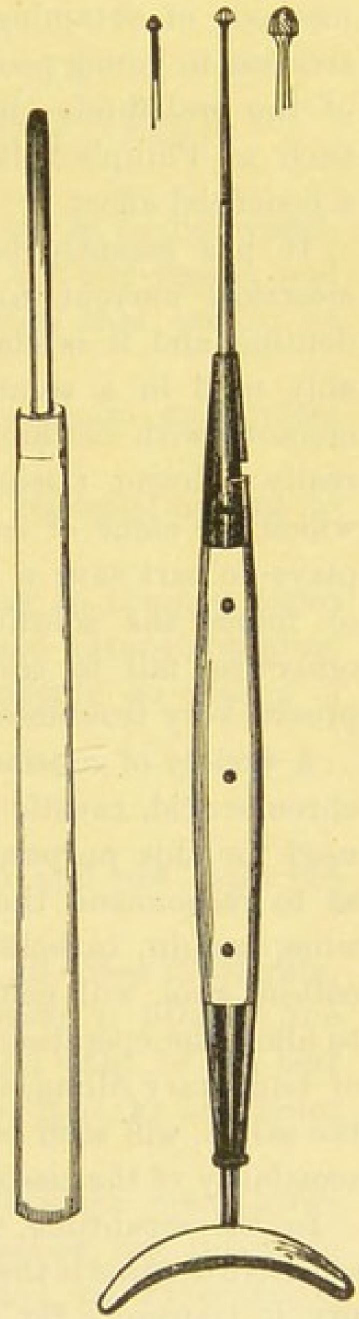


FIG. 147.—Rose head burs.

Ethylate of sodium is of some avail for this purpose; it appears to act by the formation of caustic soda, which while in the nascent state (being formed when the ethylate meets with the water in the tissue) acts as a powerful caustic without giving rise to much pain. The salts of cocaine, from which so much was expected, have proved disappointing as applications to dentine; it probably fails to penetrate, or if it does penetrate, fails to act.

Silver nitrate obtunds sensitive dentine, but discolours the tooth. Finely powdered sulphate of copper, sealed into a cavity with gutta-percha, will in a few days markedly decrease the sensitiveness of the dentine, and is one of the best practical methods of obtaining this result. Sometimes extreme sensitiveness in young people appears to be due to an acid condition of the oral fluids; in such instances an alkaline mouth wash such as Philip's Milk of Magnesia will after a few days exert a beneficial effect.

It has recently been proposed to make use of a small electrical current to drive cocaine into and through the dentine, and it is claimed that by this means cocaine, preferably used in a solution with guiacol (practically a form of creosote with certain impurities removed), may be rendered really efficient (Dental Cosmos, 1896). In this method, to which the name of cataphoresis is given, the electrical current plays no part save a mechanical one; that is to say, it drives or forces the solutions through substances which it would otherwise fail to traverse, but the method in practice has proved very troublesome and very uncertain.

A variety of substances, such as extract of Cannabis Indica, chromic acid, caustic potash, and other escharotics, have been used for this purpose, but the results are by no means such as to recommend their employment. Camphorated spirits of wine, tannin, carbolic acid, or thymol, repeatedly applied on cotton wool, will generally reduce the sensibility sufficiently to allow the operation to be performed; and, in fact, any form of temporary filling, introduced with sufficient care to exclude the saliva, will soon be followed by a subsidence of the extreme sensibility of the tissue.

In the meantime, the most generally reliable treatment of sensitive dentine is the hot air syringe; if dentine be thoroughly dry it transmits far less sensation than when wet, only, of course, the drying is necessarily very superficial, and the hot air must be frequently re-applied.

MATERIALS USED FOR FILLING TEETH.

The perfect material for filling teeth has yet to be discovered, those ordinarily employed being all, some for one reason and some for another, imperfect. The qualities that are to be desired are :—

(i.) That it shall be hard enough to resist mechanical attrition.

(ii.) That it shall be able to resist the chemical actions to which it is exposed in the mouth.

(iii.) That it shall be easy of adaptation to complex forms of surface so as to enable it to form an exact water-tight plug.

(iv.) That if introduced soft it shall undergo no change of form or bulk in hardening.

(v.) That it shall be a non-conductor.

(vi.) That it shall be non-irritant.

(vii.) That it shall keep a good colour and not stain the tooth.

As no one of the materials known fulfils all these desiderata, and yet each has its own points of excellence, it behoves the operator to think what he most desires, and what he can best dispense with in the individual case, and so to make his choice of material intelligently.

Clinical experience has furnished us with much information on the relative merits of different preparations, but there are other points which can be best elucidated by experiments carried out under conditions of greater rigour than can be secured in the mouth. One of the most useful tests which can be applied is the capability of the filling to form a perfect or water-tight plug, known as the "ink-test." This consists in taking a slab of ivory in which holes have been drilled, or an extracted tooth (properly moistened if it has been long extracted), carefully preparing the cavity of decay, filling it, and then immersing it for five or six hours in an ink-pot—preferably in Draper's ink. The tooth is then broken, and the extent to which, if at all, the ink has penetrated between the filling and the tooth ascertained. Any one who experiments in this direction for the first time will be quite astonished at the extreme difficulty of making a tight filling with either gold, amalgam, or gutta-percha.

It will be convenient to take first in review those materials, the imperfections of which are so manifest that plugs made with them can only be regarded as temporary fillings.

There are a variety of conditions, such as a doubtful exposure of the nerve, extreme sensitiveness of the dentine, or the pouring out of a certain amount of discharge through or from the pulp cavity, which render it undesirable to insert a permanent filling. We may have resort to some of the various temporary fillings, either for the specific object of curing one of the conditions which preclude the immediate use of a permanent filling, as, for example, the use of gum mastic and creosote when the nerve is aching slightly, or the insertion of a gutta-percha filling in a tooth very sensitive to changes of temperature; or we may employ them simply then as experimental fillings, to be replaced by permanent plugs so soon as we are satisfied that no mischief is going to be set up by the tooth being filled.

Solutions of various **gum resins** in ether or alcohol are exceedingly useful; gum sandarac, animi, mastic, copal, or dammar, reduced by the solvent to the fluidity of thin treacle, may be introduced into the cavity on a suitable piece of cotton wool. By evaporation of the solvent, and partly by its dilution by the saliva, the gum is precipitated, and forms with the wool a tolerably hard mass, capable of lasting for some days, or even a few weeks, though, as a general rule, it should be renewed every two or three days. The cavity should be dried out with cotton wool, or what is better, Japanese paper or paper fibre lint, before the introduction of the mass.

There is but little choice between the gum resins enumerated; either of them, in a state of solution, will answer sufficiently well. We give the preference to gum sandarac, as being more free from taste than the others, if copal be excepted. But ether being the solvent of copal renders the solution rather less manageable than those made with alcohol. The rapidity with which the ether escapes, however well the bottle in which it is kept may be corked, very soon reduces the solution to a condition unavailable for dental purposes.

A very soft form of **gutta-percha** may be used to retain dressings, but it presents few, if any, advantages over wool impregnated with a resin. Gutta-percha, with which some mineral substance, such as powdered silex or glass, has been incorporated, makes a remarkably good temporary filling, capable of lasting for some time. In using this compound, pieces of suitable size must be taken and warmed over a spirit lamp, until the whole mass is softened. The cavity having been dried, the heated gutta-percha is introduced, and the superfluous portion removed with a warm instrument. Care must, of course, be taken that the filling is not too hot, otherwise its introduction will be attended with pain. But, on the other hand, it must be sufficiently warm for the surface to be a little sticky, or it will not adhere to the surface of the cavity. Care must also be taken that the gutta-percha is not burnt when it is heated over the flame. An excellent method of securing its adhesion to the walls of the cavity is, after thoroughly drying the cavity, to mop it out with a pledget of wool dipped in chloroform, or better still, in a solution of resin in chloroform ; this secures good adhesion.

Of all the temporary fillings in use, the preparations of gutta-percha are far the most reliable, for it is not acted upon by the fluids of the mouth in any very appreciable degree ; in fact, it lasts better in the moisture of the mouth than it does when freely exposed to the air. In situations where it is protected from mechanical attrition it is remarkably durable, and may rank with so-called "permanent" fillings. It is exceedingly difficult to make an absolutely water-tight filling with gutta-percha, so as to withstand the ink-test perfectly, and yet its record as a preservative of the tooth from an extension of decay is usually very good. Some advise the use of very small pieces, each introduced and consolidated into place before the next is added ; others advocate the employment of a piece nearly as large as the cavity. Whichever method be followed, the filling should be finished with cold burnishers, slightly greased, as in this way the surface is cooled somewhat and the edges sealed as completely as the nature of the material allows.

Some of the advocates of a more extended use of gutta-percha prefer to use a pure gutta-percha, believing that the admixture of glass, or what not, and the bleaching of the gutta-percha, although hardening it somewhat, yet renders it more destructible.

In suitable cavities and in certain conditions of the teeth gutta-percha is undoubtedly one of the most valuable of filling materials for saving teeth. Of the light coloured gutta-perchas Flagg's High Heat and "Yellow" are as reliable as any. For interstitial cavities in either the temporary teeth, or the permanent incisors of children, it is invaluable. Mr. Matheson, in referring to the merits of gutta-percha as a filling material, says (Trans. Odont. Soc., May, 1904):—

"In those adult mouths where the difficult conditions obtain—sometimes alone, but generally in combination—of chalky teeth and acid secretions, or where you have teeth abnormally sensitive to thermal stimuli, or in the case of patients quite unable to bear prolonged or painful operations, or where you have extensive senile decay; in all these cases gutta-percha is a most useful aid in the saving of just those teeth that are the most difficult to save. Particularly is it useful in labial cavities at the gum margin, and most particularly in such cavities when they underlie plates or the clasps of plates; and in these cases it is, I think, the general consensus of opinion that no other material approaches it in value, for here it seems to prevent recurrence of decay better than anything else, and the presence of the denture counteracts the tendency to enlarge in bulk."

Where its colour is not objectionable (and it rarely is) the pink "base-plate" gutta-percha is far the best form, although it contains a large admixture of foreign material. It has, however, the very valuable property of retaining, in most mouths, its polished surface, and it does not get soddened and offensive as some other gutta-perchas do.

In order to secure the best results with this gutta-percha great care must be taken to have the cavity dry, and it is important to heat it sufficiently to make it thoroughly plastic, and yet not to burn it, and for this reason some operators heat it over a little water-bath, and others upon a metal plate; either plan is somewhat better than passing each piece through a flame, though, if this be done with sufficient care, it is quite possible to get as good a result. The form of instrument employed is not very important, but perhaps the best is a conical point, with which the softened gutta-percha should be packed until the cavity is somewhat over full : the excess should be trimmed away with a thin sickle-shaped instrument made hot enough to cut it off without dragging, and the surface then finished with a cold burnisher slightly greased. To finish off the edges of the filling with a pledget of wool dipped in chloroform is of doubtful utility, as the surface thus left is perhaps more porous than that left by the burnisher.

The red base-plate gutta-percha unquestionably retains a better surface under wear than any of the white preparations, remaining almost polished for a long time. It is, however, much more troublesome to use, as it has a very strong tendency to curl up during packing. This is best met by using it in small pieces made quite hot, and packing it with a sharp conical point. But if the cavity be previously wiped out with a solution of resin in chloroform it will stick well to the walls, and the difficulty of its curling up will be completely obviated.

In certain cases it is an advantage to moisten this form of gutta-percha whilst hot with eucalyptus oil, then roll it up between the fingers, re-heat, and insert in the cavity.

For dead teeth gutta-percha is exceedingly valuable, as it can readily be removed if need be : and its non-conducting powers and low specific heat render it useful in cavities which are sensitive to heat and cold to a degree which prohibits the employment of a metallic plug. But although its greater durability where protected from wear gives it an advantage in many tender teeth, yet as a means of rendering comfortable an irritable tooth upon the verge of aching, it must yield the palm to the so-called "osteoplastics."

Those in ordinary use are modifications of oxychlorides or oxyphosphates of zinc. Zinc oxide is mixed with a strong solution of zinc chloride into a thick paste, which, after the lapse of a short time, becomes perfectly hard. Different makers introduce different substances, which in some degree modify the rapidity with which it sets, and possibly alter the resultant compounds to some slight extent. Thus borax is often introduced into the fluid, and powdered glass, or actual silica, into the powder, for the purpose of mechanically conferring greater hardness on the mass when it has set. But the various osteoplastic fillings on examination appear to differ only in slight and immaterial points, and the objections which can be urged against one apply, almost equally, to all.

The **zinc oxychlorides** are a class of bodies for the most part readily decomposed by the action of acids and alkalies; moreover, the manner in which the mixture is made precludes the possibility of a definite chemical compound, without excess of either constituent being formed. As a matter of fact, there is always free zinc chloride to be found in the finished filling, and the filling is consequently hygroscopic. The objections to its use, which embody the results of many experiments, have been elsewhere described[1], and it is only necessary here to say that experience of its use in the mouth goes to confirm the conclusions which had been arrived at on chemical grounds, namely, that it is unreliable.

We have never seen an instance in which a zinc oxychloride stopping, which was at any point in contact with the gum, remained intact for any considerable length of time. No matter how carefully it has been applied, if it reaches down to the gum, sooner or later it will assuredly fail; and this practical result is nothing more than what might have been expected from purely chemical considerations.

Where, however, it is away from the edge of the gum—as, for instance, on a grinding surface—it lasts much longer, though it wears down with the friction of mastication.

Notwithstanding the escharotic qualities of zinc chloride, a thin cream of zinc oxychloride has been often flowed over a small exposure of the pulp with successful results, so far as capping of the nerve went.

As a temporary filling, then, zinc oxychloride is valuable; but it has no claim to the name of a permanent filling. In applying it the paste should be used very dry, and the filling carefully protected from moisture till it has fully set; this may be done either by keeping the rubber dam applied to the tooth, or by varnishing its surface with a solution of gutta-percha in chloroform. But all our precautions are to some extent futile for the paste has hygroscopic properties which cause it to imbibe water from the atmosphere, even after it has

[1] C. S. Tomes, in British Journal of Dental Science, vol. xiii., p. 552. On Zinc Oxychloride.

hardened ; nevertheless, it is very essential to prevent a flood of saliva from washing away the zinc chloride before it has had time to combine with the zinc oxide.

Subsequently a fresh group of osteoplastic fillings was introduced, in which phosphoric acid takes the place of hydrochloric acid.

Phosphoric acid has modifications—metaphosphoric and pyrophosphoric acids—which differ from it in the number of combined equivalents of water—and these forms pass into one another somewhat readily. Thus, a solution of metaphosphoric acid when boiled passes into orthophosphoric acid; pyrophosphoric acid may be prepared by evaporating a solution of orthophosphoric acid at a temperature about 215° ; but it, in presence of water, slowly passes back into the orthoacid at ordinary temperatures. Each of these acids is capable of forming a number of different salts—monobasic, dibasic, tribasic, or tetrabasic salts—with the same metal, and thus a large number of zinc phosphates are known. The subject is one beyond the scope of these pages, but even from what has been said it will be seen that very small differences of treatment will give rise to different results, and thus it happens that there are quite a number of rival preparations in the market, differing not greatly, but still distinctly from one another. Their exact constitution is usually a trade secret, but most of them are believed to form pyrophosphate of zinc with varying quantities of other phosphates admixed.

The phosphate class of cements also, some of them, contain other salts than zinc phosphates ; thus one formula contains aluminum phosphate mixed with the phosphoric acid, whilst another has magnesium oxide in the place of, or mixed with, the zinc oxide.

The insolubility of the different salts varies greatly, so that for each preparation there is probably a method of manipulation as respects mixing, etc., which yields the best results, and this may help to explain the difference of opinion which exists as to the respective merits of the various preparations.

As a class the **zinc oxyphosphates** are to be preferred to the oxychlorides, as they are not only less irritating, but they are less affected by the fluids of the mouth. Nearly all of them require protection from moisture while setting, though "Fossiline" appears to need this less than the others ; to many of them the access of water appears to be specially destructive, apparently quite altering the nature of the compound formed. As they all require to be mixed stiffly, they are less available for nerve-capping, and some other protective should be placed immediately over the point of exposure. Poulson's cement, Harvard cement, Fossiline, Weston's and Ash's phosphate cements are all favourite forms, but which is really the best is as yet quite undecided. A slightly greased agate burnisher will be found very useful for giving a surface to them, and as they all cling well to the dentine, much undercutting is not needed in any cavity. At the margin of the gum they fail, like oxychlorides, but far less rapidly; and an endeavour to remedy this defect is sometimes made by packing gutta-percha against the cervical margin before inserting the cement.

Oxyphosphate cements are far more durable if inserted into a cavity under considerable pressure; used thus as linings under gold, amalgam, or porcelain, they cause the combined filling to last remarkably well.

Many years ago the late Mr. Fletcher experimented upon various **silicates** with a view of producing a cement available for dental purposes, but although he met with some promise of success, no cement of this composition was placed upon the market.

Quite recently, however, a cement has been introduced under the name of Ascher's Artificial Enamel, which claims to be a silicate. Sufficient time has not elapsed for its value to have been established, but it looks nice in the mouth, and so far promises well.

Osteoplastic cements are excellent for filling open roots, and for fixing posts, etc., the greater fluidity of the oxychlorides rendering them in some cases the best for this purpose.

The phosphate fillings are exceedingly useful to form a flooring in deep cavities, so as to interpose a non-conductor between the pulp and any metal filling, and thus covered in they are durable for an indefinite time.

For the purpose of capping actually exposed nerves, Mr. Fletcher has introduced a preparation which consists chiefly of zinc oxysulphate; this has the advantage of being merely astringent and not escharotic, but it lacks hardness, so that it is necessary to complete the filling with some other material. And it sets so quickly that it has to be used expeditiously.

Another cement which has obtained the approval of some practitioners for its tooth-saving properties is composed of a phosphate of copper. Its inky-black colour, however, is against its general employment.

All the osteoplastics are good in that they do not discolour the tooth, do not change in colour, are non-conductors, and undergo no change in form or volume in setting, so that they all form absolutely water-tight fillings and resist the ink test. On the other hand, they fail from a want of resistance to chemical agencies, and therefore last much better in some mouths than in others.

Hence, an endeavour has been made to confer upon them greater resistance by intimate mixture with amalgams; the amalgam is first mixed, then the osteoplastic, and they are then incorporated together, or the amalgam may be worked in at the same time as the powder and fluid are mixed.

If much amalgam be used, the appearance of the surface will be almost exactly that of an amalgam filling.

Some operators have met with considerable success with these mixtures, which seem to adhere better to the tooth than amalgam used alone. Nevertheless, the osteoplastics thus combined cannot be relied upon to form water-tight plugs, for, if tested, a large number will be found to leak badly.

The property of osteoplastics alone to form ink-tight fillings may be utilised by filling the bulk of large cavities with them, and using amalgam as a protective coat only, and not as the main body of the filling. When thus used it should be at once packed on, without waiting for the cement to set, but this method will be discussed more fully under the head of amalgams.

Amalgams.—It is difficult to read with any patience much of the literature which has accumulated about the use and properties of amalgams, for it ignores the canons of scientific experiment. Of course there are exceptions, and really valuable papers do exist, amongst which may be mentioned those of Mr. Fletcher, Mr. Kirby, Dr. Hitchcock, Dr. Bogue, Dr. Foster Flagg, Dr. St. George Elliott, Dr. Black, and a few others.

And though metallurgists have devoted of late years a great amount of time and skill to the investigation of the properties of alloys, their results have not so far been very helpful to dentists.

Metals, when melted together in certain definite proportions, undergo changes in specific gravity, which prove that they are not quite mere mechanical mixtures, but that some sort of chemical union has taken place between their components. Of this the several varieties of fusible metal are a good example, for they have melting points much below those of their constituents. Mercury has the property of dissolving many of the metals, and, after the lapse of a little time, of entering into a loose or firm combination with them; thus, when palladium is rubbed up with mercury it is at first dissolved, but very speedily a solid compound is formed, with the evolution of a very sensible amount of heat, and so the amalgam sets. The compound thus formed is not easily broken up again, but in the case of copper it is different; in the well-known Sullivan's amalgam the mercury originally mixed with the precipitated copper is again set free under the influence of heat, and the mass becomes plastic; left at rest for a time it recombines and the amalgam sets again, this process admitting of indefinite repetition.

This property of softening under the influence of heat is shared by many amalgams, but for the most part they set again almost instantly.

When, instead of a simple metal like copper, a mixture of a number, such as tin, silver, and copper, or tin, silver, and gold, be taken, the mercury at first dissolving them brings them into intimate relation with itself and with one another, just as melting would have done, and then they combine with greater or less speed, according to the particular metals and the proportions in which they are present; thus, some amalgams set in ten minutes, while others take two or three hours.

Heat in many cases accelerates the formation of the final compound; thus an amalgam which would take hours to set, if heated till it begins to swell, sets almost instantly. Conversely, the setting of those amalgams, which, like palladium, set with inconvenient rapidity and with the evolution of much heat, is retarded by robbing them of that heat; hence a cast iron mortar is the best thing in which to mix them up.

In experimenting with amalgams (Trans. Odont. Soc., 1896), the writer found that on examining with a microscope the surface of a freshly-mixed amalgam, smoothed with a burnisher, small globules were to be seen upon it, but that, as it set, crystals appeared, till, when it was fully set, the whole surface consisted of a mass of crystals; in the case of silver and tin amalgams these were of rhomboid form, or six-sided plates, with very appreciable intervals between them.

This is the reason why an amalgam left by the burnisher

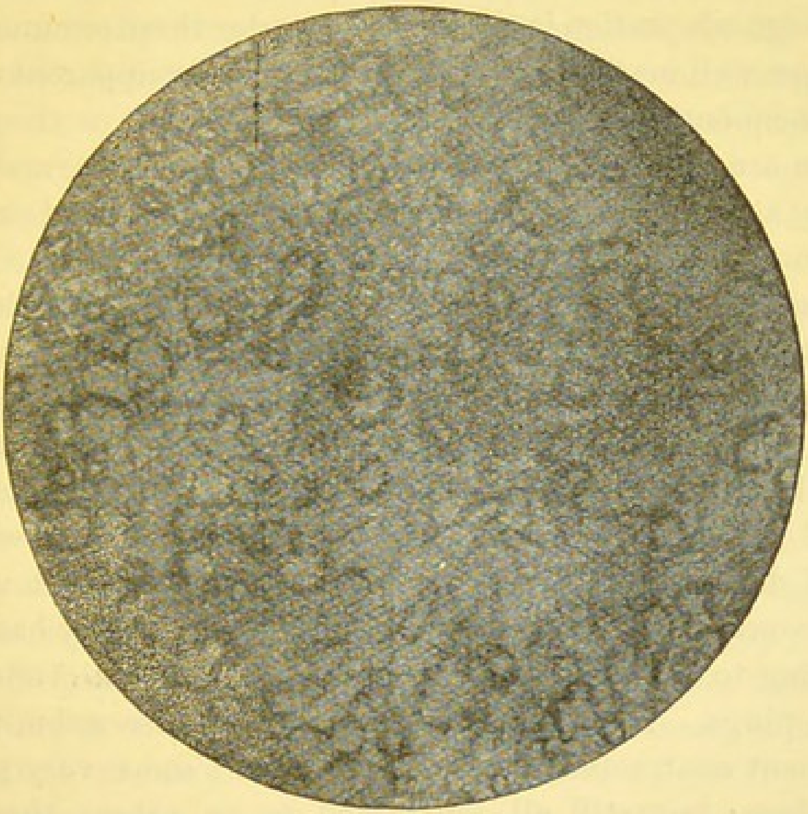


FIG. 148.—Surface of fully set amalgam upon which crystalline forms have appeared during setting. Photographed by opaque illumination from above. It was impossible to get a photograph at all representing the beauty of the object, owing to the differences of plane.

with a bright surface acquires a mat surface when it is set; and as this change takes place not only upon the free surfaces, but also on those surfaces which have been squeezed against glass, it follows that there is a less perfect adaptation after setting has taken place than there was when it was left at first.

The size of the crystals is little influenced by the proportion of mercury present, but it differs greatly in different amalgams; *cæteris paribus*, the smaller the crystals the better the amalgam should be.

Heat causes their immediate formation in an amalgam in which it would otherwise take some hours; heating a slab already crystalline causes the disappearance by solution of the crystals, but they almost immediately reform. Whether the setting of every amalgam is a process of crystallisation is a point not yet settled; it would seem probable that it is. And if an amalgam which becomes notably crystalline be packed in hot, so that the crystals form at once and it sets at once, and the burnishing be continued as it sets, a much better surface and better edge adaptation is obtained, for under these circumstances the large well-marked crystals are no longer apparent and do not subsequently reform.

There are defects to which all amalgams are open, and as yet there is a good deal that is imperfectly understood in their behaviour.

It would be impossible to enter at any great length into the chemical and physical properties of amalgams in this work; they have been more fully discussed elsewhere [1]; but there are some few characters shared by all of them which require mention here. Dissatisfied with the amalgams then in use, the writer in 1872 undertook an extended series of experiments with the view of determining the real sources of failure, and was led to the conclusion that chemical action on the alloy had little or nothing to do with it, but that amalgams at no time form perfect plugs. Every one of those which were submitted to experiment contracted as it became hard; some very greatly, others less; but still all contracted to an extent that must imperil the preservation of contact all round the circumference of the plug. But this contraction takes place with the greatest rapidity in the first few hours after the amalgam has been mixed up, and subsequently is slight in amount, though it is often not completed for twelve hours. Hence we may partly get over the difficulty by employing an amalgam which sets with great rapidity, such as palladium. In using this metal as an amalgam the greater part of the shrinkage is over before the plug is completed.

General experience had already shown that of all amalgams in use, palladium was decidedly the best, and it was exceedingly

[1] C. S. Tomes, on Physical and Chemical Properties of Amalgams. Transactions of Odontological Society, March, 1872, 1895, and 1896.

satisfactory to find, in these experiments that it displayed less shrinkage than any of the others. But of the numerous other amalgams submitted to experiment there was not one which did not contract markedly as it hardened; so that they had, one and all, to be pronounced unreliable. It seemed that the addition of platinum to silver and tin amalgams greatly hastened their setting, whilst the addition of gold lessened their contraction; there is, however, a limit to the quantity of gold which can be advantageously added, inasmuch as it eventually interferes with the complete setting of the compound; but subsequent researches have shown that no statement quite so simple as this is of universal applicability.

There is, however, another fault possessed by amalgams, which was pointed out by Mr. Kirby; not only do they contract, but they often undergo considerable changes in form as they harden. Thus, he found that on moulding specimens of amalgams into the form of long bars, with a view of measuring their longitudinal contraction by a micrometer screw, that in some instances it was impossible to replace the sample in the little trough used for the purpose.

From various grounds, it might seem advisable to use as little mercury as possible in mixing up an amalgam, and that the most durable plugs would be made in this way; but it should be mentioned that in Mr. Kirby's hands the bars which showed the greatest alteration in form were those which had been mixed very dry.

The experiments which I made were in the first instance conducted by filling teeth out of the mouth and immersing them in the ink-pot; upon splitting them subsequently it was found that with the exception of palladium water-tight plugs were rarely or never obtained. But as this method gave no means of comparing the results with one another, it was soon abandoned in favour of the plan of taking the specific gravities on first mixing, and then at intervals until the amalgam had set. This, which was done by means of a very delicate chemical balance, with the observance of every precaution against error which occurred to me, in the way of the observance of constant temperature, the use of an exceedingly fine wire for suspension, etc., afforded a means of comparing the contractions of different compounds, and of the same compound used in different ways.

More recently Dr. St. George Elliott, adopting the same method, has carried out a far more extended series of experiments upon about forty of the compounds most commonly in use (Trans. Odont. Soc., Feb., 1884). He finds that almost all contract, Fletcher's "expanding" amalgam included, unless this last was used very dry; but with palladium he did not experiment, owing to its quick setting rendering it difficult to make it compare with his other experiments.

There are some factors which render it probable that the results obtained by myself and others are all more or less wrong, but up to a certain point the results may be fully relied upon as indicative of important facts as to the relative shrinkages; one thing which probably upsets the accuracy of all the determinations is that amalgams give out heat as they set, and this in very varying degree, and they many of them set very quickly. The first weighing must, therefore, be performed pretty rapidly, and thus it is impossible to give time to ensure the temperature of the interior of the mass being at exactly the same point as that of the water. In Dr. Elliott's paper will also be found a good deal of valuable information as to the strength of the various amalgams when made into discs of uniform size and shape, and it is most clearly brought out that no general law can be laid down as to the proportion of mercury to be used, as different compounds behaved their best, some with little, some with much; it was, however, unusual for very dry amalgams to give results satisfactory in respect of shrinkage.

Another curious result was, that there often appeared to be a slow change going on in bulk for a long time after apparent setting, that is for days and even weeks; but I strongly suspect an experimental error in these minute estimations of change, not from any inherent improbability in their occurrence, but from their minuteness, which approached the limits of sensibility of any balance which could be employed.

Accepting the fact that some degree of contraction has to be reckoned with in all amalgams except perhaps palladium, I have devoted a good deal of time to experimenting in the direction of minimising it.

If amalgams are to be used in a thoroughly plastic condition—and if they cannot, half their usefulness is gone—Dr. Bonwill's method gives in my hands the best result of any of the accepted methods of manipulation.

In it the amalgam is placed in the cavity in a fairly plastic condition, and each successive addition is squeezed hard with pledgets of bibulous paper, the expressed more fluid portions being removed before the next piece is added. In the adoption of this method by the time the filling is complete it is very firm, and sets as quickly as that particular amalgam will.

Using in this way a fairly quickly setting amalgam (Eckfeldt and Dubois standard amalgam—silver, 52; tin, 40·60; copper, 3; gold, 4·40), I have got very good results as to water-tightness. But still the results were not absolutely perfect, and I found that the only way in which I could absolutely secure an ink-tight plug was by employing fragments of old fully-set amalgam, strongly heating them, and at once packing them in with hot instruments.

Fillings so made are water-tight, and retain their burnish after they have set, but the process is so difficult in the mouth that its practical utility is not great.

I then found that I could get nearly the same results by using freshly mixed amalgam, and heating each piece; but here again the difficulty was almost as great.

My next step was to employ a mix of fresh amalgam, and to rub up with this some old reheated amalgam quickly; in this way a mass can be got which will set rapidly under the operator's hands, but yet not so rapidly as to prohibit its use in ordinary cavities; the larger the proportion of the old to the new, the more quickly it will set. A convenient way of using this quick-setting amalgam is to mix up a quantity of amalgam (say standard amalgam) to a moderately plastic condition, spread it into a thin layer, and when it has set, break it up into coarse powder in a mortar.

About one-fourth part of this is mixed with fresh filings, heated in a spoon when wanted, and quickly rubbed up with mercury; or the old and the new may be kept separately and mixed in the proportions desired at the moment; with a little practice this can easily be used in most places, and I have practically employed it for some time past with far better results than were obtained by older and less troublesome methods.

Upon the whole I am convinced that unless some new departure in the matter of amalgam is taken, it is not possible to get the very finest results of which they are capable without a degree of rapidity in setting that is at least inconvenient and often prohibitive; the amalgam should do its setting actually under the burnisher.

It need hardly be pointed out that this is a strong indication for filling up at least a large proportion of the cavity with an osteoplastic, and so minimising the amount of the changing amalgam; the osteoplastic, we know, will not shrink or otherwise alter.

The results with the aid of heat which I arrived at through my observations upon the crystallisation of silver and tin amalgams had been to some extent anticipated. Years ago Dr. Bödecker pointed out some of the advantages to be gained, but his observation seems to have fallen stillborn: more recently Dr. Otolengui recommended working in bits of old heated amalgam to hasten the setting of the surface of an amalgam filling inserted in the ordinary way.

Mr. Kirby is of opinion that in an amalgam filling inserted in the ordinary way, there is, owing to the pressure exercised in putting it in, an unequal distribution of the mercury through the mass, and that this rearranges itself even after the setting of the amalgam, and becomes equal. To this rearrangement he attributes the warping which has been observed as taking place long after setting, and in order to obviate it he advises using a soft mixture with as little pressure as possible for the first portions of the cavity and finishing with much drier amalgam; in this way he expects to get from the first a more equal distribution of mercury in the filling, but in my hands the result so got is not so good as that by Dr. Bonwill's mode of insertion.

A great deal has been written about the tendency of amalgams to assume a spheroidal shape—there is not a jot of evidence that it does so—and the assumption is merely *à priori* reasoning of the loosest character such as we often have to regret in dental literature. What real observations do exist upon the subject are to the effect that it does nothing of the kind.

Dr. Black, however, discovered a very curious and interesting property of amalgams; he finds, that though, unlike a soft metal like lead, they cannot be indented or altered in form by immediate force, yet that, given the element of time, they do change under pressure without any crushing or breaking.

This, which he terms "flow," is best seen when a piece of fully set amalgam is placed under spring pressure, by which a substance as soft as dentine can be squeezed into it; in the form in which I confirmed his experiment, a piece of platinum wire was placed under a strong spring on the surface of a flat piece of amalgam; after a couple of days it was found to have produced a linear depression, very bright and polished.

On examining this depression with a glass, it was found to be longitudinally striated, the striations being due to the marks on the wire which had been left when it was drawn down; thus the hard amalgam had taken a mould of the wire of an exactitude and beauty far beyond that which fresh soft amalgam will; indeed, a check experiment with soft amalgam showed, after it was set, not a trace of the striation. This again is an indication for the use of an amalgam which will set under the instrument; on my old reheated amalgam I could get and keep this striation, which was so fine that it was not noticeable to the naked eye upon the wire itself.

Dr. Black (Dental Cosmos, Dec., 1896), has performed a large number of experiments, upon what has been termed the "ageing" of amalgam. By this is meant the curious fact that, as regards expansion or shrinkage, the same sample of alloy will be found to give different results according as it is used when freshly cut from the ingot, or after the lapse of some time.

This was found not to depend on oxidation nor on any result of exposure, and when the alloy was kept in the ingot no "ageing" occurred: but heat (boiling water) effected the result in a few minutes, and a temperature of 120° F. produced it in four days, while on the other hand, a temperature below freezing prevented its occurrence. Alloys kept in a warm room undergo the change slowly, and it is noteworthy that coincidently with the change in shrinkage there is a distinct change in its working properties, fresh cuttings (silver 65, tin 35) working harshly and hardening quickly, while that which had "aged" worked more smoothly and set more slowly.

But an alloy containing 75 per cent. of silver or more cannot be made to shrink by ageing, though its initial expansion can be greatly modified. The best alloys, however, are those containing from 65 to 75 per cent. of silver, there being objections to the higher percentages. By annealing, an alloy of 70 per cent. silver can be brought to a point at which neither initial expansion nor ultimate shrinkage occurs. Unfortunately it does not stay at this state, but after the lapse of time shrinks more. It seems probable that the force employed in cutting the amalgam up from the ingot may alter the physical condition of each particle, and that a subsequent annealing may undo this condensation, or whatever the effect may be.

For my own part, I have some distrust of inferences based upon experiments which show expansion first and shrinkage afterwards; not that they are not real, but that inasmuch as every amalgam heats in passing from the plastic to the solid state, it is extremely difficult to eliminate this effect, and to determine whether the expansion be merely caused by heat, or whether it be independent of heat.

In my own earlier experiments, made some thirty years ago, I found it absolutely impossible to determine with accuracy the expansion or contraction of very rapidly setting amalgams on account of this inevitable expansion by heat; and I expect it would be found that an amalgam in a state to set quickly, and the same in a state to set slowly, would set free the same amount of heat in the long run, only in the one case its effects would be very apparent, and in the other they would not be noticed.

But in some cases the shrinkage is said to occur first, and the expansion afterwards, according to Dr. Black, and this is less easy to explain on the hypothesis of heat set free, though it is possible that at first while a process of solution is taking place there may be actual cooling, to be followed by heating as the solid state is assumed.

So far from becoming simple, the more the subject is investigated, the more complex does the problem of getting a good amalgam become. I note, however, that Dr. Black inclines to the belief expressed by me, that the best results seem likely to be got with an alloy which sets with inconvenient rapidity, but which when it leaves the operator's hands is fully set. An amalgam may be composed of silver 65, tin 35 parts, and if used freshly cut (not annealed or altered by time), ground in a mortar, worked till plastic in the hand, and the excess of mercury wrung out, Dr. Black says that it will give good results.

To this formula he has added gold, platinum, and various other metals, but his experiments on this head are not complete nor conclusive; but gold seems beneficial, as does copper. Zinc is decidedly to be added with caution, as it gives curious and anomalous results. An alloy of silver 68·5, tin 25·5, gold 5, zinc 1, has however promised well.

Dismissing the most serious defect of amalgams, viz., that of failure to produce a water-tight plug, some of their other shortcomings may be touched upon, such as their tendency to themselves discolour, and also to stain the tooth. Given the same amalgam, the discoloration is greatest when much mercury has been used; palladium, which combines with a very large amount of mercury, gets very black itself, but does not stain the dentine at all; copper, which takes up far less, stains the tooth deeply; the obsolete amalgams made by filing up silver coins also stained the tooth deeply, and the cadmium amalgam, at one time introduced, stained the tooth a deep yellow colour, thereby demonstrating conclusively that the staining was due to the formation of the sulphide of that metal in the substance of the dentine; and although they are most of them hard enough to resist wear, yet they are brittle, so that the edges are prone to chip away.

The drier most amalgams are used, the better they will keep their colour, yet the instance of the cadmium amalgam would go to show that it is not so much the mercuric sulphide as the sulphides of the other metals which cause the discoloration of the tooth.

The presence of gold and platinum seem advantageous both in respect of the amalgam keeping its own colour and not staining the tooth.

Much may be done to prevent this staining by lining the cavity with an osteoplastic, but varnishing does very little good.

Copper amalgam is the worst offender in this respect, but it is so useful in many places that its use is not likely to be abandoned. It answers admirably in most cavities, specially in children's teeth, and seems to lead to some hardening and sterilisation of the surrounding dentine. It answers less well in cavities against the gum, where it often wastes rapidly.

There is no amalgam in ordinary use of such toughness that its edges can safely be left thin, as the edges of a gold filling may be; the edges of the cavity should be so formed that nothing like a feather edge should be left, and if this precaution be neglected, the edges of the amalgam will infallibly break away and leave a crevice likely to leak. But amalgams differ much in their strength; here again the reduction of the mercury to moderate amount is usually advantageous, whilst its extreme diminution is often the reverse of advantageous.

On account of this frailness of thin amalgam edges, it seems advisable to draw attention here to the great importance of completing the trimming and shaping of all edges of an amalgam filling immediately after its insertion, whilst it is setting.

If a matrix has been used, on its removal any slight overlap at the cervical margin should be trimmed away flush with the tooth substance, whilst on the coronal surface, any overflow into crevices or fissures must be removed so that the cavity margin is clearly defined. The filling should then be burnished, and the final polishing left till a subsequent visit.

The so-called felts of tin are to be classed among the amalgams, and though they are not exactly plastic, and do not set, yet they are compounds of mercury and tin, and owe their physical properties to this. They are not of much use as materials of which to make a complete filling, but many operators like them as foundations for a large gold filling, as the gold will to a certain extent adhere to the tin, to a sufficient extent, at all events, to render easy the commencement of the building on of cohesive gold; for our own part, however, we prefer actual tin-foil in those positions where anything of the sort is desirable.

It has been alleged that the mercury in amalgams is so feebly held, that it can escape at ordinary temperatures and exert its poisonous effects upon the person in whose mouth the filling is, and upon those who handle the amalgam. Mercurial salivation, headache, insomnia, diarrhœa, amaurosis, aphthæ, loss of memory, gangrene of the mouth, and most other ailments have been attributed to this fell agency. But it happens that there is ample internal evidence in the reports of the cases to relieve us of the necessity of paying much attention to the dicta of the writers, and it is at least curious that these gentlemen see not one, or two, or three cases, but they see them by dozens, though other practitioners seeing at least as many patients, but handicapped by the habit of scientific accuracy, never see one at all.

Some years ago it was alleged that the use of red rubber for plates had in numerous instances, within the experience of a single hospital physician, produced salivation and other untoward results. The Odontological Society of Great Britain, recognising the great importance of ascertaining whether this belief was true, sent out a circular inquiring from all its members whether they had ever had reason to suppose that such a result had come under their personal notice. The outcome of this collective investigation was, that not a single instance could be found in which there was the least ground for accepting the conclusions of the writer alluded to, and it was clear that he had accepted evidences of ordinary inflammation arising from irritations of the most familiar kinds, such as want of cleanliness, etc., for the effects of a specific poison. The fallacy of *post hoc ergo propter hoc* runs through almost all that has been written on this subject, even where there is not actual carelessness of observation or recklessness of assertion.

Moreover, if mercury does escape, it is in quantities inappreciable by the finest chemical balance.

A few cases have occurred which have attained to a degree of notoriety, which renders it desirable that they should be noticed here. In the Medical Union of New York, Jan., 1873, a case is related which at the time attracted much attention. A lady in good health, free from strumous or syphilitic taint, had arsenic applied to an exposed nerve; it was removed next day, but after a week of pain she sought the advice of another dentist, who, finding the nerve dead in the one, but alive in the other root, cautiously applied it again. *At that time, however, he had noticed that some exfoliation of the anterior wall of its socket was commencing.* Three days afterwards, though the parts around were then exquisitely tender, he filled the tooth with amalgam. A period of intense suffering followed; she became prostrate with hectic fever, and was at times delirious; pus oozed from the sockets of the teeth, which all became loose, so that several were removed without the use of any forceps, and mingled pus and saliva were constantly oozing from the mouth. As the patient was evidently in great danger, the whole lower jaw was removed, the periosteum being carefully preserved. The patient rapidly recovered, and in the space of six months a new jaw formed, which was firm enough to allow an artificial denture to be inserted.

There hardly seems a possibility for doubt that in this case the escape of arsenic, known to have occurred, was followed by extensive acute necrosis; and it seems hardly credible that the medical attendant, as well as several dentists, should have adopted any other view; yet it was confidently set down as a case of mercurial salivation, caused by the amalgam filling. This diagnosis was based largely on the occurrence of salivation, ignoring the familiar fact that there is always a profuse flow in any acute inflammation in the mouth, and the still more significant fact that commencing exfoliation had been noticed prior to the insertion of the filling, at which time there was excruciating tenderness around the tooth.

The foregoing case has been quoted at some length as being a fair sample of the sort of evidence that we are often asked to accept as proof that amalgams do all sorts of mischief; it so happens that it was reported in sufficient detail to allow of our forming our own opinion upon it, but it more commonly happens that the report is so imperfect that the data for a conclusion are really not there; but even in such there are often little pieces of internal evidence which lead one to doubt the competence of the reporter to form a just opinion; indeed, I may say, that, having given close attention to every instance known to me of alleged mercurial influence from an amalgam filling, I have never met with one single account which upon internal evidence appeared to me to be worthy of any particular consideration.

Without going so far as to say that it is a physical impossibility that an amalgam should exert the effects of mercury upon a person in whose mouth it has been placed, it may safely be said that clinical experience is wholly opposed to such an idea, and that I personally have never read of any case which would even tend to make me suspect its having exerted any baleful influence. Indeed I may go so far as to say that a careful perusal of the papers of those who have advocated a contrary opinion has done much to convince me that it never does happen, and I venture to predict that with the advance of liberal education which will ensure to the dentist some degree of acquaintance with collateral subjects, such as physics, chemistry, and therapeutics, we shall hear no more of this bugbear.

Palladium is the best of all amalgams when it is quite out of sight, so that its blackness is of no importance, its greatest usefulness being in tolerably strong-walled cavities which could be well filled with gold but for an inaccessibility which would render it necessary to cut away the tooth largely, or would render the packing of the gold so difficult that a filling would be unlikely to be made perfect; in the same way it fills a useful place where the difficulty of keeping the cavity dry long is really very great.

But it has one drawback which should be remembered; it tends to expand as it sets, and will often cleave off a weak margin of enamel, so that the caution given as to leaving thin enamel edges applies with extra force to palladium, and it is inapplicable in a good many cavities otherwise well suited for amalgam filling on this score.

Samples of palladium, reputed to be chemically pure, differ a good deal in their behaviour in amalgamating; some unite very readily with the mercury, others resist it for a time and then unite rapidly, and all give out a good deal of heat as they set; sometimes a sample is met with which, if left at rest for a few moments after being mixed, actually explodes; but what happens in this case is not well understood, for although there is always a good deal of heat set free, it would not be sufficient to volatilise mercury in the middle of the mass with such suddenness; and it has been suggested that the explosion is due to the setting free of occluded hydrogen, of which palladium is greedy.

A special mortar should be kept for palladium only, and it facilitates the mixing if it is not too carefully cleaned, but is left with a little amalgam adhering to the glass, stoneware or iron; it should be mixed with a large excess of mercury, so as to be very fluid, and the excess squeezed out at the last moment before introducing it into the cavity.

The cavity should be all dried out and absolutely ready before the amalgam is mixed, and no time lost in its introduction, the mass being kept in motion by rolling it between the fingers all the time till it is packed in ; it should cease to be plastic in three or four minutes at the longest, so that the filling is hard and can be nicely finished at the time.

No time should be lost in trimming away the overplus, as if there is any delay it will have become so hard as to render this troublesome.

And its rapid setting renders it quite out of the question to use it in any other than a very plastic condition, so that no special directions as to its insertion are called for.

Samples which set slowly are to be rejected, as they for some reason lack the special merits of palladium.

Some years since, partly under the influence of Mr. Fletcher, who did much towards the improvement of amalgams, it was thought necessary to use most of the amalgams, other than those already mentioned, in a very dry form ; as has been mentioned before, this at least had one advantage, viz., that this secured the minimum of discoloration ; and Mr. Fletcher advised that the mercury should be weighed out, and little pellets made in an almost pulverulent form by pressing it into little ivory moulds. It being often difficult to convey this very dry amalgam to the cavity, several instruments were devised by Mr. Parkinson, Dr. St. George Elliott and others, to meet the difficulty ; the one here figured terminating in a short tube, which is filled with the amalgam ; and this is pushed out by a little piston which runs through it when it reaches the cavity.

Very good fillings *may* be made with appropriate amalgams thus employed ; and by the aid of matrices even difficult places may be tolerably expeditiously filled ; but after all, half the value of an amalgam is gone if it cannot be used in a moderately plastic condition, for it is very troublesome to contour a tooth with a crumbling amalgam.

In order to avoid mixing an amalgam at one time too soft and at another too crumbly, it is desirable to measure the exact quantities of filings and mercury that have been found to give the best results with any given amalgam. Few who have used reliable measures will ever revert to the former haphazard plan of mixing an amalgam with an excess of mercury, and squeezing out the surplus. It is obvious that the advantages of employing an amalgam correctly proportioned and of the same unvarying consistency must be very great ; the amalgam becomes, as it were, "a known quantity," working uniformly and hardening with the same rapidity on every occasion. The most reliable, speedy, and accurate instruments for this purpose are Tulloch's "Mercury Measure" and "Instrument for measur-

FIG. 149.—Amalgam carrier.

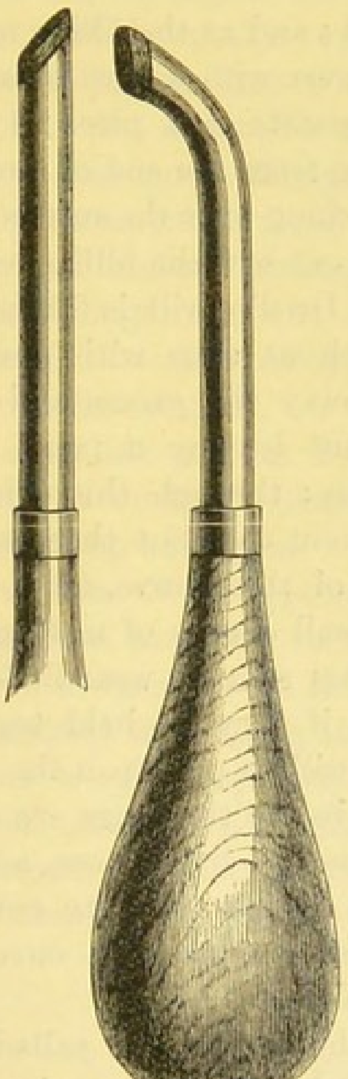


FIG. 150.—Amalgam squeezers, after Dr. Bonwill's pattern.

ing filings," introduced by Mr. W. J. May, and brought by him before the notice of the Odontological Society in 1903.

Nevertheless Dr. Bonwill has shown that an excellent result may be got by using a plastic alloy, and, so to speak, squeezing it in the cavity; and the writer's experiments prove that, so far as water-tightness goes, at least as good results can be got by this as by any other way of employing amalgams.

The amalgam is mixed not thin, but still thoroughly plastic; it is introduced in successive portions, pads of bibulous paper being forced into it from time to time, by which means the mercury is to a great extent squeezed out at the edges.

These more fluid portions which have thus been squeezed out are removed and more packed in, very strong pressure being employed; and as the filling approaches completion, its surface is gone over with a sort of squeegee, devised by Dr. Bonwill, which consists of a piece of velum rubber contained in and projecting from the end of a metal tube.

By working over the surface with this instrument mercury is squeezed out and the filling becomes hard almost at once.

When Dr. Bonwill is filling two contiguous cavities, he fills them both at once with one mass of amalgam, at the end cutting away the excess and trimming each up to a certain extent, but leaving a point of contact where the two are continuous; through this bridge he cuts with a fine saw on a subsequent day, but there seem to be valid objections to the adoption of this course, for it must be remembered that teeth have a small degree of motion in their sockets, and rub upon one another so as to wear little flat facets where they touch.

Hence, if they be held together by a bridge, some degree of strain will be put upon the walls of the cavities; and this, if it occurs before the plugs are quite hard, will have the effect of making both a little loose, a fact which will become apparent when the file is applied to cut them apart; this has happened to the writer more than once, when the hold in the cavities was but slight.

With the exception of palladium, no ordinary amalgam filling can be finished satisfactorily at the same sitting; it should always be polished with sand-paper discs, etc., after it is hard; upon the fine finish of its edges a good deal of its durability is likely to depend, but, at all events, if so finished it will certainly keep its colour and polish far better than if this is neglected and its mat crystalline surface left.

After making a large number of experiments out of the mouth, and comparing the results so obtained with the operations performed in the mouth, Dr. Bonwill's method of manipulation appears to have advantages over all of the others. Dr. Coffin had been in the habit of practising something of the same kind by using pledgets of gold or of tin, with considerable pressure, which absorbed the surplus mercury, but Dr. Bonwill has carried it out with a greater thoroughness than any other operator, and obtained in his own practice results with amalgam of exceptional excellence.

For cavities which are not much in sight, Dubois and Eckfeldt's Standard Alloy, manipulated in this way, gives very good results; it sets very rapidly, but does not keep a good colour, as it contains copper. Dr. Bonwill's amalgam, also a rapidly setting amalgam, makes good fillings, but is not quite in the front rank as regards colour; and Welsh's amalgam is also an excellent one. Fletcher's Extraplastic or Expanding Amalgam makes good fillings, but the colour is not first rate, Fletcher's Gold and Platinum Alloy, Davies' Amalgam, and Ash's, being better in this respect.

Of amalgams recently placed upon the market Fellowship Alloy is good; Tulloch's Gold Alloy, a modified Black's No. 2 formula, is a most excellent quick-setting amalgam.

In order to get over the fact that some of the best amalgams do not keep a good colour, it has been proposed to form the bulk of the filling with such, and to surface it with thin wafers of an amalgam specially good in respect of keeping its colour, but this has not found much favour in every-day practice.

For an account of this, as well as for much information upon the subject of amalgams, the reader is referred to Dr. Foster Flagg's work on plastic fillings, where a number of formulæ

	Tin.	Silver.	Gold.	Platinum.	Copper.	Zinc.	Antimony.
Welch's Amalgam	51·52	48·48					
Welch's Gold and Platinum Alloy .	51·90	46	1·70	·40			
Arrington's	57·5	42·5					
Fletcher's Platinum and Gold Alloy.	50·35	43·35	3·35	1·30	1·65		
Flagg's Submarine	35	60			5		
Flagg's Facing Alloy	35	37	5			3	
Dawson's White Alloy	49·27	48·24	·05			2·44	
Standard (Eckfeldt and Dubois) .	40·60	52	4·40		3		
Chase's Stannous Gold	40	40	20				
Chase's Incisor Amalgam	40	50					10
Chase's Plastic Tin	50	50					7
Tulloch's Gold Alloy	25·5	69·5	4			1	
Tulloch's Silver Alloy	27	67·5			4·5	1	
Black's No. 2	25·5	68·5	5			1	

are given. Eckfeldt and Dubois' amalgam is a favourite one with him, in positions where its colour is not a disadvantage.

The preceding table, abridged from the "American System of Dental Surgery," gives the composition of a few well-known amalgams, which may be taken as fair samples of the alloys in general use. The last three amalgams we have added to the list.

In the insertion of difficult amalgam fillings all the aids to which we have recourse for gold fillings, such as matrices, platinum posts, or screws, are available, and it is sometimes advisable to leave the matrix, which in such a case should be a belt of platinum or of german silver, on till the next day.

The Lennox matrix used with either the original or the improved clamp is an excellent one for amalgam work, especially where there is much loss of tooth substance to replace. In mesial or distal cavities, where the contiguous tooth is standing, a good contour filling can perhaps be inserted best by means of a thin flexible steel matrix, cut as required from ribbon steel. It is inserted between the teeth, and then wedged tightly up against the cervical margin of the cavity by means of shallow, triangular-pointed wooden wedges. By this means the amalgam can be firmly packed against the floor of the cavity without the matrix yielding at all at this point, whilst in working up towards the orifice the flexible matrix is allowed by the shape of the wood wedge to yield till the filling knuckles up tightly against the next tooth. On removal of the wood wedge the thin matrix can be pulled out from either side without any risk of disturbing the filling.

Absolute dryness of the cavity is of course desirable, and without it the finest results are not attainable, but fair results may be obtained with care and repeated dryings with bibulous paper or paper fibre lint even in places from which the absolute exclusion of moisture is hardly practicable.

And in conclusion it may be said that *amalgam fillings will repay the operator for all the care and skill which he can bestow upon them.* The difference between a good and an indifferent amalgam filling is so great that those who are in the habit of hastily and carelessly inserting it, as a thing upon which much trouble is time wasted, would hardly credit its capabilities when used to the best effect.

In discussing the defects of amalgams, a good deal has already been incidentally said as to the methods of using them. Sullivan's amalgam should be well washed, even with a little weak acid, if it proves to contain much red oxide of copper, but if it has been well prepared it will contain but little of this; the staining of the tooth appears to be due to the copper rather than the mercury, and this takes place to a greater extent when there is free oxide of copper in the mass. The bright yellow stain produced by amalgam containing cadmium (which has a yellow sulphide, used in art as cadmium yellow) indicates that the black stain caused by Sullivan is sulphide of copper, and this stained dentine is to some extent protected against caries.

But this is doubted by some observers, and Mr. Goadby has found that in cultures, colonies of bacteria grow right up to a pellet of copper amalgam, even in a zone coloured green by the copper.

It remains to notice the very valuable method of inserting phosphate cement at the same time with amalgam, strongly advocated by Mr. Baldwin (Trans. Odont. Soc., 1897, and British Dent. Journal, 1904). The cavity is lined with phosphate cement, and whilst it is still soft amalgam is pressed into it, the immediate margins of the cavity quickly cleared of cement, and amalgam packed into the rest of the cavity with considerable pressure. A matrix should be used where applicable, and the amalgam packed in with small or even fine-pointed instruments. As a means of saving frail bicuspids and molars these combination fillings are perhaps unequalled, and the following advantages are claimed for them. The property of phosphate cements of effecting a water-tight contact with the walls of a cavity is utilised, except at the immediate margins; indeed, it is found that cement strongly pressed in in this way actually adheres more tightly to the walls than when inserted in the ordinary way, so that a combination filling will actually stay in where a cement filling alone would hardly do so. This fact, as well as the support afforded by the cement to frail walls, minimises the sacrifice of tooth substance necessary in shaping the cavity, and so also the pain inflicted in its preparation, and renders the tooth less liable to subsequent fracture. Further advantages are that it interposes a non-conducting layer between sensitive dentine and the metallic filling, at the same time preventing staining of the tooth substance by the amalgam, while it is actually a quicker method than the insertion with due care of a filling wholly composed of amalgam.

Tin.—Owing to its greater softness tin may be manipulated in larger pieces than gold, and therefore with greater rapidity; for the same reason it is comparatively easy to make water-tight plugs with it, and it is less spoilt by the access of moisture during the progress of the work. These qualities render it useful as a filling for children's teeth, and for certain portions of the fillings of adults' teeth; it resists attrition fairly well, and although its surface becomes dark it does not stain the tooth, nor is it acted upon by the fluids of the mouth beyond this superficial discoloration.

It is by many operators used for commencing the cervical edges of interstitial fillings, its use being abandoned in favour of gold when that part of the cavity has been lined; and it is thought that failure at this most vulnerable point is thereby rendered less frequent. The only disadvantage appertaining to this method is that there is in time a black line at the edge of the filling, and this may be mistaken for failure at this point, particularly by an operator not accustomed to see tin thus used.

Tin is also employed in conjunction with gold, the metals being more intimately mixed; a sheet of tin is enclosed between two sheets of gold and then twisted into ropes or cut into strips, etc., according to the fancy of the operator, and when thus dealt with the mixed metal works with almost the softness of pure tin.

It, however, possesses this peculiarity, that after a time some chemical action takes place which extends deeply into the mass, in consequence of which the plug takes on much the appearance of an amalgam, and becomes exceedingly hard, cutting with a peculiar gritty cut.

Some think that this change takes place more fully if the access of moisture has not been prevented; however this may be, it is certain that a most serviceable plug may be made with the mixed metal under circumstances where the partial access of moisture would have wholly ruined a gold filling. The fillings are quite hard enough to withstand the wear of mastication, and are in certain places very valuable, but they do not look very nice, and are therefore not suited to places exposed to view.

Gold.—Gold, as prepared for the use of dentists, takes two very distinct forms, which are distinguished by the terms cohesive and non-cohesive, or soft. The difference does not appear to be one of purity, as soft foil at once becomes cohesive on being strongly annealed, but it appears to consist in some trifling difference in physical condition, of a nature not well understood; indeed, it may be doubted whether even the most successful manufacturers of soft foil know more than an empirical plan of treatment which they very generally keep to themselves. However that may be, there is far more difference between the soft foils of various makers than there is between the cohesive foils, which are of, comparatively speaking, uniform quality. An endless controversy goes on as to the respective merits of the two forms, which seems no nearer to its settlement than it was when it commenced.

If fragments of cohesive foil be shaken up together in a pill-box, they will cohere so firmly that they can only with difficulty be torn apart, but pieces of soft foil so treated will not stick together at all. It is obvious that this quality is a very valuable one when we wish to make a filling; but there is unfortunately a fault to set off against it, namely, that it is a harsh material which does not readily adapt itself to an irregular surface like that of an average cavity, but on the contrary, it has a strong tendency to ball up under the instrument, and so curl away from the tooth. At one time the writer made a large number of experiments with various forms of gold, inserting fillings into teeth out of the mouth, and dropping them into an ink-pot to test them as to water-tightness. The general result of the experiments was to show that with tin or with soft foil it was a matter of ease to get a tight plug, but that with cohesive foil it was so difficult that it but rarely succeeded, and then only by the use of gold in exceedingly small pieces, such as ½ A cylinders. In fact, the writer came to the conclusion that the difficulty being so great when the tooth was in a vice, on all sides accessible, it was only in a minority of cases that the same result could be hoped for in the mouth.

A form of gold has been introduced by Wolrab of Bremen, which combines, in a degree not hitherto attained, the qualities of softness and cohesiveness ; this has been imitated with more or less success by other makers, their preparations being named "velvet gold," etc.

Pack's loose rolled soft and semi-cohesive cylinders also exhibit these combined qualities of softness and cohesiveness in a marked degree, being, moreover, extremely easy to manipulate, and making hard lasting fillings.

The qualities which we desire in a **soft foil** are, that it shall be tough, so as not to crumble under the instrument, and that it shall be exceedingly yielding and free from harshness ; as there is no true cohesion, the portions of the plug are held together by being intimately interlaced and wedged against each other, and this is only attainable by the several portions sliding readily over one another as they are introduced ; any approach to cohesiveness is therefore destructive to its working properties and would result in the plug containing hollow places.

Soft foil is used in the form of foil variously folded or rolled up, the object being, whatever the form preferred, to secure some degree of parallelism in the layers ; it is also frequently rolled up into cylinders of various sizes and hardness, and in this form the parallelism is excellently well secured.

With **cohesive foil**, a totally different set of properties is desired ; each piece should cohere to that already in place at the smallest touch, and so far from sliding over it, it should never move in the very smallest degree after it has once touched the filling. The cohesiveness of foil is destroyed by the least moisture, grease, etc., so that it is important that it should not be handled ; exposure to the air even seems to have an effect in destroying this property, so that it should be kept protected. Annealing restores its cohesiveness, but it is difficult to anneal it with such regularity as to get its best properties when once it has deteriorated.

Cohesive foil is prepared in pellets which consist of many super-imposed layers of very thin foil, but it is more frequently used simply folded in strips or in ropes ; many operators in place of folding it, prefer to use rolled or beaten foil of a thickness equivalent to that which they would have obtained by folding a thinner foil ; these so-called heavy foils are numbered 10, 20, 40, 60, 70, up to 240 ; these numbers denoting that a sheet of the ordinary size would contain that number of grains.

Another form of gold adapted for filling teeth has been produced by chemical means. The metal is thrown down from a state of solution in a more or less crystalline form.

The late Mr. Makins, once Lecturer on Dental Metallurgy to the Dental Hospital of London, was, probably, the first who procured sponge or **crystal gold,** as it is now called, with a view to its being used for dental purposes. His preparation consisted of minute octahedral crystals, connected loosely together by fibres which at parts exhibited a crystalline character, the whole forming a spongy mass of dead gold colour. We have seen, from time to time, fillings which were made with Mr. Makins' first batch of sponge, and for a long period they have remained unaltered.

Subsequently Mr. Barling, of Maidstone, gave his attention to the subject, and introduced a sponge gold not altogether dissimilar to that which Mr. Makins produced. It was formed mainly of octahedral crystals and indistinct fibres.

Ultimately, however, a very beautiful preparation was made by Mr. Watts, and this is, we believe, the principal form of sponge gold used in America. We know it as Watts' American crystal gold, the valuable properties of which have been very strongly put forward by Dr. Dwinelle and others in the American dental journals. The gold comes to the hand of the operator in the form of light spongy cakes readily compressible between the thumb and finger. Several degrees of density are produced, but the character of the gold is otherwise the same. By the aid of the microscope we are enabled to see that the American differs in its structure from the English sponge gold. Each is crystalline, but while the latter consists of crystals of the form normal to the metal, the former is made up of beautiful foliaceous crystals closely resembling in general appearance the leaf or frond of a common fern. They have considerable superficial extent with very slight thickness, and lie together greatly entangled and interlocked.

In the earlier samples a considerable amount of amorphous gold was entangled amongst the crystals, and in some cases oxide of gold was present in a small amount. These imperfections have been remedied, and the reguline condition is obtained by all the manufacturers. The most recent variety is the so-called Solila gold, which is an excellent specimen of a sponge gold.

In order to command the best results in the use of the crystal gold, four points require attention.

The gold must have been recently manufactured or recently annealed, in order that the adhesive property shall be fully pronounced. The plugs must be built up of small fragments, each one being perfectly consolidated before another is added. The metal must be preserved from the contact of moisture until the plug is formed. And appropriate instruments must be used in performing the operation. The neglect of either of these conditions will be followed by an unfavourable result.

Sponge gold on exposure to the atmosphere soon loses its peculiar adhesive quality, and becomes quite unmanageable; instead of welding together under the stopping instrument, it falls to pieces, and all attempts to make additions to that which is already consolidated are unsuccessful; on this account it is desirable to anneal the metal where any doubt exists as to its condition. By the process of heating the adhesive property is restored, even though the temperature to which the gold is exposed falls short of a red heat. But to whatever extent the welding property is produced, the presence of moisture will at once render it unavailable. The metal, from its porous condition, absorbs like a sponge, and instead of consolidating under the pressure of the instrument, works up into powder. We must therefore guard against the admission of the saliva, and also protect the tooth under operation from the expired breath, which being charged with moisture will, if the metal be of a lower temperature than itself, deposit upon it a sufficient amount of fluid to interfere with the cohesive property of the gold.

Sponge gold has not very many constant adherents, though properly manipulated it is capable of yielding the finest results; there is however a somewhat general impression that there are pitfalls which render a failure of a kind not always visible at the time rather more likely to occur with it than with any other form of gold. Thus it is possible to get a plug which looks very hard and dense on the surface, but which is porous beneath, and perhaps against the edges; such a result is very likely to happen if the operator, seduced by the facility with which it is packed, is tempted to use fragments which are too large.

It is, however, very useful to make a foundation whereon to build cohesive foil, as it is easy to make it lie dead, and it will occasionally help us out of a difficulty in filling a shallow cavity in which it is for some reason or other not desirable to make retaining points, and which is of such shape that there is but little hold; in such positions its property of packing dead and not rolling is of much value.

Instituting a comparison between gold foil and crystal gold, the microscope may be called into requisition with advantage. If plugs be made in perforated pieces of ivory (in the manner already alluded to) with the various forms of crystal gold, we shall find that the surface which has been pressed against, and has rested upon the ivory, is made up of crystals, the forms of which have been unaltered by the pressure. Their presence in this situation indicates a certain amount of porosity, and it is due to the dentine not offering sufficient resistance to interfere with the crystalline character of the metal. Had the whole been in metal, instead of ivory, the inserted plug would have presented a much greater density upon the lower surface; or had the cavity been lined with enamel, a similar advantage would have been gained.

In those cases where decay has commenced upon the labial surface of the front teeth, the crystal gold may be used with great advantage. The filling should be made to project, and then be filed down to the level of the surrounding surface of the tooth.

Dr. St. George Elliott was of opinion that a filling made of or at least finished with, sponge gold retained its perfection of polish for a longer period than a foil filling.

The attainment of absolute solidity in a gold filling made in the mouth is not possible. If crystal gold be used, the microscope will show a certain amount of porosity; if foil be employed, it will show the presence of fissures in the peripheral surface of the filling. Yet it is possible to produce a filling the specific gravity of which shall very nearly approach that of melted gold. Dr. Black, who made a number of determinations upon fillings made for him by other operators, found that the specific gravity of these experimental fillings was above that of old fillings taken from the mouth, and that the fillings made of soft foil fell behind those of cohesive foil in this respect.

Mr. Cass Grayston,[1] during his experiments with various forms of gold, came to the conclusion that it was comparatively easy to make gold plugs of a specific gravity varying from 17·1 to 18·9; the specific gravity of a solid button of melted foil being 19·0. He also noted that a filling is not necessarily well adapted to the cavity walls because it happens to appear cohesive, solid, and strong. Hand pressure gave good results with unannealed or soft gold, but if used for cohesive gold a very fine plugger was necessary to secure good results. Nevertheless mallet force produced decidedly better adaptation than hand pressure with cohesive gold.

Sponge gold, when long kept, appears to undergo some molecular change, greatly interfering with its welding properties, which are only in a measure restored by annealing.

Gold foil is prepared by beating, or sometimes, in the case of very heavy foils, rolling into thin sheets a perfectly pure metal. The sheet when prepared for dental purposes is usually four inches square, and is numbered in accordance with its weight. Thus the numbers 4, 5, 6, 7, 8 indicate the number of grains contained in each four-inch sheet, and by some very much heavier foils have been employed, reaching as high as two hundred and forty grains per sheet.

The gold leaf of commerce is an altogether different article. In order to produce a leaf sufficiently thin for gilding purposes, it is necessary to introduce a certain amount of copper, as otherwise the metal when greatly reduced in thickness will not leave the vellum, between sheets of which it is beaten.

Considerable care is necessary in the preparation of the gold leaf, as it is absolutely essential that it shall possess certain physical characteristics as well as chemical purity. Thus it must be tough and soft, and must possess either a high degree of adhesiveness, or else must be completely non-adhesive. In the one case, if several slips be placed in a pill-box, and well shaken, they should become inseparably united, while in the other they should not adhere when firmly pressed together.

Much light has been thrown on this matter of cohesiveness

[1] Odonto. Trans., Nov. 1901, and his book, "Notes on the Filling of Teeth."

in a valuable paper read by Mr. Makins,[1] in which it was laid down that the requisite conditions for complete welding were a perfect absence of impurities from the surface, adherent air even operating disadvantageously; freedom from moisture; and a soft, yielding condition of the metallic particles, which must not have suffered great previous compression. Thus, although silver, copper, or platinum, when in the pulverulent condition, may be welded by pressure, careless manipulation of the powder by which the particles have become in a measure burnished effectually prevents their union. Mr. Makins, in speaking of adhesive foil, says, "The surface obtained is not a smoothed one, and is far from polished; when examined by the microscope it will be seen to be covered with corrugations with corresponding depressions. The upper edges of these appear burnished, but the depressions with which the greater part of the surface is covered are perfectly matted; and this is particularly the case in what is sold as adhesive foil, which is far more matted, and of that brown colour, which in precipitated gold, denotes but slight condensation of the metal." Again, he says, "In adhesive foil we have a rough surface, and also many of the conditions present in sponge gold. Thus, in adhesive gold it seems that the mètal is only partially welded, so that it is in a very favourable condition for further welding under an instrument; whilst in non-adhesive foil the surface is already burnished, so that it has no great tendency to cohere. A very slight amount of molecular change, such as may be brought about by annealing, suffices to convert the non-adhesive into the adhesive form; this process of annealing is, however, advantageous from other causes besides that of altering molecular condition, as it secures the absence of moisture, and also gets rid of adherent air.

Like crystal gold, gold leaf appears to undergo some molecular change when kept for a length of time, which leads to its assuming a hard, harsh texture.

To recapitulate, soft foil is easier to introduce so as to make a water-tight filling, and thus in positions where it is not exposed to much stress, is more likely to preserve the tooth.

[1] G. H. Makins, "On the Union of Metals by Welding." Transactions of Odontological Society, June, 1872.

But it is not possible to get it up to the same density, so that it is in greater danger of porosity; and it will hardly withstand the strongest bite, unless in a very favourably shaped cavity. It can be more quickly inserted, as larger portions of soft foil in more or less parallel layers can be condensed at one time. But it cannot be used at all in some open cavities which can be well filled with cohesive foil: it will not keep so good a surface, and if exposed much, it will wear away much faster.

Exclusion of Saliva.

Whatever filling material may be decided upon, it is necessary to thoroughly dry the cavity, and to keep it dry during the whole performance of the operation.

The oldest, and still very generally useful appliance is the **napkin** variously folded, and supplemented by pledgets of bibulous paper; and this will be found adequate for most short operations, and indeed in some hands for fairly long ones, though there are but few nowadays who venture to trust to it for long or difficult fillings.

In applying the napkin no two operators will adopt precisely the same disposition of it, and it would be unprofitable to devote much space to a description of what can only be taught by demonstration; but it may be said in general terms that it is often advisable to employ it not only to sop up the moisture in the immediate neighbourhood of the tooth, but also to prevent to some extent the entrance of saliva into the mouth by making pressure on the mouth of the salivary ducts; thus when working in the lower jaw it should be pressed well under the tongue against the orifices of the submaxillary glands, and the parotid of that side may be guarded by a separate pad over its duct.

On the left side of the jaw the first and second fingers of the operator's left hand may be most conveniently used to hold the napkin down, whilst in operating on the right side of the lower jaw, it will generally be more convenient to stand behind the patient and employ the thumb of the left hand on the inside and the first finger on the outside of the teeth; or the patient may be made to hold it down with one finger of his left hand. It is often, however, excessively fatiguing to hold the napkin in its place, and this may be done by a Hawes's tongue-compressor applied over the inner portion of napkin, whilst a single finger of the operator's hand holds down the outer fold. Dr. P. Smith has modified and greatly improved Hawes's tongue-compressor, and the instrument so altered is extremely useful. The figure which is here given will explain itself; in applying it the napkin is first adjusted, and then held down by the introduction of the horizontal arm with its horse-shoe end, which has been previously detached from the rest of the instrument. Whilst this is held in its place, its free end is slipped through the hole at the top of the upright (which has been previously raised to its full extent), and the padded plate

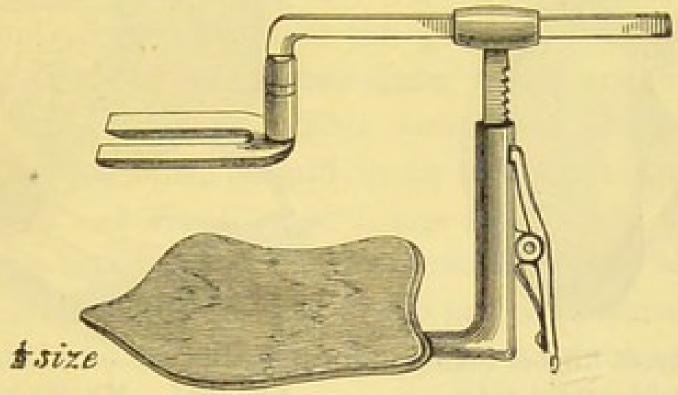


FIG. 151.—Dr. Smith's tongue-holder.

adapted below the patient's chin. The upright, which is furnished with a ratchet at its back so that it will slip down, but not upwards, is then pressed down until the napkin is securely fixed. As a rule, patients much prefer the use of this instrument to the introduction of the operator's fingers, as it takes up less room in the mouth.

Although the use of the rubber dam has to a great extent banished such instruments, and the napkin is but rarely used except under circumstances in which the operator's fingers are available, it will be found useful in a certain number of cases; ends of various shapes may be substituted for the horse-shoe, so as to interfere less with the tongue than that form does.

A sheet of rubber dam inserted between the folds of a napkin will often be found to be a useful expedient in the case of upper teeth, but in prolonged operations the napkins are apt to become saturated, and the difficulty of keeping a lower tooth dry by their means is often very great.

To meet this difficulty, as well as to relieve the patient of the discomfort of a great accumulation of saliva in the mouth, **saliva pumps** are employed; of these there are a good many patterns, but they all have much in common, suction being exercised in a flexible india-rubber tube terminated by a glass mouth-piece by means of the fall of water down a vertical tube. The flexible tube is so arranged that when once it is filled it goes on acting as a syphon, but the fall of water from a supply

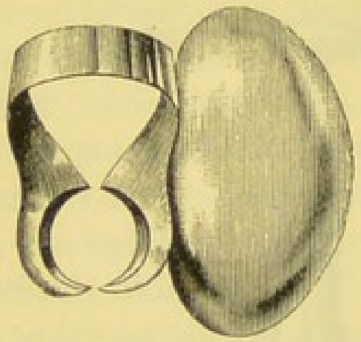


Fig. 152.—Mr. C. Rogers' clamp, for use on the right side.

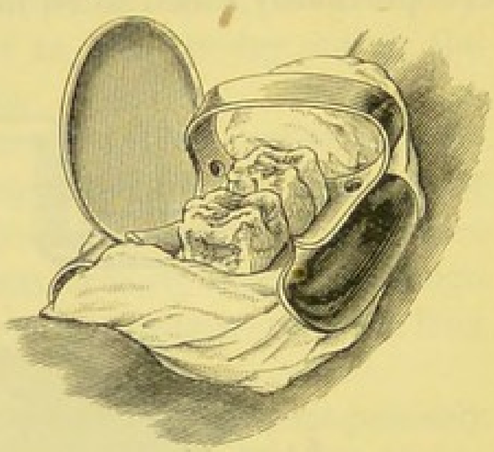


Fig. 153.—Mr. Stokes' clamp.

down the vertical tube is needed to start it again whenever it has drained itself empty.

Other and more powerful saliva pumps are made in which the principle of the injector used for feeding steam boilers with water is made use of.

In conjunction with the saliva pump a form of clasp designed by Mr. Claude Rogers, which has a shield on one side to hold the tongue out of the way, is exceedingly useful; with a pad over Steno's duct and this clamp, crown cavities can be quite securely filled.

Another useful form of clamp is that of Dr. Stokes, which is a further development of Rogers' clamp; in this there are downward curved shields, beneath which rolls of bibulous paper are packed.

Absorbent cotton wool rolls of different sizes are useful for excluding moisture during short operations, and they can be quickly changed if necessary; several varieties of clamps have been devised to hold these wool rolls snugly in position.

Paper fibre lint, which is supplied in sheets, is also extremely useful when simple cavities in bicuspids and molars have to be filled; it occupies but little space in the mouth and rarely inconveniences even the most sensitive persons. An effective method of employing this material is to cut a strip about four inches long by one and a half inches wide, fold this lengthwise on itself and round off one end with the scissors; this is then placed by the conveying forceps in position between the teeth and cheeks, the rounded end being passed as far back as it will comfortably go. For an upper tooth this will usually suffice, but in the case of a lower tooth it should be supplemented by a wool roll passed down by the side of the tongue.

But the appliance which gives the greatest security against the inroads of saliva is the **rubber dam,** which was invented by Dr. Barnum, of New York. This consists of a sheet of thin india-rubber, which must be sufficiently tough to stretch readily without tearing. A sheet of such size is taken that all four corners may be brought outside the mouth when it is applied; holes are then made in it in a suitable position, through which the crowns of the teeth are passed. These holes may be made with a punch, by scissors, or by stretching the rubber tightly over the end of an excavator handle (which must have a flat end), and touching it while stretched with the edge of a knife; a perfectly circular clean-edged hole will then be obtained.

It is seldom sufficient to pass the rubber over one tooth only; unless the tooth to be operated on stands alone, the rubber would rise so high around it that the light and the view of the cavity would be obscured. Hence it is usually passed over the tooth in front and that behind the one to be operated on; but, of course, no general rule can be laid down on this point. If the teeth stand close to one another, only about the eighth of an inch should intervene between the holes in the rubber, but if there is an interval between the teeth a larger space must be left, so that the intervening gum may be covered.

In applying the rubber the sheet is put on the stretch between the forefingers of the right and left hands, placed on either side of the first hole: it is thus forced over the front tooth, then over the next, and so on from before backwards, till all the teeth which are intended to be included are through their respective openings in the sheet.

The rubber is then slightly pulled away from each tooth, and the free edge lying against the neck of the tooth, which, from the manner in which the rubber has been applied, will look upwards, is tucked in by the side of the neck of the tooth so that it is directed downwards; this may easily be effected by the use of a burnisher, or other blunt instrument, or by waxed silk forced up. When the shape of the teeth is favourable to its retention, no further measures are required to keep it in its place; but should it tend to slip off, pieces of waxed silk may be passed down between each tooth, and their ends tied together. The so-called "sticky wax" is the best material to wax or re-wax silk ligatures with. In other cases wooden wedges may be employed to retain it in its place, or ligatures of waxed silk tied around the neck of the tooth previously to the application of the rubber, so as to form artificial ledges, which may be increased by threading one or two small glass beads on the silk prior to applying it.

Another means of holding the rubber down, and also of keeping the tongue out of the way when it is inclined to obscure the view by bulging up the rubber, is to employ clamps; these in their proper place are quite invaluable, but they should not be used indiscriminately, for they add to the patient's discomfort and are not so very often absolutely necessary, though some operators seem never to consider the application of the rubber complete without a clamp being placed somewhere.

There are two ways of applying the clamp and the rubber; the clamp may be adjusted in place first, and the rubber passed over it and the tooth simultaneously, or the clamp may be held in the clamp-forceps and passed partially through the hole in the rubber, and clamp and rubber put on to the tooth at once; this latter plan is often the most expeditious and the easiest.

Clamps are also very useful in holding the rubber above the edges of cavities which extend below the cervical edges of teeth. A number of specially shaped clamps, such as Libby's and Ivory's, are sold for this purpose, and are exceedingly useful in dealing with cervical edge cavities.

There are a few cases, however, in which the difficulty and the pain attendant on the adjustment of the rubber are such as to make it hardly worth the trouble. Minor difficulties may,

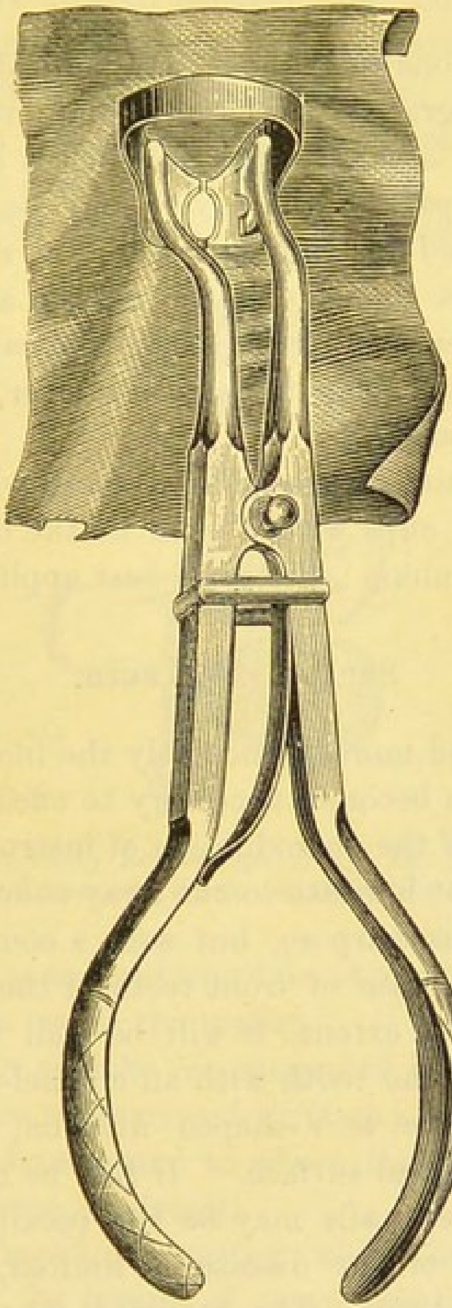


FIG. 154.—Clamp and clamp-forceps, ready for application to the tooth.

however, be got over; in the first place, it may be stated as generally true that, wherever the waxed silk will pass down between the teeth, it will carry down the rubber with it. When, owing to the conical shape of the tooth, the rubber, after being fairly applied, slips off, and cannot be retained by a ligature of waxed silk, it may sometimes be held down by a piece of soft iron wire passed round the tooth, and having its free ends carried out on the buccal side, where they are held down by a single finger. Silk may be used in the same way.

In certain positions the rubber may be held out of the way by an instrument grasped in the left hand ; thus, in an interstitial cavity, the cervical edge of which is below the gum, a view of the upper part of the cavity may be obtained by the use of a blunt-ended instrument bent at a right angle, which is employed to force the edge of the rubber above the margin of the cavity ; when the upper part of the cavity is filled, the necessity for holding back the rubber is over, and the instrument may be laid aside.

For short operations, especially on teeth which stand alone, little india-rubber cups with a hole in the bottom have been devised by Mr. Denham : these are best applied with a clamp.

Separating Teeth.

As the teeth, and more particularly the incisors, are in close apposition, it often becomes necessary to effect some separation in order to allow of the introduction of instruments. In some instances we do not hesitate to cut away sound portions of the tooth to effect this purpose, but such a course is not always advisable. In the case of front teeth, if the decay has a considerable superficial extent, it will be well to cut away the lingual surface of the tooth with an enamel-cutter, in such a manner as to leave a V-shaped division, which does not encroach on the buccal surface. If this be not done, a cavity with brittle, ragged walls may be the result ; but where the superficial extent of the disease is limited, it will be better to avoid cutting away. The required space may be gained by the introduction of strips of wool, of india-rubber, or of cotton wool, or what is much better, of tape between the teeth.

The separation may be effected at once, or the force may be more gradually exerted, which latter is the safer course if any considerable amount of space has to be gained.

The method of "quick wedging," as it is termed, has, however, a good many advocates, and may be first described. For this purpose two wedges of orange wood are required ; one is forced between the necks of the teeth, and the second, which is more tapering, is forced between the points of the teeth. Gentle taps of a mallet are given to the latter, and the space thus gained is secured by a tap on the first wedge. Thus, by alternate taps on the wedges, the teeth are forced apart, and when an adequate interval has been gained, the second wedge is withdrawn. The force which may be exerted in this way

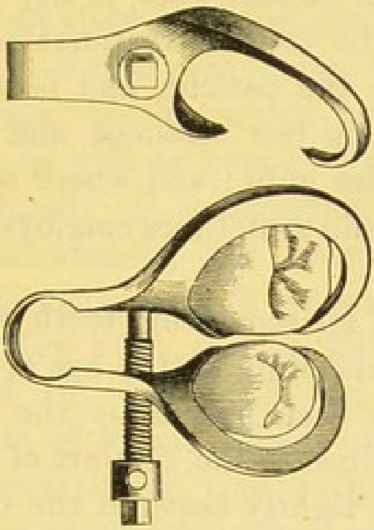


FIG. 155.—The Perry-Bogue separator. Dr. Perry has since added a second screw on the other side.

is very great, and many untoward accidents have been reported from an incautious use of the mallet.

This method can only be recommended in the case of incisor teeth which require to be moved through a very short distance ; and it must not be resorted to where there is any unhealthy condition of the gums or alveoli.

A method of rapid separating which has a good many advocates is that by means of screw separators; these were introduced by Dr. Jarvie, and have since been modified and improved by Dr. Perry and Dr. Bogue, and others. Figures of them are appended, which will explain themselves.

By the use of these separators an amount of space adequate for the performance of most operations may be obtained at the first sitting.

But in a large proportion of cases slow wedging will doubtless continue to be adopted. If wood be employed, only a moderate degree of force should be used in inserting the wedge, which may require to be replaced by a larger one after the lapse of a few days. If india-rubber be employed, it should be in very thin pieces, which may be cut from the solid lump, or thick rubber dam may be used for the purpose. It should not be left many days without renewal, and in no case should a thick piece be introduced at once, as this would exert a degree of force which might prove injurious.

In many cases the separation may be very conveniently effected by the use of cotton wool, firmly pressed between the teeth: this should be frequently renewed. But tape is the most comfortable to the patient, and is to be generally preferred, both as causing less soreness, and being less liable to worry the edge of the gum; and where several cavities have to be reached, Dr. Coffin sometimes employs one of his expansion plates.

The time required for separating teeth will vary from two to seven days, much depending on the age of the patient.

When teeth have been moved by the process of wedging, it will generally conduce to the comfort of the patient to place a wedge moderately tightly between the teeth while they are being filled, as this will keep them firmly fixed, and to a considerable extent obviate the tenderness which always exists in teeth forced from their proper position. A separator may be used for this purpose, and a clamp which answers well on molars and bicuspids has been designed by Dr. Perry. When the question of time is not important, a slow but quite painless separation may be effected by packing insterstitial cavities very tightly with gutta-percha, preferably of the red variety, leaving it if possible a little too high so that it is bitten upon.

This has the further advantage that the teeth are not left tender in their sockets, and yet when finally filled quickly regain their old position.

METHODS OF INTRODUCING GOLD.

In the use of **non-cohesive gold** it is desirable that the portions of foil should slide over one another with the greatest facility, the solidity of the plug being secured by the interlocking of the several pieces, which have to be as it were entangled together, as well as keyed by the application of the last portions introduced. It is therefore not desirable to use deeply serrated instruments, and many of the most skilful manipulators use perfectly smooth points.

Dr. Dunning, of New York, and his followers, amongst whom may be mentioned Dr. Lord and Mr. Davis, make use of wedge-shaped points of various sizes, quite sharply pointed; indeed it is their practice to constantly sharpen them upon a piece of Arkansas stone which has never been oiled, so as to preserve sharpness both of the point and of the edges during the progress of the work. For the packing of soft foil we prefer these points to any others. The gold may be prepared either in the form of twisted ropes, or of firm pellets of graduated sizes; if ropes are selected, the middle or one end of the rope is carried down to the bottom of the cavity by using the side of the instrument, and pushed up against one side of the cavity; successive portions are tucked in, taking care to preserve some parallelism of the layers which pass from the bottom of the orifice of the cavity, and the portions tucked in by each application of the instrument should be of such length that a slight excess protrudes from the cavity. As soon as there comes to be some little quantity of gold in the cavity, the sharp point of the plugger is used to force the gold into the undercuts, but the surface of the plug is hardly touched till no more gold can be introduced. When the cavity is nearly full, small pieces of tape, or tight little pledgets are used, and when no more can be got in, the surface is condensed with a broad-faced plugger with a flat or a globular end, and then the whole surface severely tried over with a smaller sharp point. If the operation has been skilfully performed the cavity is now filled with layers of foil generally parallel with one another and perpendicular to the surface of the plug, carried in by the sides of the sharp wedges, and, when in, consolidated towards the walls by the applications of

FIG. 156.—Pointed plugger of the form used by Dr. Lord.

FIG. 157. — Serrated plugger, used for condensation, and also for packing annealed foil. Dr. Lord's form.

FIG. 158. — Sharp-pointed plugger. Dr. Dunning's form.

the sharp points; such a plug will finish to have almost the appearance of cohesive gold, but of course some degree of strength is needed in the walls of the cavity, which must be of some depth in proportion to its surface. Instead of a rope, somewhat firmly folded pledgets might have been used, smaller ones being packed in as the filling approaches completion. A method by which a perfectly satisfactory plug may often be made with non-adhesive foil, consists in folding the sheet into a long, flat riband of suitable width, and cutting it into narrow strips. These strips, which should be rather more than twice as long as the cavity is deep, are successively picked up by a blunt-pointed plugger, so that they are arranged on its point like a star; or the strips may be so arranged on a thick piece of vulcanised caoutchouc, and picked up by pressing the point of the instrument on the centre of the star.

In this form the strips are carried to the cavity and pressed in, leaving the radii of the star projecting; a second and a third star are taken up in a similar manner, and forced into the cavity. When the centre has become full, the projecting ends or radii may be forced in near, but not at the circumference, by the use of a fine-pointed instrument. If the instruments have been well chosen with respect to a gradual

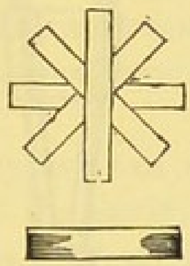


FIG. 159.—Strips of folded foil arranged in star shape, ready to be picked up by the instrument.

diminution of size, an extremely dense plug will be the result.

In former days, when cohesive foil was less used than it is now, this was a very favourite method for filling small cavities, and many most serviceable fillings were thus made, though it has now fallen out of fashion.

The Americans were the first to propose the formation of the foil into cylinders; these cylinders may be made in two ways, the one by loosely folding the sheet three or four times and then twisting it into a rope, from which short lengths are cut off; the other, by closely folding it into a flat riband, and rolling the riband round a fine broach, or what is better, an instrument made for the purpose. The cylinders produced by the first method are soft and very compressible; those by the last, much less so, the respective advantages of the two forms being dependent on the nature of the cavity.

The cylinders are made a little longer than the depth of the cavity which they are intended to fill, and are introduced by plugging forceps. (See Fig. 168.)

There are, however, so many and various styles of cylinders now to be bought ready made, that it will seldom happen that the operator will make his own. The fault that most of the ready-made cylinders have is that they contain too little gold,

FIG. 160.

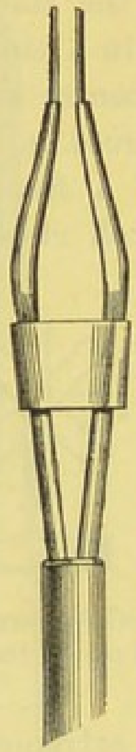


FIG. 161.—Instrument for rolling the foil into cylinders. The sheet is cut into two, and folded on itself till the resulting riband is somewhat wider than the cavity is deep ; it is seized close to one end between the thin points of the instrument, which are closed by pushing up the sliding ring. When a sufficient length has been rolled up, the riband is cut off, and the cylinder released by very slightly drawing back the sliding ring. It is convenient to make a stock of cylinders of convenient sizes, keeping them in a bottle until required for use.

and are not, therefore, dense enough for their size. The whole advantage, or almost the whole advantage, of employing cylinders at all lies in the fact that the layers of foil being all parallel, a larger quantity can be inserted at once without fear of failure of condensation than when other forms of gold are employed. But if there is very little gold in each cylinder, a great part of this advantage of rapidity of completion of the operation is lost.

Every cylinder is placed in such a position that one end rests on the bottom whilst the other projects from the orifice of the cavity; thus, if the cavity be on the grinding surface, each cylinder will stand vertically, but if it be interstitial, every cylinder will lie horizontally. As it has been happily expressed, the cylinders are placed in the cavity like cigars in a tumbler.

Two methods may be pursued in their introduction into the cavity: a number of the tightly-rolled cylinders may be set upright in the cavity till it is loosely filled by them; a wedge or trocar-shaped instrument is then forced in between them at any point where it can be made to enter, and the holes thus produced filled by fresh cylinders. At the last, when only small perforations can be made, it will be found easier to fill these up by the use of stars of gold foil, or of adhesive gold, the heavy numbers of foil answering this purpose admirably. The last small perforation may even be closed by a short length of actual wire driven in.

Or, to begin with, a cylinder of such a size that it will only just enter the orifice of the cavity is placed in it, care being taken to avoid pressing it, lest it become condensed before it has reached its place: this cylinder is then forced against one wall of the cavity by the use of a foot-shaped plugger or by one of those figured on p. 344, and malleted, if the mallet be used; other cylinders are then placed in the space so made, and similarly condensed against the walls of the cavity and the gold already introduced, the filling being, as in the first method, finished by making perforations in the centre and filling these up.

As the foil, rolled up into cylinders, is already closely pressed together, great care must be taken not to render the cylinders hard, unmanageable lumps, by compressing them against the edges of the cavity during their introduction, or by incautious touches of an instrument. The cylinder should be carried to its place perfectly soft, and there condensed by pressure applied to its sides, and not till afterwards to its ends.

The great point to attend to is to apply all the force to the sides of the cylinders; we are then compressing together parallel layers of foil, and can succeed in making an extremely solid plug, whereas if we attempt to condense them by compressing their ends, they at once become knotty and hard. Of course, when the utmost solidity attainable has been produced by force applied to the sides of the cylinders, whether by wedging or by the use of foot-shaped pluggers, then the surface of the plug must be condensed; but if the preceding directions have been followed, very little impression can be made upon it.

When, from the shape of the cavity, it is likely that the first portion of gold introduced would roll about, the softer cylinders loosely rolled are the most convenient to commence with, changing to the firmer ones when the first pieces are well fixed. By introducing the foil rolled up into cylinders, the layers all run from the orifice to the bottom of the cavity, instead of lying in any chance direction, so that it is quite impossible for fragments to peel off the surface of the plug: moreover, the foil, being arranged in parallel layers, is readily condensed by a force applied in the proper direction, so that far larger quantities of foil may be safely introduced in a single piece than by any other method. Hence for large cavities with strong walls the method of cylinder-filling is the most expeditious, and, probably, the most certain in its results. Of course, the softer the quality of the foil, the easier the operation: with a hard harsh foil, very unsatisfactory results would be got by using cylinders.

Cohesive Gold.—Hitherto the methods of filling described have depended on "packing," or the pieces being wedged in so that they cannot escape, though they remain individually separate, and on breaking the tooth might be parted from one another. But there is a property of gold, as far as we know, accidentally discovered, which enables us to fill cavities where some of the walls are defective; this is the capability of pure gold of welding into a solid mass under pressure. In filling a cavity with foil in which this cohesive property has been developed to its fullest extent, a very different manner of procedure is a necessity. Perforating with a large wedge-shaped instrument is inadmissible: were it attempted the result would be that the gold would become hard just round the instrument, and nowhere else. Hence each small fragment has to be thoroughly consolidated as it is introduced. The first step is to thoroughly fix a mass of foil at some part of the cavity; this may be done by drilling a small hole at some point, and wedging a small portion of foil into it, but more commonly it is possible to securely fix a ball of non-cohesive foil against some part of the cavity; or, by using a second instrument in the left hand, the first piece of gold may, in difficult cases, be retained in position until it is fixed by being thoroughly condensed.

But before proceeding to the description of the use of cohesive foil, mention may be made of another method of introducing the gold which has attracted a good deal of attention, viz., that proposed by Dr. Herbst. It consists in the moulding of the gold, best used in the form of soft cylinders, to the walls of the cavity by means of rapidly rotating burnishers. When thus introduced the adaptation of the gold to the walls of the cavity is beautifully close, and the fillings stand the ink-test perfectly; considering the extraordinary difficulty of making watertight fillings with cohesive gold, the writer was much struck with the complete success in this respect of even his earliest experiments with the method. And if the tooth be cracked open, the surface of the gold against the walls will be found to present a dense burnished surface quite unlike that obtainable by any of the ordinary modes of packing, so that for the lining of the cavity it presents great and obvious advantages.

Although the surface of the gold already introduced is always burnished, fresh portions adhere without difficulty, the gold which is soft or but very slightly annealed acquiring some degree of cohesiveness during the process. The resultant fillings, although of less specific gravity than malleted plugs, are yet of sufficient density for anything save contouring, and Dr. Herbst claims that even this may be quite safely done by the rotation method. It is essential that the gold employed be very soft, and yet capable of readily becoming cohesive, and these requirements are admirably fulfilled by the gold supplied by Wolrab, of Bremen.

If it is desired to complete the whole filling by the rotation method, it is well to carry the edge of a matrix a good deal higher than usual, else so much difficulty will be experienced with getting the last portion to cohere, that all the advantages of the method will disappear. Although it is often possible to make use of the rotation method in open and accessible cavities, yet its advantages in the way of easy and rapid manipulation are chiefly found in interstitial cavities, and with a matrix carefully adjusted. Large loose cylinders are packed into the cavity until it will hold no more without condensation, and then a large burnisher slowly revolving is plunged into the middle and then towards each side. When the first portions are thus fixed, a blunt cone point is taken and worked against the matrix and into the undercuts; the process is repeated till the cavity is nearly full, when it is completed with cylinders slightly annealed, or by the abandonment of the rotation method in favour of the mallet. In the earlier stages of the filling, the soft foil becomes slightly cohesive under the burnisher, perhaps from the heat developed by the friction; at all events, at starting, soft large pellets may be used, their cohesiveness only becoming developed as they become partly condensed.

One of the drawbacks of the process is that the instruments themselves become gilded, and as soon as this has taken place they will not work properly till they have been cleaned on a stone or upon fine emery paper, for if this be not done the gold coheres so strongly to the instrument, that it is ripped off by it in small fragments. It has been proposed to overcome this difficulty by the use of agate points, but though these are free from the fault indicated, they are difficult to make on a sufficiently small scale, and can hardly be got to run true. Bloodstone points have recently been produced which are superior to anything else in the market.

In the early stages of the operation, round burnishers, used either in the engine or by hand rotation, are employed; then, as it becomes desirable to develop a greater degree of cohesiveness, roof-shaped points are substituted, and revolved very rapidly. Under their use the surface speedily becomes highly cohesive, and successive portions are built on.

Great things were expected from the Herbst method when it was first introduced, but it has hardly fulfilled its promise, and is not now very largely adopted. Hand burnishers have, for the early stages of the work, superseded the engine burnishers, and disappointment in the use of the process for the entire completion of fillings has led to its points of real value being overlooked. As has already been mentioned, by its means a beauty of adaptation to the wall of the cavity, rarely attained by other means, is easily got; and there can be no doubt that a soft gold burnished against walls is the very best way of securing complete adaptation.

Hence it is an excellent method of commencing those fillings, which, from the shape of the cavity, do not need the strongest cohesion between every part of the gold, and this part of such fillings can be often advantageously done by the use of ball-headed hand burnishers, or engine burnishers if preferred.

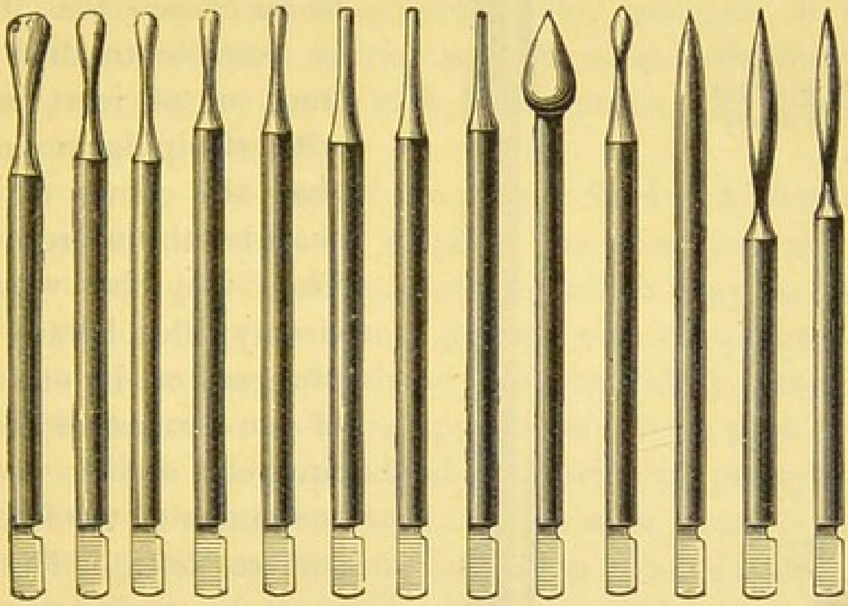


FIG. 162.—Burnishers of the forms approved by Dr. Herbst.

But the cavity once lined and diminished in size, the rest can be filled as expeditiously, and perhaps more solidly, with cohesive gold employed in one of the ordinary methods.

In the working of cohesive gold it is absolutely essential that no piece of gold once at all condensed shall again shift: to secure this end retaining pits may be drilled, not so much for the sake of holding the filling when completed in place, as to anchor securely the first fragments.

As has already been intimated, the whole cavity should, if possible, be so shaped that it will retain the filling quite independently of retaining pits; but in difficult cavities this is not always feasible, and in any case certain precautions should be observed in forming the retaining pits. They should be drilled with a very sharp square-ended drill just inside and more or less parallel with the enamel, and, if possible, their direction should be such that, as they are deepened, they do not approach any nearer to the pulp; that is to say, that the point at which they start should be so chosen that it shall be possible to drill away from, or at least parallel with, the pulp surface, so that the point of entry shall be the nearest to it. They may be very efficiently filled by any small plugger or by one made of an excavator broken squarely across, and the roughness of the fractured surface left. The gold must be made as solid as it can be, and thin strips either of heavy foil, or of folded lighter foils, will be found the most convenient. The subsequent steps of the operation may often be advantageously performed with foot-shaped pluggers.

Another mode of giving support to filling in teeth of which the walls are largely destroyed, is the insertion of a post, or several posts, fixed into holes drilled into the dentine.

FIG. 163.—Foot-shaped plugger. Dr. Varney's form.

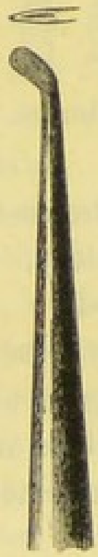


FIG. 164. — Dr. Lord's form of hand-plugger.

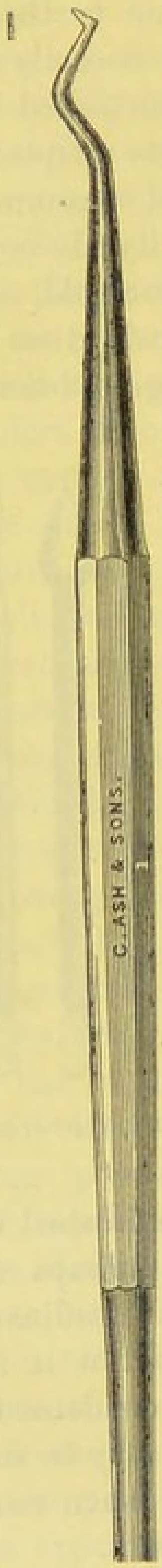


FIG. 165.—From Dr. Redman's set of pluggers.

These posts may be little gold screws, which are screwed into holes previously tapped in the dentine, though it must be remembered that the dentine is not a first-rate material in which to form a fine screw thread; or they may be simply jammed into holes which they tightly fit, their function being mainly to resist lateral shifting of the filling; or again, they may be anchored into the empty pulp cavity or the enlarged root canals by plastic cements which are allowed to get quite hard before proceeding with the body of the filling. In the restoration of very badly decayed teeth they will be found to be of great advantage, and many operations are rendered practicable by their aid which would otherwise be barely feasible. They are useful alike for gold, amalgam or white plastic fillings, but much caution must be used in drilling holes for their reception in teeth with living pulps, lest this organ become seriously irritated.

When once the first part of the plug is fixed and thoroughly consolidated, the subsequent steps of the operation are comparatively easy: small portions of foil, which may be loosely rolled, or simply torn, are firmly pressed with the point of the instrument upon the gold already in the cavity, care being taken that the instrument is applied to every part of the surface, and that the gold added is distributed pretty evenly over that upon which it is placed. Piece after piece is added, each one being thoroughly consolidated on the gold already in the cavity before any more is added, until the plug projects slightly from the orifice of the cavity. In applying the gold, it should be pressed against the wall of the cavity as well as on to the rest of the plug, else minute fissures are apt to be left. Now, if the foil has been good, and the operation carefully performed, we shall not have a plug made up of a series of small masses, and retained together by the walls of the cavity; but we shall have a solid mass of gold, which, if the tooth be broken, will form a cast of the cavity from which it has been liberated.

Difficulties in the use of adhesive foil may arise from the gold already in the cavity having been insufficiently consolidated, and so yielding before the instrument and the superadded layer, instead of affording an unyielding surface against which the latter may be welded; or the failure may arise from the surface of the gold being soiled, or wetted by saliva, the condensation of the breath, or condensation from the atmosphere. If the gold does not adhere readily it should be annealed, either in the sheet, or by passing each fragment through the flame of a spirit lamp; with the heavy foils the latter course is preferable.

If gold be annealed by passing it through the flame of a spirit lamp, the wick must be clean and the spirit sufficiently pure to give off no carbon: the least trace of dirt or carbon deposited on the gold will spoil its cohesive working qualities. The best methylated spirit does not deposit carbon in burning, but it is no doubt better to use rectified spirit.

Many prefer to anneal gold on a sheet of mica or platinum, and for sponge or crystal gold it is essential that some such method be employed. Perhaps the most perfect device is the Electric Annealer, which has the additional advantage of preventing all risk of over-annealing.

Either sponge gold, cylinders, or foil will exhibit the maximum degree of cohesiveness when heated momentarily up to a dull red, though this supreme effect is seldom desirable, except for building out a contour or finishing the surface of a filling. Slightly heated gold works with far greater ease and softness than that which is fully annealed; consequently as a general rule it is advisable to commence a filling with unannealed, or very slightly annealed, gold, and to gradually bring out the cohesive properties of the metal as the work progresses towards completion. Very heavy foils, which may be rolled in the place of being beaten out, are remarkably adhesive; the manner of using them does not differ in any material particular from that just described, save that they should be cut into pieces nearly the size of the cavity, as it is difficult to fold them: by having pieces of a suitable size, each piece is laid on flat, and forms a complete layer in itself. The very heavy numbers, such as 140, are not easily condensed without the use of some form of mallet; still, with care, and in a suitable position, very dense plugs may be made by hand pressure alone.

Although the very heavy foils will probably never have more than a limited applicability, such numbers as 20 are exceedingly useful, and in large cavities, where it is necessary or desirable to commence the use of an adhesive gold early in the procedure, they are very valuable.

Wherever cohesive gold is employed, each successive piece should be laid on as flat as possible, and no attempt made to crumple it up into deep holes, as though it were non-cohesive; and the best cohesion will be gained by using a moderate-sized point at first, afterwards exchanging it for one somewhat smaller; and this applies with double force to the use of heavy foils.

It must not be supposed that in the formation of a plug any one of the methods which have just been described in general terms is necessarily adhered to from beginning to end. Thus, for example, it is very often exceedingly inconvenient to commence a filling with cohesive foil: on the other hand, it is often a great convenience to finish the surface of a plug constructed of non-cohesive gold with additions of gold used cohesively.

In using cohesive gold there is perhaps rather more risk of the gold rolling away from the edges of the cavity, and so leaving minute fissures, than when non-cohesive gold is employed; hence we sometimes see beautiful hard, solid fillings failing, and comparatively soft fillings succeeding, simply because the gold is in the latter case better applied to the edges. On a cohesive filling, properly consolidated, the burnisher can do comparatively little in securing good contact round the edges, but in a soft-foil plug, however firmly it may have been condensed, the edge may be efficiently burnished down.

At the risk of recapitulation, attention may once more be called to the experiments made some years ago by Mr. Fletcher, and by Mr. Ewbank and myself. We all found that it was a matter of the most extreme difficulty to make truly water-tight plugs with cohesive foils, and Mr. Ewbank and I found that we could only do so by using very small portions of gold at a time with the most extreme care. While therefore cohesive plugs look far better, at all events after a little wear, and can be made in places where soft-foil fillings are hardly possible, yet it must be remembered that there is a liability to invisible imperfections that does not pertain, at all events in the same degree, to soft foil.

So far it has been assumed that the consolidation of the gold has been effected by the use of hand pressure; but there are few operators who do not make use of malleting in some form or other, though the extent to which it is resorted to will vary with every individual. A greater degree of solidity will be conferred upon soft-foil fillings, whether cylinder fillings or others, by the use of a mallet; but it is in cohesive fillings that its employment becomes in the majority of cases all but essential.

Reference is made to the use of the mallet by Koeker ("Prin. Den. Surg.," 1826), and it was used by Dr. Hoffman, of Margate, about 1846, but it is to our American *confrères* that its reintroduction into every-day practice is due. In its simplest form the dental mallet consists of a hammer, a very good form consisting of a head of lead enclosed in a cylinder of German silver, with a handle about eight inches long. Steel heads of varying weight, wooden heads, etc., are preferred by some. But this actual hammer is only well adapted to the needs of those who employ an assistant to mallet for them, and hence a variety of automatic mallets have been devised. Several of these repeat, in the form of a blow, the force which has already been put upon the filling in the form of pressure; but this is no real objection to their efficacy, inasmuch as the same force, applied in the form of a blow, is far more effective than in the form of a steady push. Of this class Salmon's, or Snow and Lewis's, are the favourite forms, but Kirby's is also very good.

All these mallets give a somewhat slow, heavy blow, more or less resembling that of an actual hammer, and we regard one or other of them as almost indispensable.

A spring mallet, giving a very direct blow without antecedent pressure, was invented by Sir John Tomes, but this, though at the time of its introduction an admirable instrument, has been superseded by the forms already alluded to.

From these we may pass to the consideration of those which give very rapid blows, a linking form being the pneumatic mallet also invented by Mr. A. S. Kirby. In this the blow is given by a puff of air acting upon a freely moving piston of some weight, the puff being given by the pressure of the foot upon an india-rubber ball. This is an exceedingly good instrument, and was in extensive use; it has more in common with the automatic mallets previously described than with those which are to follow, but appears to have fallen out of favour.

Several forms of mallets have been contrived which convert the rotary motion of the dental engine into a succession of blows, the traverse of the point being short, and great rapidity of blow being obtained; of these, Power's is one of the best. These rapid short taps are only well suited to the packing of

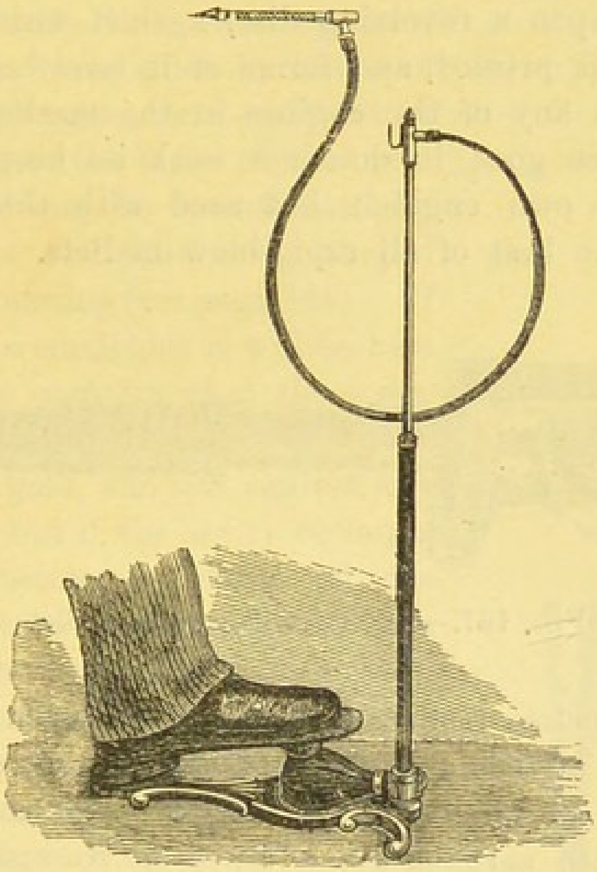


FIG. 166.—Kirby's pneumatic mallet.

cohesive foil, and for a long time the electric mallet took the first place amongst those which give this character of blow.

The electric mallet now used owes most of its good points to the great mechanical ingenuity of Dr. Bonwill. With the mallet in thorough adjustment, the battery at its full strength, and all conditions favourable, it is a nearly perfect tool, and is admirably adapted for the packing of strips of cohesive foil, of a thickness of "20," or even up to "60"; for its effective use it is absolutely necessary that the first pieces of gold should be very secure, or it will shake them loose, hence those who employ it generally start from a strong retaining point.

Dr Bonwill has, however, discarded the child of his own brain, and has invented an engine mallet, which he uses to the entire exclusion of the electric mallet, and he predicts that it will drive its rival altogether out of the field, as indeed it has already done to a very large extent, many of the most enthusiastic workers with the electric having transferred their allegiance to it.

It is very simple, the blow being given by a slight steel prominence upon a revolving disc, against which the end of the plugger is pressed, and forms of it have been introduced to work with any of the engines in the market. So far as our experience goes, it does not work its best except upon Dr. Bonwill's own engine; but used with this it is, upon the whole, the best of all rapid-blow mallets.

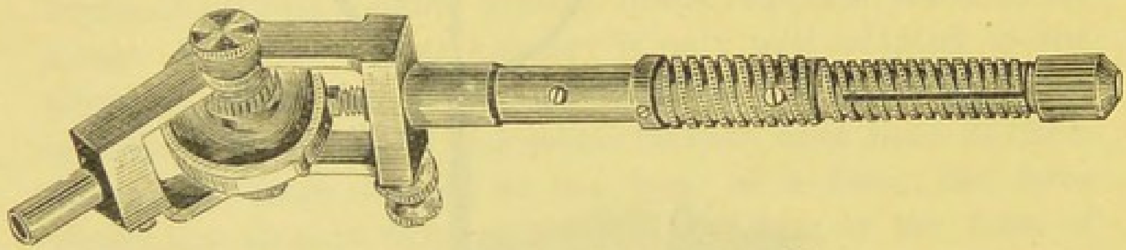


FIG. 167.—Dr. Bonwill's engine mallet.

It is a hopeless task to endeavour to teach much about the filling of teeth with gold by description in any moderate compass, and we shall therefore only attempt to give general principles, with perhaps a few hints as to manipulation in special cases. As the simplest, a crown cavity of moderate size in a strong molar tooth may be selected; we will suppose the caries to have been removed, all overhanging portions of enamel cut away with enamel chisels, or with a bur in the engine, and all deep undercuts got rid of, the interior of the cavity being only in the smallest degree larger than its orifice, so that it is almost cylindrical. If caries has extended into the fissures they of course have been opened up.

We have next to make choice of the method to be adopted, and for such a place almost all the methods already alluded to are available; it is a cavity eminently well suited for cylinder filling, so we will first take that. Choice having been made of the napkin, rubber, or clamp with the saliva pump, cylinders are placed in the cavity by means of plugging forceps, like cigars in a tumbler, and it may be mentioned that it is quite a waste of time to use very soft cylinders containing but little gold ; Ash's style C, or the hardest of Williams's or Hood and Reynolds's are well suited to the purpose in hand. The cavity being loosely filled with cylinders of such length that their ends project a little beyond the edge, they are consolidated towards the walls by pressure put upon their sides by means of foot-shaped pluggers, and malleted or not, according to the taste of the operator; or they may be consolidated by hand pressure with the wedge-shaped pluggers of Dunning (see page 344). If the cavity be a small one, it will be best so to arrange matters that the space got by their compression shall be in the centre of the gold, and not against any of the walls ; but if the cavity be large, it will be better to drive all the cylinders up towards one side, and then insert into the space still left a fresh charge. When by the repetition of this proceeding the hole is nearly filled up, the spaces must be formed in the middle of the gold, as in the case of the small cavity.

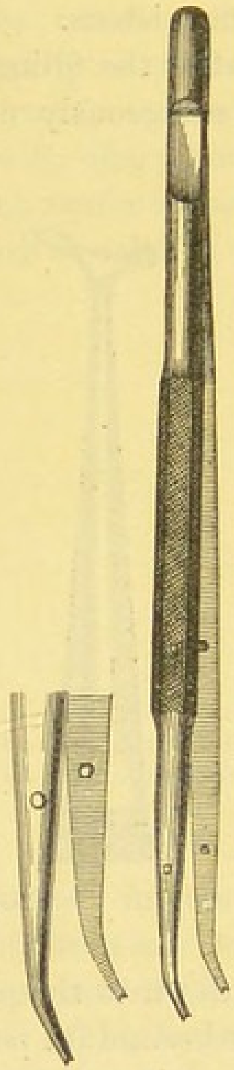


FIG. 168. — Plugging forceps. They may advantageously have larger and more expanded handles.

The compression of the gold towards the walls may sometimes be effected by driving into the midst of the gold a point shaped like that of a trocar. The effect of this will be to drive the gold outwards against the walls with great force, and it is therefore an unsafe proceeding in a tooth much weakened by caries. The hole thus made may be filled with pellets or strips, or with a little cohesive foil, of which the last is to be preferred.

Now for the first time the ends of the cylinders, which will project a little beyond the level of the edges of the cavity, are to be condensed, and when they can be no more condensed, and the solidity of the plug has been tested by trial with a fine point, it is to be burnished.

As a general rule we prefer the handles of condensers and burnishers to be large and rounded, so as to lie in the palm of the hand. On this page are a few ordinary forms of burnishers.

After the filling has been burnished, which may sometimes be advantageously done by an engine burnisher, the surface is

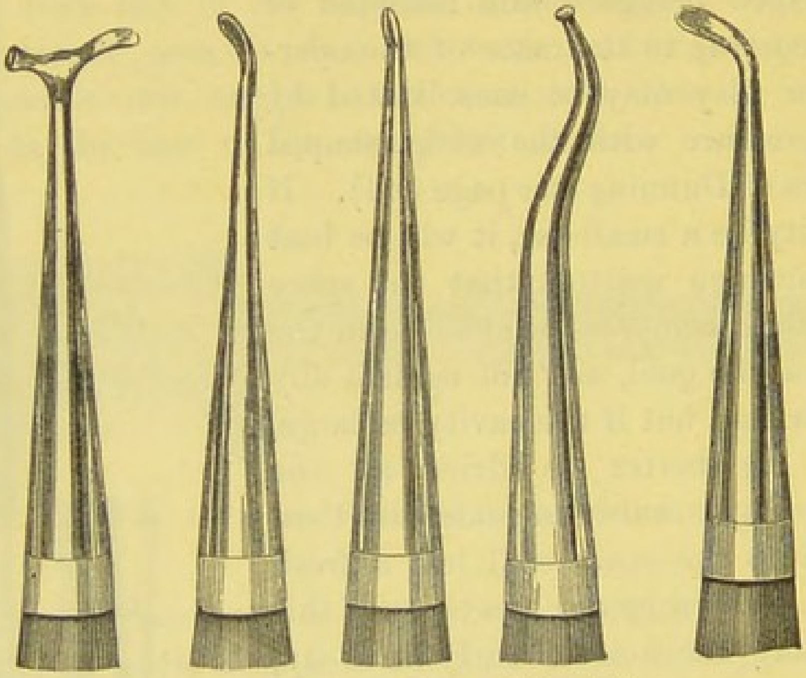


FIG. 169.—Various forms of burnishers.

cut down to the proper level by a plug finishing bur, then by a carborundum point, and lastly finished with pumice.

A plug so executed is likely to preserve the tooth for a very long period. The margins of the cavity are everywhere in contact with soft foil, which is arranged in parallel layers perpendicular to the surface, whereby the greatest resistance to wear is secured, at the same time that the adaptability of soft foil renders it likely that the plug will be water-tight. At the centre of the plug will be a portion of cohesive foil, which will still better resist the attrition of mastication. Moreover, the whole process can be carried through with considerable rapidity.

When the edges of the cavity are formed by soft foil, the free and forcible application of the burnisher will be of great use, but it is of little use where cohesive foil is against the edges, as the portions of this being unable to move upon one another, it can effect but little good, and the finish must be wholly got by carborundum, pumice, and the like.

A cavity of the class just described may be filled equally well, but with hardly the same rapidity, by using a firmly rolled rope of soft foil, so folding it into the cavity in successive folds that the layers shall for the most part run from the floor to the orifice, or by means of pellets used with sharp-pointed pluggers ; but if soft foil is to be used we much prefer cylinders, both for greater rapidity and greater assurance of solidity.

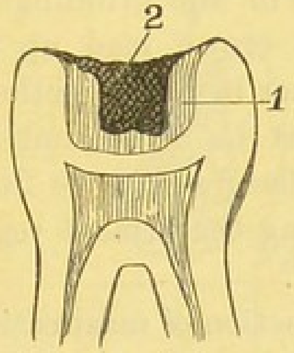


FIG. 170.—Diagram of a composite soft and cohesive foil filling in a molar tooth (grinding surface). 1, represents the soft ; 2, the cohesive foil.

It may also be filled with cohesive foil in strips ; in this case the start may be made from a retaining point, from any corner into which the first piece may be wedged, or sometimes from a mass of crystal gold impacted upon the floor. This last is by no means a bad way of getting a cohesive foundation upon which to build in a simple crown cavity.

If a cavity when excavated extends down to the cervical margin of the tooth, involves the greater part of the interstitial surface, and extends so nearly up to the grinding surface that there is but little besides enamel at this point, it would be very difficult to fill solidly underneath this, and when done it would be likely to give way under mastication, so that it is better to chip this right away with an enamel chisel, and so get a cavity with three walls instead of four, and also get a free and direct access to the whole from the grinding surface.

Care should be taken at the cervical margin that if the termination of the enamel be at all nearly reached, the excavation should be carried well down so as to remove it all, as that last thin edge of enamel is very apt to flake off when any pressure is put upon it in packing the gold. And as the cervical edge is the most probable point of future failure, it requires special attention. No deep groove should be made here, lest it be not solidly filled, but it should be left almost flat, with the smallest amount of undercut; and the immediate edge may with advantage be very slightly chamfered outwards. The edge of the cavity towards the grinding surface will also require a little attention; if it ends with a thick and fairly level rim of enamel it may be left so, but if it approaches near to the pits or grooves of the grinding surface, or any of the natural fissures of the crown lead up to it, then it will be better to carry it further in this direction, and extend it right into the pit, which must be drilled out to form a good anchorage; or similarly the fissure may be deepened and undercut, the object in view being the utmost regularity of edge when the filling is completed.

In such a place the action of mastication will be more trying than in a simple crown cavity, as it will have a tendency to drive the filling out of the cavity instead of into it, as in the previous case, and hence a purely soft-foil filling is less adapted to the requirements of strength. Still, the filling may be commenced and a large proportion of the gold impacted in the soft form, and with this method we will first deal; at the cervical margin three substantial cylinders may be placed, containing a quantity of gold sufficient to make it hold in place when condensed; and this condensation may advantageously be done with some little method, one side cylinder (1 in Fig. 171) being first a little condensed, then 3, and lastly the central one, 2; then returning to the first, that should be fully condensed, then the second, and lastly the middle one. If this order is followed, it will be found that there will be but trifling difficulty in getting the early portion of the gold condensed without rocking. This sort of procedure may be repeated till about half the height of the cavity has been filled, and then it will be time to commence the use of cohesive foil, which can best be started in the centre by wedging a freshly annealed cylinder or other piece of cohesive gold between two cylinders of soft foil. An anchorage thus obtained, the whole of the rest may be completed with cohesive foil, or the use of the two may be gone on with by building cylinders against the walls, at the same time that the central portion is being carried up with annealed foil, also conveniently applied to such position in the form of soft cylinders, which will of course contain far less gold than the outer ones; as the grinding surface is approached the use of the soft foil is altogether abandoned.

This mode may of course be varied in many ways. Tin might have been used at the cervical edge on account of its

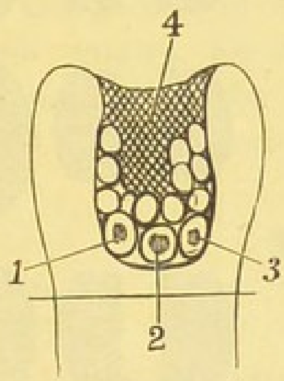
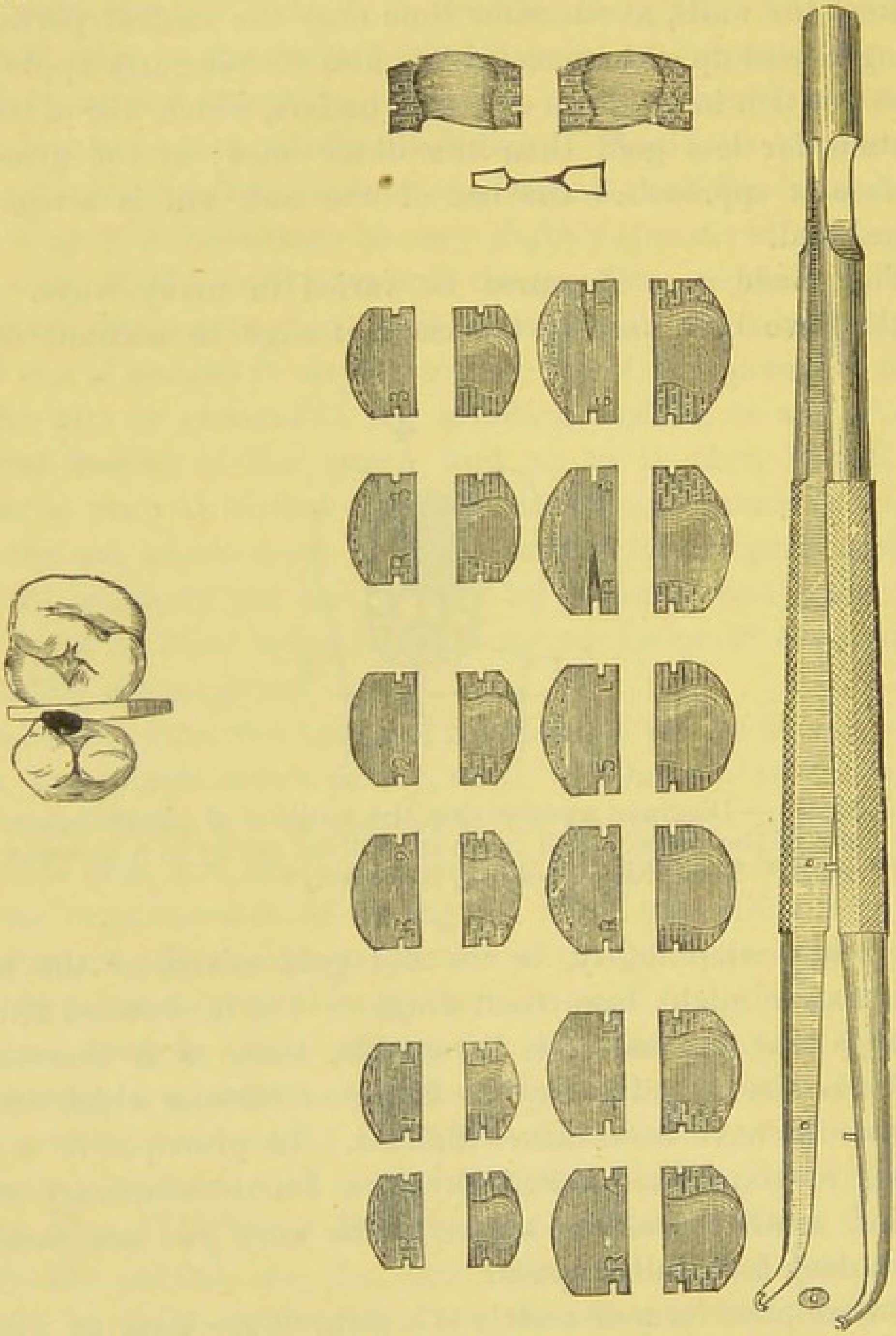


FIG. 171.—Diagram representing the position of the cylinders and of the cohesive foil in an interstitial cavity in a bicuspid tooth. The cohesive gold (4) is shaded.

very ready adaptability, or tin and gold mixed, or the help of a matrix might have been sought. For interstitial fillings of large size the matrix is invaluable, both as a time-saver and as rendering quite easy the filling of cavities which otherwise would have been rather difficult. In principle it is the giving to your three-walled cavity a fourth temporary wall, so that in all the earlier stages of the work you are packing into a deep four-walled space.

The simplest form of matrix is a strip of clock-spring passed between the teeth and wedged up against the one which is being operated upon by means of wooden wedges, or ordinary pins driven in between it and the next tooth. But Dr. Louis Jack has introduced a form of matrix, which is very far superior to this wherever there is a little space; his matrices, of which a figure is given, are hollowed towards the cavity, and highly polished, their other surface being more rough, so as to give a good grip to the wedges; this hollowing of the matrix renders the filling convex, and a little projecting from the cavity, so that a better finish can be given to it.



FIGS. 172 AND 173.—Dr. Jack's matrices.

The disadvantage which is urged against the use of the matrix is, that the cervical margin, the most vulnerable point of the filling, is concealed from view, and this, which is true, has to be met by the adoption of a precise method in the introduction of the first pieces of gold. Dr. Jack folds his gold leaf into a long strip, which is a little narrower than the width of the cavity; this long strip he folds again longitudinally upon itself four or five times, the resultant pieces being about four times the depth of his cavity, and each piece containing about a grain of gold.

The strip is taken in the forceps and, sliding it down the polished face of the matrix, one end is carried into the retaining groove at the cervical margin towards one side; the rest of it is folded in, keeping it only half condensed; then a similar piece is carried down and worked into the opposite corner, and a third down the middle. Great care is taken to keep the instrument well against the surface of the matrix, thoroughly condensing the gold here even before it is fully malleted into the tooth groove, for by this means a good margin is secured. It must never be forgotten that in proportion as you lose sight of the cervical edge, so must you

FIGS. 174 AND 175.—Pluggers suited for use with a matrix.

substitute a step-by-step method, so as to ensure each portion being solid.

The hand mallet or the automatic mallets are well adapted for this stage of the work, and points of a particular bend are almost essential to ensure easily reaching every part of the cavity. When the cavity is half full or more, cohesive foil may be adopted, and if the matrix is at all in the way it can now be removed, but it is usually quite easy to finish without disturbing it. When the matrix is removed there will be only a small amount of surplus gold, and that will be pretty smooth, so that a great deal of time will be saved also in finishing the plug.

In the execution of any of these composite plugs, partly soft and partly cohesive, it must be remembered that there is little cohesion between the two portions, and it is therefore quite necessary that the residual cavity occupied by the cohesive gold, the walls of which will be partly soft foil and partly tooth, shall be of such shape as to firmly retain the gold.

The matrix may be secured by thin wedges of wood, as has already been mentioned, and these will be less likely to slip if they are dipped in gum sandrach, or in copal, prior to being pushed into place; gutta-percha, model composition or sealing-wax may also be used for this purpose, but it is essential that the matrix should be quite steady during the whole operation.

It will also be found to be very serviceable in large amalgam fillings, or in other plastic operations, and space for its application may be often obtained by the use of Perry's separators. Another mode of getting space may here be mentioned. If base-plate gutta-percha be crowded into the cavity and between the teeth, being left a little above the bite, the teeth will in a few days or a week be separated quite painlessly, and if they be left for a much longer period, a very wide space may similarly be gained. For this hint we are indebted to Dr. Bonwill.

An excellent matrix may often be made at the time of use by bending up a thin strip of platinum foil of some thickness, so as to encircle the tooth, its ends overlapping a little, and soldering it together by a little piece of solder in the flame of a Bunsen burner; this is, of course, only available when the tooth stands more or less alone, but it can be made in as little time as it takes to adjust the more complex forms of matrix.

Mr. Brunton has devised an excellent matrix, which consists of a thin band tightened upon the tooth by means of a small screw: the band is so thin that it generally can be got between the teeth, and the appliance is an excellent one.

Another of the more complicated or apparently complicated forms of matrix is that of Mr. Lennox, and this is the one which we prefer. By it very perfect adaptation is readily secured, and the clamping screw, supplied in two patterns, is of very convenient form and but little in the way.

The treatment of caries in the front teeth.—The most common position for caries in the front teeth is upon the surfaces of contact, and therefore these may first be spoken of.

A combination of filling and excision will sometimes suggest

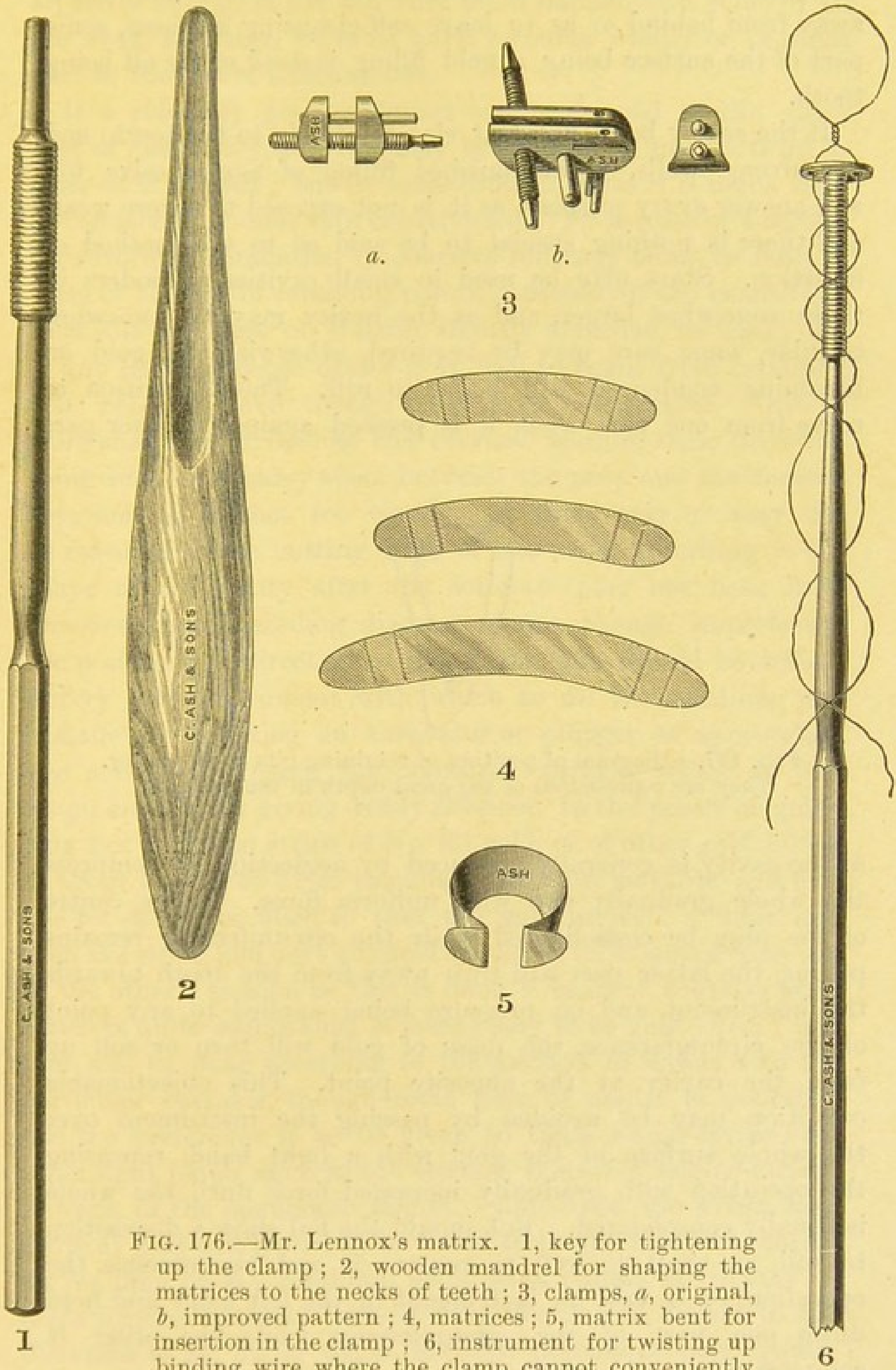


FIG. 176.—Mr. Lennox's matrix. 1, key for tightening up the clamp; 2, wooden mandrel for shaping the matrices to the necks of teeth; 3, clamps, *a*, original, *b*, improved pattern; 4, matrices; 5, matrix bent for insertion in the clamp; 6, instrument for twisting up binding wire where the clamp cannot conveniently be applied.

itself as the best for a particular case, the teeth being sliced away from behind so as to leave self-cleansing surfaces, some part of the surface being a gold filling instead of its all being tooth.

If the cavity be of no great size relatively to the tooth, and has strong walls, a well-finished filling of non-cohesive foil will answer every purpose, as it is not exposed to severe wear, and there is nothing special to be said as to the method of insertion. Stars may be used in small cavities, cylinders in those somewhat larger, and as the cavity may be somewhat circular, some care may be required, otherwise the gold on becoming condensed will begin to roll. The disposition to move from one part when it is pressed against another part

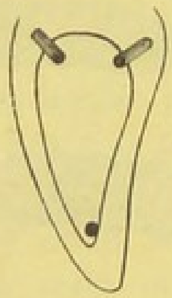


Fig. 177.—Diagram of position of retaining pits in an incisor. They are represented of too great depth in the diagram.

of the cavity is generally produced by neglecting to compress the whole gradually and with uniform force. If the centre of the plug be consolidated while the circumference remains porous, the latter part will turn away from the tooth towards the instrument, and on pressure being applied to any point of the circumference, the mass of gold will turn or roll up from the cavity at the opposite point. This objectionable condition may be avoided by passing the instrument over the whole surface of the gold with a light hand, repeating the operation with gradually increased force until the whole is equally consolidated. But should the foil show a disposition to roll, we shall do well to remove it and recommence the operation, or to take an instrument in the left hand and hold down one part of the circumference while the other is compressed.

So far it has been assumed that the walls of the cavity are all fairly strong, but it will very often happen that some or all are weak, and then we must have recourse wholly or in great part to the use of cohesive foil.

If a tolerably good undercut can be formed in the upper part of the cavity, soft foil may be packed in until a third or more of it is filled; but in more difficult cases it is much safer to commence at once with cohesive foil. By the use of a second instrument a foundation of cohesive foil may often be built in without the use of retaining points, especially if the beautifully workable cylinders of Wolrab, slightly annealed, be used; but in any really difficult cavity it is well to begin from retaining pits, necessary evil though they may be thought. One or more should be drilled at the cervical margin, their direction being such as to carry them between the pulp and the enamel, approaching neither too closely. A third may or may not be required at the cutting edge of the tooth according to the shape of the cavity after the softened part has been fully removed; the preceding diagram shows, though imperfectly, the position and direction in which the pits should be drilled. A very good instrument with which to fill the retaining pits is made by breaking an excavator or plugger of appropriate size across, and using the fractured surface, which is just rough enough for giving ready cohesion to the pieces of gold; long but very thin strips of No. 20 gold, or of other gold folded to about that or to 32 in thickness, are most suitable, and first one pit should be filled so that the gold projects a little, and then the other, and next the gold should be built across from one to the other; so soon as this is done, a basis of cohesive gold, which is quite immovable, is there ready to be built upon; and this will be done according to the method in favour with the particular operator, though some form of mallet is desirable, and the preference is to be given to those which strike very rapid light blows, such as the electric, Bonwill's engine-mallet, Power's, or the pneumatic mallet. And upon the whole, long strips of gold will generally be found to be the most convenient for building upon a retaining point basis; these strips may be made by the operator himself from No. 4 foil, folded to the thickness of 24, 32, or 64, as his own preference may dictate, or heavy foil may be used, such as No. 20, which works very nicely with the electric or with Dr. Bonwill's mallet.

Upon the form in which the gold is used it is not safe to dogmatize, as equally good results may be got with suitable cylinders, or with crystal gold appropriately worked; but this much may be said, that if, after consolidation, the least movement is detected in the gold, it is far safer to take it out and begin again than to attempt to fix it by packing in any additional piece. This can never be safely done with cohesive gold, and but seldom with soft foil, without the greatest risk of a very imperfect result being obtained.

Although it is always very desirable to have space enough between the teeth for a disc or thin file to pass through, in order to finish the filling satisfactorily, there is another method of obtaining access to it without wedging, which, when the cavity is such as to lend itself to this method, is available; this is to enter the cavity from behind by cutting away its posterior wall very freely, down, in fact, to the floor of the cavity in almost its whole extent, and then, relying upon the appropriate shaping of the cervical wall and of the opposite portion, to fill with cohesive foil, soft foil being but little suited to a cavity so shaped, as its lingual surface would be with difficulty made perfect without cohesiveness in the foil employed.

A question which will frequently occur in dealing with interstitial cavities in the front teeth is the extent to which the contour of the tooth, when it has been interfered with by disease or by the necessary preparation of the cavity, shall be restored; an exuberant display of gold in the front of the mouth, giving to the patient what may in too literal a sense be described as a golden smile, must, we think, on æsthetic grounds, be condemned, though it is, maybe, to be preferred to a display of dirty-looking jagged teeth, with worn gutta-percha fillings in them. If white plastic fillings, as we at present know them, be employed, the teeth will, unless the patient is exceedingly assiduous in having the fillings renewed, undergo a gradual deterioration. Much must be left to the judgment of the operator, as well as to the predilections of the patient; though, for our own part, we so dislike the appearance of a glitter of gold every time the mouth is opened, that our tendency in advising a patient would always be against the extensive contouring of front teeth with gold; and it must be recollected that those reasons which render desirable the restoration of contour in the back teeth, which are engaged in the heavy work of mastication, do not apply with equal force to the front teeth, in which there is little tendency for food to be forced down upon the gums, and still less towards its remaining there long.

But it may happen that the labial has been encroached upon by disease, while the lingual surface is comparatively uninjured. In that case the gold may be introduced from the front, leaving the whole of the back part of the tooth standing. By the adoption of this plan, more even of the front of the tooth may be retained than though the firm, strong lingual wall of the cavity had been reduced. For with the three sides of the cavity strong, the fourth may be preserved, although too weak to stand unsupported by the plug, the firmness and the retention of which will be sufficiently secured by the upper, the lower, and the lingual walls of the cavity. In conducting the operation, however, great care must be taken to avoid injuring the weak part; and it will be found expedient to introduce the foil in small portions, making each piece firm before the succeeding one is added.

A difficulty which is frequently met with is the intrusion of the gum into the cervical edge of the cavity, so as to render difficult and very painful the adjustment of the rubber; the excess of gum may be burnt away with a minimum of pain by means of sodium ethylate; or, after two or three paintings with cocaine, violence may be done to it without much if any pain, when it is not desirable to pack it out by means of cotton-wool, which would involve the postponement of the operation to another day. If a jaw from which the soft parts have been removed be examined, it will be seen that a triangular space separates the necks of the teeth, the base being formed by the alveolar process, and the apex of the triangle by the convergence of the mesial and distal surfaces of the contiguous teeth. The interval so produced (Fig. 104) is occupied by the gum, and our object is to prevent its bleeding, and at the same time to move it from the margin of the cavity. To accomplish both purposes we may take a strip of soft wood, such as willow or plane, and cut or file it into a triangular rod. When reduced to a suitable size, introduce it by a steady pressure between the teeth, taking care that the basis of the triangle corresponds to the edge of the alveolar process; by this means the gum will be pressed up against the latter part, the bleeding will be stopped, and the cavity in the tooth fully exposed to view. The introduction of the wood will occasion a little pain at the moment, but it soon gives way to mere uneasiness. When teeth have been gradually separated by caoutchouc, the presence of the wedge tends to keep them steadily fixed, and thereby renders the operation of plugging less painful than it would have been had the teeth remained unsupported. The ends of the wood will, of course, be cut off close to the lingual and labial surfaces of the teeth, and the operation may then be accomplished without interruption.

If, as will usually be the case, the rubber is to be applied, the wedge should be forced in after the rubber is in place: sometimes it will be of a little assistance in forming a matrix for the upper third of the cavity.

A troublesome form of cavity met with frequently upon the front teeth is that which occurs along the margins of the gums; it usually requires a good deal of alteration of form before it is suited for the retention of a plug, having to be deepened at its two extremities, and a groove formed along its upper and lower edges. In filling such places cohesive gold may be employed from the first and a thoroughly good result obtained, but there is often a good deal of difficulty in keeping them dry, and a more expeditious mode is to be found in the use of cylinders, which for this purpose should be very short, so as not to project far beyond the margins of the hole, but at the same time should be very dense and of considerable circumference relatively to the size of the hole. Such are the 15 B cylinders prepared by Williams, and the reasons why large cylinders can be safely employed are several: one that the cavities are always strong-walled, another that they are very accessible, and a third that the regularity and curved form of the margins render it easy to force even a very dense cylinder into water-tight contact with all its parts, while the large amount of gold introduced at once removes, after the insertion of two or three cylinders, all disposition to roll.

The plugs may be finished entirely with soft foil, or, after there remains only a small central place to fill in, cohesive gold in any convenient form may be resorted to; very careful finishing and polishing of all the edges is especially necessary in this class of cavity.

When, owing to the loss of back teeth and to peculiarities of bite, the edges of the front teeth have become worn down to an extent that imperils the pulp, it is sometimes desirable to tip them with gold. The operation calls for no special description, save that it is generally desirable to form a slight groove all round the cavity, as well as to form a retaining pit at each extremity: of course cohesive gold is alone suitable for this work.

Closely allied to the form of decay just alluded to, is that in which we find a narrow groove at the cervical edge of the enamel, deep in the centre, but cropping out to nothing at either end, with walls that diverge outwards; this may vary, from a slit tolerably obviously produced by the tooth-brush to the wide shallow depression attributed to erosion, a condition which nowadays many authors deem to be but a form of attrition. Putting its origin out of the question for the moment, it may or may not be needful to treat it, according to the rapidity with which we believe it to be advancing, and the imminence of its approaching to the pulp cavity.

It must be remembered that no filling material save gold is of much use in such a place, and gold will be very disfiguring; the practice, therefore, of those who cut into shape and fill every spot where this form of mischief is to be detected, as some especially among our American *confrères* do, does not recommend itself, as it is no uncommon thing for the trouble to be stationary, at all events for a long time Where, however, it is so deep as to threaten the pulp, or where any softened tissue lines the depression, there is no choice, and it must be filled.

During recent years porcelain inlays have been brought to such perfection that they are eminently suited for use in these and similar cases.

Bicuspid Teeth.—The treatment of caries in canine teeth, and those upon the grinding surfaces of premolars, may be passed over as not involving any material differences in practice from such as have been already described; but a very large part of the dentist's time will be spent in combating interstitial decay in the premolars, and a few remarks respecting the best methods of procedure are therefore called for. It may be premised that there is much more difficulty in making enduring operations upon these teeth than upon the incisors, partly in that they are more prone to decay, but much more because their shape involves larger surfaces of contact, and their greater function in mastication renders it difficult so to treat them as to get self-cleansing surfaces. To cut them away freely, so as to leave them apart, is not altogether satisfactory; for they are almost sure to close up; whilst to cut the proximal surfaces apart, leaving a shoulder at the gum level, is very apt to leave a dangerous spot at or just beyond the points of contact; so that we are reduced, in a much larger proportion of cases, to the necessity of making contour operations, even though we may not be especially fond of contouring teeth with gold.

And in contouring them it is desirable to leave none of the enamel of the affected tooth in contact with its neighbour, if the cavity be of any considerable size; but so to shape the cavity and the filling that the gold only shall touch the next tooth, or the filling in the next tooth, as the case may be—which will sometimes involve a good deal of alteration in the shape of the natural cavity. It is but seldom, therefore, that it is advisable to enter the cavity from the labial aspect of the tooth, leaving the grinding surface intact, but it will generally be better to cut straight down from the grinding surface.

There is no instrument which answers the purpose better for this stage of the operation than an enamel chisel, the edge of which is formed by grinding off at an appropriate angle the end of a half-round piece of steel of about a quarter of an inch diameter; and the enamel should generally be cut back to the full depth of the cavity, or thereabouts, so that access may be had to all parts of the cavity with a perfectly straight instrument. There will then be a cavity with three walls to deal with; the labial and lingual walls must be cut away till they are quite strong, bearing in mind the point already alluded to as to the ultimate points of contact between the tooth and its neighbour; and unless the grinding surface of the tooth be a very smooth one, with the groove across it but feebly pronounced, it will be best, even though caries do not exist in the groove, to cut it out and make a pit in it, so as to get a better form of edge to the finished filling. If this be not done there will be a fissure upon the grinding surface leading to the junction of the filling with the edge of the enamel, and it will form a very likely place for ultimate failure.

The preparation of the cervical edge will need very particular attention, as here also is a vulnerable point: if it extends down so far as to be close to the end of the enamel, it is safer to extend it quite to the end, so as to avoid leaving a small remnant of enamel, which will very likely split off in impacting the gold against it. Even if it does not extend so far, no deep groove should ever be formed or left at this part; it should be cut square, with only the least trace of an undercut, and many of the most careful operators bevel the immediate edge outwards a little. For the shaping of this part of the cavity the spoon-shaped excavator is most useful, as by it there is less danger of an approach to the pulp than would be the case were its end square. The labial and lingual walls may be slightly undercut, remembering always that the minimum of undercut which will retain the filling will leave the walls strongest, will render the operation easiest, and will minimise the danger of failure to consolidate the gold under the edges. Of course the whole cavity must have such a form that the filling cannot fall out towards the grinding surface of the tooth.

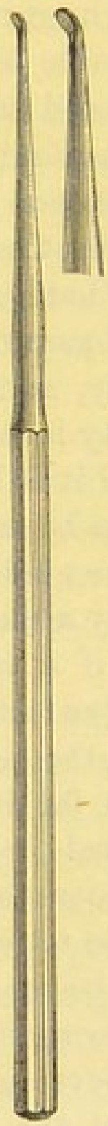


Fig. 178. — Spoon-shaped excavator.

The excavation being complete, we have to make choice of the method of filling to be adopted. We are very prone to the use of a matrix in these teeth, and therefore to the commencement of the filling with soft foil, or even with tin. Cylinders may also be used, either with or without the matrix; but whatever be done with the filling of the first half or two thirds of the plug, it will usually, if the hole be of any considerable size, be advisable to complete the operation with cohesive foil. Heavy foil is very convenient for the completion of the fillings in these situations.

It is always an advantage for the teeth to have been wedged prior to the insertion of the filling, as this enables the filling to be thoroughly polished, and yet when the teeth close up again, leaves the gold in contact with that in the next tooth. When contiguous cavities have to be filled it is a very good plan to put in gutta-percha plugs, making one filling of the two, and if possible leaving the bite slightly upon the gutta-percha. By the end of a few days the teeth will be found to be separated with a minimum of pain and tenderness. Or the requisite separation may be got by the use of Dr. Perry's separators during the excavation of the cavities.

Whatever process be followed in the insertion of the filling, it is of paramount importance to finish the cervical edge very perfectly, and it is even proposed by some to do this when the cavity is only half full, because it is then a little more accessible than it is later on ; but this is rather an ultra-refinement, and it can be very efficiently done after the completion of the insertion of the gold. If a matrix has been employed, and has been nicely adjusted, the cervical edge will want but little trimming, and if it is composed of soft foil that little can be done with greater facility than would be the case were it cohesively worked from the very first.

So far it has been tacitly assumed that the operator had decided upon restoring the contour of the tooth, at least in considerable degree ; but it will sometimes appear to be the best course to leave a space when the operation is finished ; and this may be rendered almost necessary by the weakness of the walls rendering it unlikely that they would be able long to withstand the leverage exercised upon them by a filling projecting far out of the mouth of the cavity. It must be borne in mind that this is one of those things where no compromise is to be entertained.

That is to say, *if there is not to be restoration of contour, let there be real separation, and no half-and-half condition.* Bicuspids so cut away that their sides are perfectly flat and consist partly of polished dentine forming the immediate surrounding of the filling, will often stand exceedingly well. The teeth may then be left so as to be completely isolated from one another, but it must be remembered that their usefulness in mastication will be materially impaired ; for they will have lost a good deal of their masticating surfaces, and, in addition, the gum will not be fully protected against food being packed down upon it. And as food will of necessity get down to the gum, care must be taken that the surfaces are so shaped that it will be easy for the tongue to remove it ; and, with this object, the separation should be a little wider on the lingual aspect than it is upon the labial.

Or the alternative form may be preferred, in which there is a shoulder left at the gum level, to serve the double object of preventing the teeth from closing up together, and to protect the gum. This shoulder requires to be shaped with considerable care, so as to leave but a small area of contact; and the patient must be cautioned to pass floss silk through frequently, so as to keep the spot scrupulously clean.

There is not much to be said as to the details of the operation when the insertion of the gold is commenced by the filling of retaining pits, as the proceeding will not differ in any respect from that which would be followed in the case of incisor teeth; but it may be worth while to say a few words as to the combination of cylinders with a finish of cohesive gold.

It can hardly be too often repeated that, although it is quite possible so to insert highly cohesive foil in such a manner as to be water-tight, yet the difficulties and the pitfalls are such that, in any given case, it is far more likely that success in this direction will attend the use of soft foil, with which it is comparatively easy. Hence the warm advocacy for its use in places where it is not exposed to heavy wear, such as cervical edges ; and cylinders are valuable in this place as being a means of introducing quantities of gold sufficient to steady one another at the same time that the parallelism of their layers ensures the possibility of condensing it uniformly.

Cylinders of such length having been selected that, when placed at the cervical edge with their ends towards the next tooth, they shall project slightly, three or four are placed side by side, so as to bridge across from side to side without any material condensation. That which lies against the one side is then slightly condensed, then that which lies against the opposite side, and lastly, that which lies in the middle; then, returning, condense them fully and mallet them, if the mallet is to be used at all.

By observing such an order in the condensation it will be found that the tendency to roll about is minimised. The mistake into which those little accustomed to the use of cylinders are most likely to fall is the use of cylinders of too small a size, in the fear that they will fail to efficiently condense them. But it is their great merit that they enable us to use large amounts of gold at once, because the gold is all in parallel layers; and to use very small ones is simply to throw away precisely that advantage which induces us to select them. Thus, in an average bicuspid cavity, three, or at most four cylinders should, when introduced at the cervical edge, bridge it across and afford a mass of gold amply sufficient to hold firmly in place. A fresh set of cylinders may be placed in the same manner, and the building of the gold carried up to the point where it is thought better to change to cohesive foil.

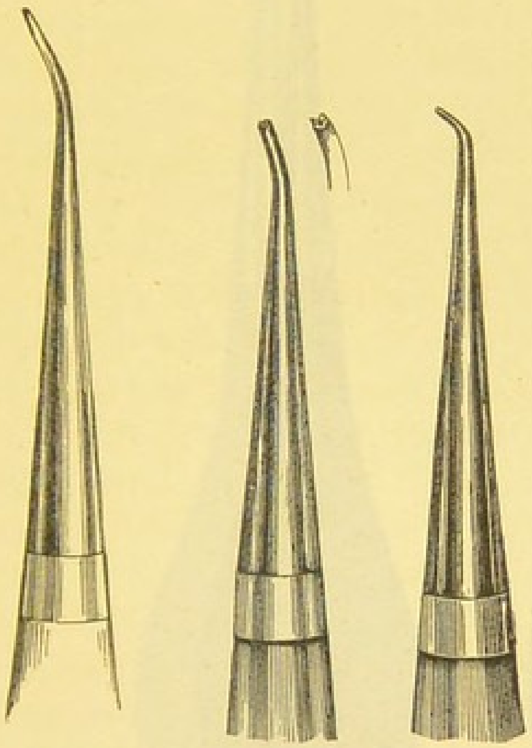
There is a very easy way of doing this; namely, to place, as before, firm cylinders against the lingual and labial walls, but to put in the centre between them a good large softer-rolled cylinder of freshly annealed gold, such as (in a large cavity) a 36 A William cylinder. These all being condensed down together, the result will be that in the middle there is a region of cohesive gold upon which more may be built, and at the sides, forming the contact with the walls, there is soft foil. Successive additions of cylinders at the sides, and of cohesive gold in the middle, are made; the amount of the latter being gradually increased as seen in Fig. 171, until, as the grinding surface is approached, the whole filling is composed of cohesive gold.

Of course every one will vary the precise method in accordance with his own fancy. Thus, the start with cohesive gold might have been made by digging a hole in the soft foil; but the plan described, of gradually including the annealed gold between cylinders of soft gold, will be found a very convenient one.

For the condensation of the first portions of cylinder gold, foot-shaped pluggers will be found the best; and their use may often be continued right through the whole operation; but oftentimes, as the cohesive gold is being introduced, bent pluggers, with square serrated ends, will be advantageous, such as those in Fig. 179.

The cavity having been filled with the gold projecting a little from its mouth, the gold may be gone over with an instrument the round face of which is serrated. This is used with a sort of rolling motion, and will serve to reduce the surface to some degree of evenness; though, of course, it can have but little effect upon the more purely cohesive portions.

Molar Teeth.—In operating upon the upper molar teeth it will be found advantageous to throw the patient's head well



Figs. 179, 180 and 181.—Serrated hand-pluggers.

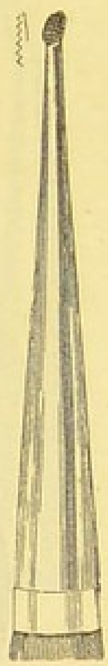


Fig. 182. — Broad-faced condensing instrument.

back, and for the operator to sit down; indeed, there are but few filling operations which cannot be performed with far less fatigue in a sitting posture, and the trifling difficulty which will at first be encountered will disappear with a little perseverance, which will be richly rewarded by the relief gained in a day's work.

The use of the mirror should also be assiduously cultivated, as a large number of cavities cannot be directly viewed except by the assumption of a stooping posture, which is exceedingly trying. When seen in the mirror, which for this purpose should be as large as can be introduced without inconvenience, the whole operation can usually be conducted without the assumption of any constrained attitude.

Simple crown cavities of roundish shape can be rapidly and well filled by ropes or strips of annealed foil inserted with a ball-ended plugger, like a very fine-cut engine-finishing bur; in fact, a slightly worn bur makes a capital instrument for the

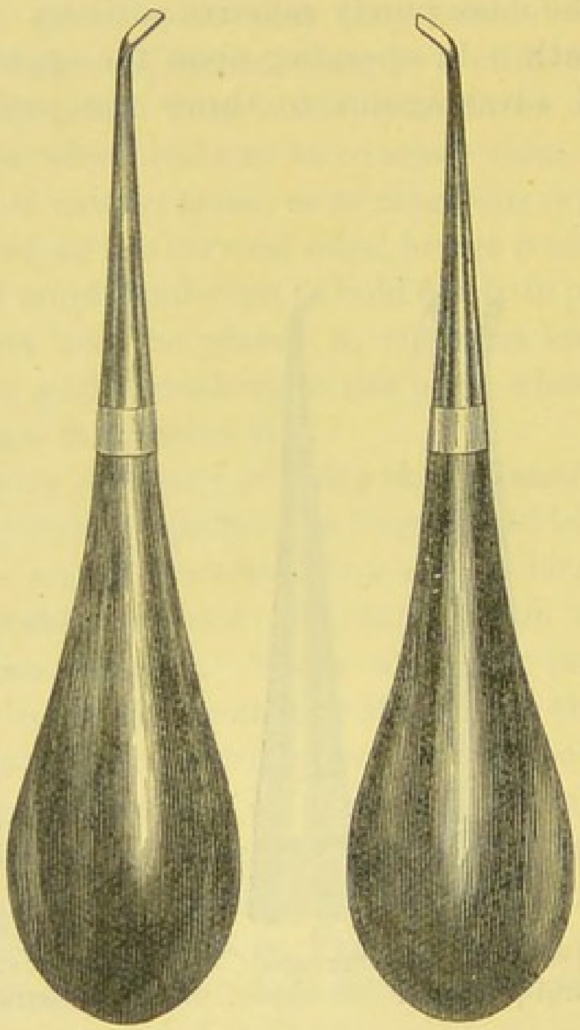


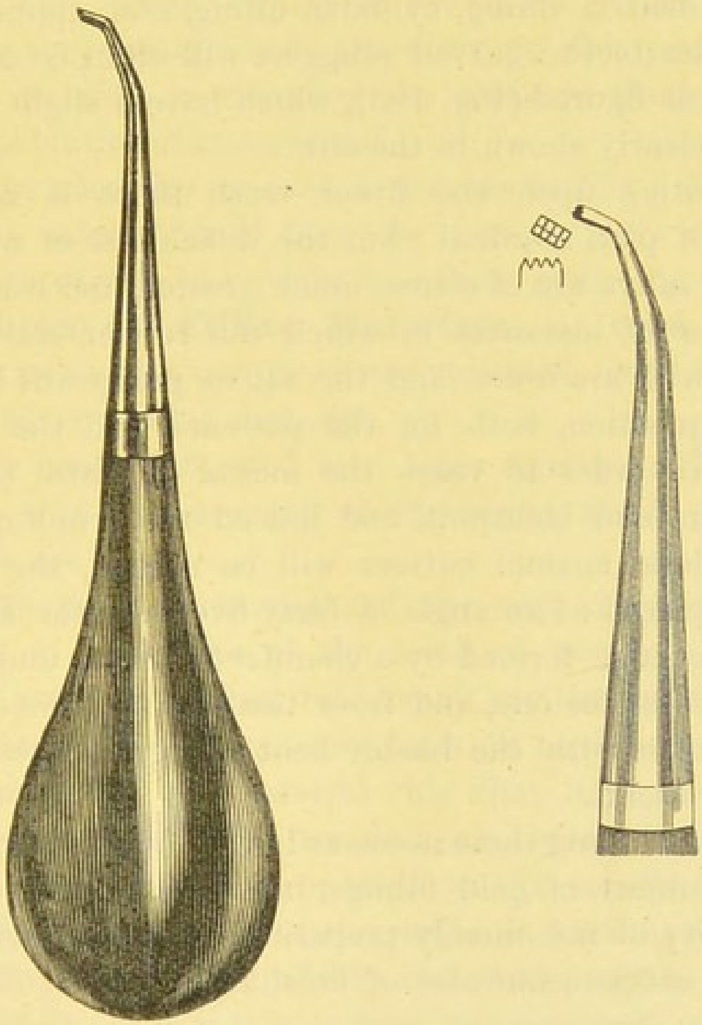
FIG. 183.—Curved hand-pluggers.

purpose, though a pear-shaped one does best, as the shoulder behind a round one tends to pull the gold out in the early stages.

A perfectly smooth point may be used, like the hand-point supplied for the Herbst method, though personally we prefer slight roughness; but, whichever be chosen, it should be of such size as to easily enter the mouth of the cavity (which should not be materially undercut), but at the same time should be large enough to nearly fill it.

The ball-ended plugger is used with a sort of rocking motion, and the rope or strips of foil rapidly packed in; a smaller similar instrument being taken up to complete the filling, and to go over all its edges.

These ball-shaped instruments are also very well adapted for filling in the centres of plugs which have been commenced by



FIGS. 184 AND 185.—Hand-pluggers with a double curve.

packing soft foil, whether in the form of cylinders or otherwise all round the sides of the cavity.

In dealing with interstitial caries in the molars, it will be necessary to use the enamel chisel or burs in the engine pretty freely. It is quite impossible to make a good gold filling in a place which cannot be well seen, and in a very large proportion of cases it will be better to cut straight down from the grinding surface than to attempt to work round corners; and tin at the cervical walls will be of more general avail than in the case of teeth further forward in the mouth, as the dark line which it forms will be of no consequence; for the same reason the combination of tin and gold folded up together will come in very usefully, and its hardening property, the exact nature of which is still not understood, renders it valuable where the strain of heavy mastication has to be met. All that has been said as to matrix filling, cylinder filling, etc., applies equally to the molar teeth; curved pluggers will often be convenient, such as those figured (Fig. 183), which have a slight corkscrew curve not clearly shown in the cut.

In operating upon the lower teeth there is no general difference of plan required; but the difficulties of overcoming the flow of saliva are of course much greater, and consequently the number of instances in which the rubber can safely be dispensed with are fewer, and the saliva pump will be in very general requisition, both for the patient's and the operator's comfort. In order to reach the mesial or distal surfaces of lower molars and bicuspids, and indeed the grinding surfaces of the molars, enamel cutters will be needed, the blades of which are placed at an angle of forty-five with the shafts, and the cutting edge formed by a chamfer from the under-surface of the blade in the one, and from the upper in the other, and enamel cutters with the blades bent at right angles will also prove very useful.

Before concluding these necessarily very fragmentary remarks upon the subject of gold fillings, it is necessary to emphasise the necessity of not merely preparing the cavity and filling it with every caution, but also of finishing down the filling with the greatest care.

The immediate object in filling a tooth is to perfectly exclude from the cavity all extraneous matter, fluid or otherwise, and at the same time to leave a surface upon which mucus or minute particles of food cannot readily adhere. If the surface of the gold be left rough, these indications are not fulfilled; food and other matter will collect, and necessitate the frequent use of the toothpick, which, falling from time to time into the inequalities of the gold, eventually disturbs the filling. There is another advantage resulting from finishing with care the surface of a plug, and it is this: after the outer part has been filed away, and the surface of the plug and the contiguous surface of the tooth reduced to the same level and polished, we may find that the plug is defective at some point. The discovery of a defect having been made, a remedy must be found, even though its application may necessitate the removal of the gold and the recommencement of the operation. For to leave the plug pervious to moisture will be to endanger, if not to ensure, the further injury of the tooth. Unfortunately, the fault is very commonly in the worst possible position, both as regards its effect in exposing the tooth to further disease, and its capabilities of amendment.

Hence the necessity for even extra care in filling the cervical part of the cavity, for if there be a weak place there, it is well-nigh impossible to remedy it without removing the whole.

The Choice of Filling Materials.—It need hardly be said that, unless its use is contra-indicated, gold is still the most satisfactory filling material.

But it is contra-indicated in a large number of cases even where the size and strength of the cavity would apparently allow of its use.

Owing to the greater size and the very markedly greater irritability of the pulps of the teeth of young people, it is unsafe to put gold fillings into many cavities which in adults might be so treated without any fears as to the result; and it may be laid down as a general rule that it is unwise to fill with gold any tooth which has decayed before the entire completion of its development, or when in the mouth of a young patient a large number of teeth are simultaneously and severely attacked by caries, especially by interstitial caries. Death of pulps is apt to ensue if this caution be neglected.

For such cases a good permanent gutta-percha such as Flagg's, or red base-plate, is the best preservative, to be replaced by gold at a later period when the violence of the attack of caries is gone by; as, however, this is quickly worn away when much exposed, the harder but far less durable white plastic fillings may be used.

Where irritability of the pulp is greatly to be feared, the white plastic fillings afford the most complete protection, and should always be used, at any rate as a lining, when the pulp is nearly exposed, in the hope that the latter may undergo some protective calcification and be better able to bear with a metal filling at some later date.

And where extreme fragility of the walls is the difficulty, the phosphates afford the best support: it is sometimes feasible in the front teeth to pack gold against the cervical edge of such cavities, even where it is impossible to get sufficient anchorage to ensure the retention of an entire gold filling; then by filling the remainder of the cavity with zinc oxychloride or phosphate it is secured in its place. In several instances we have known such fillings to last much beyond the average duration of osteoplastic fillings, though, of course, they are at best but a "dernier ressort." To finish such a plug effectually the zinc salt must be allowed to set, and the stopping filed and burnished on another day.

Similarly gutta-percha may be employed at the vulnerable cervical edge, and the rest of the filling completed with plastic white fillings; and, where its colour does not render it objectionable, that form of gutta-percha which is prepared for base plate will be found to endure better than the white gutta-percha. It is more troublesome to manipulate, but, although it is softer, it is much less friable, and preserves in the mouth a surface almost polished.

It is a very good plan to line all very large and deep cavities with phosphate cement, especially if a little oil of cloves or thymol be incorporated with the fluid before mixing, even when it is intended to insert a gold or amalgam filling, as it is a good non-conductor, is water-tight, and diminishes the size of the cavity, but of course it must in such a case nowhere be exposed on the surface.

It is unfortunately the case that some of the amalgams which preserve teeth the best do not stand high in respect of retaining their own colour.

For cavities of large size in molar teeth, or in the second bicuspids which could only be reached sufficiently freely to insert a good gold filling by a large sacrifice of sound tooth substance, palladium is certainly one of the best fillings that can be used; notwithstanding that, this statement will probably elicit unfavourable criticism from many both here and in America; but then palladium is but little known in America, and not half so much used in this country as it ought to be.

In very frail-walled cavities there is, however, a fear that palladium may crack off the wall, as it seems sometimes, or at some period in its setting, to actually expand a little. It is also very valuable in cavities of smaller size, in which, from extreme inaccessibility or other cause, it is impracticable to insert a gold filling well, as it never discolours the tooth, though it goes black itself. For a large number of cavities with weak walls the cement lined amalgam fillings described by Mr. Baldwin are extremely satisfactory (see page 325).

Sullivan's copper amalgam is excellent in temporary teeth, or in the grinding surface of young teeth which it is intended to fill with gold later, such as the first permanent molars in quite young patients who would hardly submit to long operations, or in cases where these molars may perhaps not be ultimately preserved.

The choice of other amalgams must be determined on the grounds already set forth in the pages treating of their respective merits and defects.

Conspicuous cavities in front teeth, and many labial cavities, may be advantageously filled with porcelain inlays, which last well, and are certainly more artistic than gold in the front of the mouth.

It need hardly be said that the efforts of the dentist must be seconded by those of the patient in keeping the mouth clean, and, as far as can be, aseptic.

With this end in view antiseptic dentifrices should be ordered, and the greatest care be taken by the use of tooth-brush, quill tooth-pick, and waxed silk, to provide against any lodgment of food ; it is no unimportant part of the duty of the dentist to continually impress upon and teach his patients the necessity of a degree of care which they are not prone to appreciate for themselves.

Success and Failure of Fillings.—There is, perhaps, no other operation performed upon the human body which is attended with the same unqualified success as that of filling teeth, for we not only succeed, in the great majority of cases, in arresting the further progress of disease, but we also replace the part which has been lost by an imperishable material, and render the organ as useful as it was prior to becoming the subject of caries. It is, however, a great error to suppose that filling will under all circumstances permanently save the tooth, even in cases which at the time the operation is performed promise favourably.

There are those who are disposed to regard the decay of a tooth which has been filled as the result of want of skill or of care in the operator; such an opinion is perfectly untenable, when the character of the operation is considered in connection with the tissues which are involved, and the various conditions under which disorganisation may be effected. The very fact that caries has appeared in a tooth demonstrates its predisposition to disease; and a filled tooth is not better than the same tooth was before it decayed, except in so far as the caries may have occurred at some spot specially weak, so that this having been cut out and the cavity filled, no other spot equally susceptible remains. This is notably the case in crown cavities in molar or bicuspid teeth, in which caries has occurred at the bottom of a natural pit or crevice. We can, for the time being, arrest the disorder and put the tooth back to the point whence it started, but it may reappear in some other part of the tooth, and may in fact commence a second time in the enamel and dentine in the immediate vicinity of the plug, which will then form part of the circumference of a new cavity. Such results will occasionally arise in the practice of those who use the utmost skill in their operations, and they will be seen still more frequently among the patients of those whose cry is infallibility. The ultimate success of an operation will in great part depend upon the skill with which it is performed, but it will not depend wholly upon the operator. There are other sources of failure than the assumed want of skill in operating, some of which are not under the control of the dental surgeon nor of the patient.

In some mouths the majority of the teeth will contain plugs of various ages, ranging perhaps over a period of twenty or even forty years, all of them looking bright, and the contiguous dental tissue free from discoloration, the mucous membrane of the gum healthy in appearance, and free from adhesive mucus. In another mouth, again, in which there are many filled teeth, treated by the same operator, we may find each plug surrounded by discoloured dentine, associated with a thickened and vascular state of the mucous membrane. With the lapse of time the decay indicated by the discoloration extends, and the plug falls out. Again, instances will be seen in which a number of filled teeth, after standing without appreciable change for very many years, show signs of giving way—not, however, in consequence of the defective character of the operation, but in consequence of failure of the general health, and concomitant vitiation of the oral fluids.

PORCELAIN INLAYS.

ALTHOUGH for many years pieces of porcelain have occasionally been fitted and inserted with cement into tooth cavities, yet this method of replacing lost tooth substance has only recently been brought to any degree of perfection or practical utility. The introduction and gradual perfecting of porcelain bodies fusing at high, medium, and low temperatures, the invention of efficient and convenient furnaces, coupled with a vast amount of experimental work, have resulted in rendering this method of filling teeth perfectly reliable and almost indispensable in certain cases.

But it must be remembered that porcelain inlays can only be expected to give permanently satisfactory results in a certain distinctly limited class of cavities. They are not suitable for very shallow cavities, *e.g.*, the idea of utilising them for "enamelling over" a discoloured depression on the surface of a tooth is obviously absurd; the cavity must at least be capable of being made easy of access and of a reasonable depth; and though a perfectly designed and fitted inlay replacing part of the cutting edge may reasonably be expected to withstand the strain in an incisor or canine tooth, yet no inlay correspondingly placed in a bicuspid or molar will for long resist the force of mastication. Inlay work demands a most careful attention to details, and its success as an artistic and lasting method will depend on the judgment, care, and skill exercised by the operator.

There may be said to be three useful varieties of porcelain inlays. The first two of these are suitable for circular cavities only, and by their means most perfect fillings can be produced in suitable cases. The first variety consists of tapered porcelain rods of various shades, ground and trued ready for cutting into lengths corresponding to the depth of the cavity to be filled; if the final fitting be effected by placing the porcelain rod in a dental engine mandril and rotating it into the cavity, then cutting off the required length of rod, roughening, and cementing it into place, finally grinding down the excess and polishing at a subsequent visit, an ideal inlay will result, and one that is difficult to detect unless the surface be dried.

Secondly, Dall's round inlays may be used; these are supplied in many shades and diameters, either deep or shallow, and are the easiest of all inlays to manipulate. Each size of inlay has a bur to correspond; so that the cavity having been finally shaped by the latter, the former merely requires to be fixed in place and the surplus subsequently removed. A Dall's Inlay Gauge further facilitates rapid selection of the exact size of bur and inlay required for the case in hand.

Semicircular and other shaped porcelain rods are obtainable, but they are of little practical value inasmuch as their adjustment involves the removal of much sound tissue in certain directions, with a tendency to avoid cutting away what ought to be cut away in other situations.

For all carious places that do not lend themselves to being shaped to a true circle we must utilise the third variety of inlay, namely, that in which a matrix is burnished into the cavity and porcelain body fused to the exact size and shape required.

Furnaces.—Excellent results can be obtained with a Dall's, Jenkins', Ash's, or other suitable gas furnace; but few are likely to prefer these if electricity is available. Several small electric furnaces are obtainable for medium or low fusing porcelain bodies; among the most convenient of these are the Pelton electric furnace and the small Mitchell's furnace provided with a swing door, used with or without Ash's "Resistance," which enables the heat to be gradually raised or lowered at will, and at the same time lessens the risk of breaking the muffle wires. If the current is weak it may be necessary to keep the furnace door closed, but usually one must watch closely for the sufficient fusing of the porcelain body, so as to avoid over-fusing or the possible melting of the matrix if the latter be of gold and not invested.

In fusing porcelain bodies for inlays more care is necessary in the heating up process than in the cooling down; but if a porcelain core is being used as part of an inlay, or if a crown or small bridge is being built up with body, then it is very necessary to allow the work to cool slowly.

Preparation of the Cavity.—Easy access to every part of the cavity is essential, and in interstitial cavities sufficient separation is indispensable. All decay having been removed, the cavity must be shaped so that it contains no undercuts and no sharp angles. Unavoidable undercuts must be filled up level with cement; weak walls, or those which may be undesirable for other reasons, may be freely cut away. A step or cervical edge groove combined with a flat cervical floor may be an advantage, even a necessity, in certain situations in order to enable the inlay to better resist the stress of mastication. The cavity margins require very careful attention; they should be clearly defined, well polished, and either vertical or shelving slightly outwards, *i.e.*, there must be no bevelling of the enamel edge, but this should be left as it were broad surfaced, so that it is on the same plane as the dentine. This part of the work is greatly facilitated by the employment of specially designed steel or diamond burs and small arkansas stones; the perfection of the inlay joint depends largely upon clearly defined and absolutely smooth cavity margins.

The Matrix.—Provided that sufficient care has been bestowed upon the preparation of the cavity, the securing of a perfect maxtrix impression becomes comparatively easy. There are those who prefer to take an impression of a cavity with dental lac, etc., and then burnish or swage the matrix into the model thus obtained, but this method needs no description and is unlikely to result in greater accuracy.

Either platinum or gold foil may be used for the matrix. Platinum foil is decidedly more difficult to adapt accurately to the cavity, and requires constant annealing during the process of burnishing, consequently it is seldom preferred to gold, except for high fusing bodies or for an all gold inlay; its rigidity, freedom from warpage during firing, and resistance to excessive heat are the chief points in its favour. Nevertheless, when low fusing bodies are employed, a heavy gold foil, such as a No. 30 Williams', possesses many advantages over platinum. This thickness of gold requires careful pressing and burnishing into the cavity, but it is sufficiently rigid to withstand in the majority of cases the usual manipulation without the necessity of employing an investment.

The Matrix Impression.—A film of vaseline having been painted over both the dried cavity and the adjacent gum, the centre of an amply large piece of annealed matrix foil is conveyed to the deepest part of the cavity and adapted by means of pellets of moist cotton wool, or amadou, packed down and held in place till the cavity is full. The foil must then be carefully burnished over the cavity margins until every fold and wrinkle has disappeared, and a perfect impression of every part of the cavity and its edges has been secured. If the matrix shows a tendency to "rock" it must be re-annealed and re-adjusted, being if necessary held in position by a strip or ring of rubber dam stretched over the tooth. India-rubber cut into cone-shaped points and held in a mandril is of use sometimes in perfecting edges. In a difficult case it is sometimes useful to half fill the matrix impression with body, fuse this, and then replace it in the cavity and once more adapt the foil to the cavity margins; it may be advisable to repeat this process in cavities presenting unusual difficulties.

If there is any difficulty in removing the matrix from the tooth, it will be of great assistance to fill the impression with hard wax. Cold water dropped upon this serves the double purpose of hardening the wax and of tending to loosen the matrix from the tooth by capillary attraction. About an inch of soft iron binding wire, doubled on itself and twisted, is warmed and inserted into the hard wax; this makes a convenient handle with which to manœuvre the matrix from the cavity, and with which to hold the impression till it is securely embedded in the asbestos investment. This wire should not be removed till, in drying the investment, the wax is just beginning to melt; at this moment its withdrawal brings almost all the wax away with it.

The Investing Material, when one is used, consists of finely powdered asbestos and water, which must be dried by gradually increased heat. This is the form of investment advised by Dr. Jenkins, and is on the whole the best; a little gum tragacanth added to the water increases its binding quality, though of course it disappears during firing. Many prefer to mix the asbestos with alcohol, inasmuch as the latter quickly evaporates and thus tends to dry the investment spontaneously; but the investment thus made has no binding strength, and the slightest fall or even prolonged handling breaks it to pieces.

It is by no means essential to invariably invest the matrix, nevertheless to do so undoubtedly presents many advantages. The asbestos paste holds the matrix immoveably in correct position, enabling the building up of the porcelain body to be effected with greater accuracy and ease, and moreover powerfully aids in resisting any alteration in shape during firing.

Shades.—The porcelain bodies as now supplied, after fusing, pretty accurately correspond to the shades indicated. There is no objection, in fact it is often desirable, to mix one or two powders of different stated shades to obtain the tint required. In a large inlay a more artistic effect often results from placing a darker shade towards the neck of a tooth. Overfusing reduces the colour, which may be also spoilt by the prolonged use of a steel spatula in mixing the body prior to fusing.

Mixing the Inlay Body.—Distilled water, with or without the addition of gum tragacanth, is generally employed for mixing the powdered inlay body, although the mixing fluid supplied by the depôts seems to be in some way superior. The inlay body should be mixed thoroughly, but not too thin ; it is well to bear in mind that a too vigorous rubbing with metal spatulas may considerably darken the colour of the finished inlay, imparting a slaty hue. A small quantity of the mix is taken up, either on a fine spatula or brush with the right hand, and if the matrix be uninvested it is held by suitable tweezers in the left hand ; then the shaft of the tweezers holding the matrix should be gently tapped, so as to cause the body mix to flow evenly and with a smooth surface. An invested matrix is carefully painted up to shape and should not be tapped. This water mix must be dried thoroughly by blotting paper and gradual heat before it is placed full in the furnace. Alcohol is preferred to distilled water by some, but it dries too rapidly, creating difficulties not occurring in a water mix, whilst offering no sufficient compensating advantages. If water be employed, two to four additions of body and a corresponding number of firings will suffice for all but the most difficult inlays. Care must be taken to paint the body mix exactly up to the cavity margins indicated in the matrix, but not so as to overflow them, and also to avoid the tendency to contour the inlay to excess.

Thus we see that filling of the matrix with the inlay body is a detail worthy of some consideration, although probably every operator has discovered a sort of system which in his hands appears to yield the best results. Some will at once fill up the matrix as nearly as possible to the full size of the inlay required, fuse this to a rough glaze, cool, build up to a slightly full contour and fully glaze ; thus, in most instances, completing the inlay in two firings. This plan gives good results in simple cavities of some depth. Shrinkage and warpage are apt to be induced by so rapid a method, and the surface is apt to glaze before the whole mass has fused, thus including minute air bubbles in it. We think it will be found that both time and disappointment may be saved by carrying out the following somewhat longer and more tedious plan. Line the matrix with a thin even layer of the inlay body exactly up to its edge, fuse this to a rough glaze, and repeat the process two or three times until the matrix is filled flush ; after this the contour layers are painted on and fused, while the final layer must be subjected to a slightly longer fusing, so that a perfectly smooth full glaze results. With low fusing bodies such as Jenkins' or Ash's the process in the furnace can easily be watched, and the current switched off directly the degree of glazing required is on the point of being attained.

Shrinkage during Fusing is due to the particles of body powder previously separated by interstices running together. In large inlays, or those in which the length is great in proportion to the depth, perceptible alteration in shape may be due to contraction during cooling, following on distension of the matrix previously whilst in the furnace. To overcome this, various means have been tried, such as placing small fragments of a broken-up porcelain tooth in the matrix along with the first layer of the body mix, but probably the only effective method of overcoming the difficulty is to carefully invest the matrix, embedding its overlap, so that it is held immoveably in place during firing.

Shrinkage during firing, and a small amount of shrinkage during cooling, is inevitable, but it may be reduced to an insignificant amount.

Removing the Matrix from the Inlay is usually easily effected by taking hold of the foil edges with strong flattish nosed tweezers, and as soon as the foil is thus lifted away from the margins, the inlay can be shelled out of its matrix. Overfusing has two effects ; it reduces the colour of the porcelain body, and causes the finished inlay to adhere strongly to the matrix metal.

Retention of the Inlay.—The thinner the inlay the more difficult will it be to securely fix in position. In any case the inlay must be roughened, cleaned, and dried, in order that the cement may obtain the maximum grip available. Small opposing or criss-cross slots, cut with a thoroughly wet fine-edged diamond disc, afford the best hold for the oxyphosphate; some prefer to imbed the inlay face downwards in wax and to obtain a generally roughened surface by means of hydrofluoric acid.

The rubber dam having been adjusted, or absolute dryness secured by other means, very slight undercuts should be made in the deeper parts of the tooth cavity; a little cement of creamy consistency is then worked into the roughened surfaces of both cavity and inlay, and the latter gently forced into position. The porcelain should be kept steadily pressed home for a few minutes after its insertion, when the surplus cement may be wiped away, and melted hard-wax, conveyed on a heated spatula, flowed over the inlay and adjoining tooth surfaces. Any final smoothing had better be left to a subsequent visit.

Large Contour Inlays.—Where a considerable portion of a front tooth has been lost, and we desire to insert an inlay built out to restore the lost mesial or distal cutting edge angle, the "Porcelain Inlay Cores," suggested and introduced by Mr. W. F. Mellersh, will be found very valuable. They undoubtedly enable us to reproduce the lost corner and to build up to contour with comparative ease and accuracy. The chief difficulty in employing these "cores" is to place them in correct alignment with the labial surface and cutting edge of the tooth. During the process of firing great care must be taken to raise the heat gradually, and to allow the inlay to cool down slowly, each time it is placed in or taken out of the furnace. In the British Dental Journal (July, 1902), Mr. Mellersh describes the process as follows: "After investing, the floor of the matrix should have sufficient body baked into it to fill the deeper portion, but not to show any contour. Over this a quite fluid mix of body and alcohol is laid, and the porcelain tip wetted with a little of the same by being rubbed over the palette with a pair of conveying forceps. The tip is set gently in place in the matrix, care being taken to ensure that its edge is square with the cutting edge of the tooth, as shown by the impression in the foil, and that its anterior portion is in the proper plane. After burning off the alcohol, the tip is fused in place, and the inlay rapidly completed: there is no danger of the porcelain moving during the subsequent firing."

PIVOTS, CROWNS, AND BRIDGES.

It would be impossible in the present work to enter into the question of the various methods of pivoting and crowning teeth, a subject to which much attention and great ingenuity has been devoted.

But, on the other hand, it seems desirable to discuss a few of the general principles involved, for in practice one daily sees them disregarded.

Whichever of the very numerous methods of crowning be employed, of course complete asepsis of the root, followed by an adequate sealing of its apical foramen, must precede the fixing of the pivot or crown. In the case of single rooted teeth, the root should be cut down to a level well beneath the free edge of the gum, because, as a matter of clinical experience, caries but rarely occurs or at least rarely originates in the cementum. If some portion of the root is left standing at the back, this should as a rule be enclosed within the crown. It is the favourable situation of the joint and not merely its perfection which makes crowning of practical utility. Perhaps an exception to this occurs where it is possible to leave a good deal of the tooth standing at the back; practically, pivots are found to endure well when the line of junction is well removed from the gum and is subject to the thorough cleansing action of the tongue.

And now that we are able to secure a greater degree of asepsis of pulpless teeth than was formerly the case, crowning is an operation of the greatest value—indeed it is, we think, better to resort to it before the tooth is in the very last stage of dilapidation, than to go on to the last filling a tooth with which we feel that the protection cannot but be temporary.

By a "pivot" is meant a porcelain or porcelain faced collarless crown, inserted by means of a slightly roughened metal pin passing into the prepared root canal, and fixed with cement. It serves a useful purpose where a single rooted tooth has decayed to, or perhaps below, the level of the gum. The pivot has been almost entirely replaced by the Richmond collar crown or some modification of it.

For the roots of **incisors and canines**, all porcelain or porcelain faced crowns are used; it is preferable, especially in the case of upper incisors, to fit a collar or half-collar round or partly round the root, which latter should be cut down well beneath the gum level in front, but left upstanding at the back. The strain will be chiefly an outward one, and a well-fitted collar embracing the posterior half of the root will amply suffice to preserve the root and take the strain off the pin, whilst the peridental irritation, apt to be caused by passing a complete collar somewhat deeply under the gum, is avoided.

It must be remembered that the alveolar dental membrane is the sole source of life remaining to a pulpless tooth or root, and it is well to avoid irritating this membrane by the deep insertion of a metal collar. A single rooted stump moreover will not submit to a collar being passed under the gum as deeply as a multi-rooted tooth will, probably because the area of vital periosteal contact is much greater in the latter case, and the membrane cannot be wounded round the entire circumference of any of its roots by a collar embracing them collectively.

Single roots hollowed out by central decay should as a rule be built up with cement and amalgam round a slightly vaselined pin, temporarily inserted in the root canal.

Perhaps we may state here that it is often not desirable to attempt the removal of the remainder of a gold-backed crown when the porcelain face has been broken off in wear. A suitable artificial tooth should be chosen and fitted, with its shortened pins passing through holes drilled and countersunk in the former gold backing. When all is ready and thoroughly dry, oxyphosphate cement is smeared over the gold backing, and the porcelain tooth pressed into and held in position whilst a little dryish amalgam is worked around the pins, which may or may not be bent, and the surface subsequently made smooth and polished.

The **bicuspids** are often conspicuous teeth, and consequently may require a faced crown, but, where appearance is not of great importance, an all gold crown will probably be more functionally efficient and more durable. The two small root canals in a first upper bicuspid may be a source of some difficulty, but usually one of the canals will be found sufficiently long and conveniently placed to receive a pin of sufficient length and strength to secure the crown, even should the other canal be ignored for fixing purposes.

The second bicuspid does not often present any special difficulty, and like the first should always have a collar fitted round or partly round the root.

In some cases where the bicuspid roots are decayed to or below the gum, a "pin sized" screw may be rotated home after enlarging the canal to the size and depth required, and a tube tooth fitted to this pin; a very firm and efficient crown may sometimes thus be fixed to a somewhat hopeless looking root.

Healthy rooted **molar teeth**, when past filling, should have gold crowns fitted. If such teeth present considerable tissue above the gum level, this should be freely bevelled off all round and on no account should any enamel be left; a post should be inserted in one or more of the roots if thought desirable. Should the molar stump be broken off or decayed to or below the gum margin, it is quite improbable that any accurately fitting collar can be adapted whilst so little tooth substance presents itself to work upon; such remnants of teeth should be cleared of decay and built up with cement and amalgam round a post or posts inserted in the roots; when this amalgam is hard it should be coned up in the usual way, and the collar fitted over this. The articulation should always be adapted according to the surface of the opposing tooth; the dies supplied for producing artistic effects are of little value where the "bite" has to be considered.

A hand-made gold crown is undoubtedly the best, but it is not easy to give the crown its requisite and natural form by bending and shaping it with pliers; to overcome this difficulty various methods of swaging crowns have been introduced, and of these Sharp's method is perhaps the best.

A gold crown should only be employed when a filling will not restore the masticating function of a tooth; it is seldom desirable to crown a tooth until the pulp has been

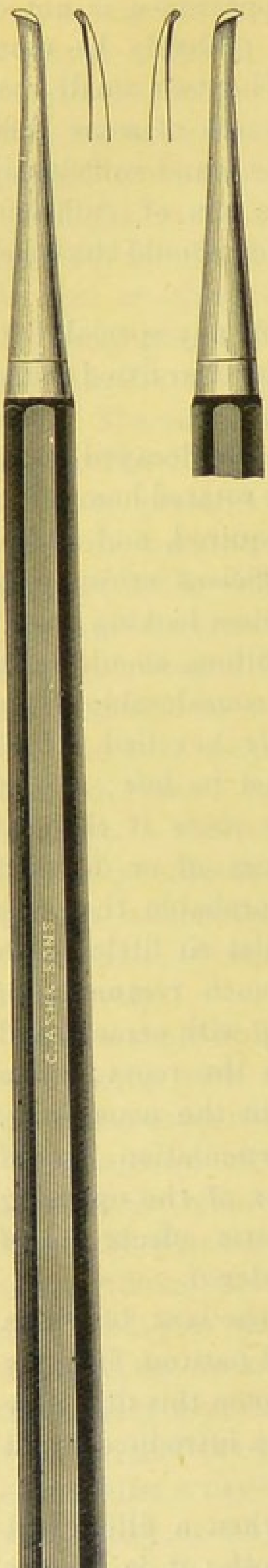


FIG. 186.—Dr. C. S. Case's enamel cleavers. For removing remnants of enamel.

removed and the root canals sealed. Every crown should either be contoured so as to knuckle up accurately against the contiguous teeth, or a space large enough to be self cleansing should be arranged for. Gold crowns placed on bicuspids or molars for the reception of dentures are better not contoured on the side to be embraced by the clasp or band of the plate.

With regard to **bridge work**, there are not, as in the case of crowns, a great many places in which it is the best thing to be done; still, there are just a few; this word of warning is the more needed, as nothing in modern dentistry has been so abused as bridge work. The implantation of teeth in the jaws is in man, as also in animals, very closely proportionate to the strain which comes upon them in mastication, and is not greatly in excess of their necessities, even making due allowance for the fact that we cook and soften a great deal of our food.

When then, as is too frequently done, a bridge carrying quite a number of teeth is fixed upon two or three roots or complete teeth, these unfortunate teeth have to bear all the strain, which in the normal mouth would be distributed over the roots of many teeth; and not only that, but the remoter parts of the bridge when bitten upon may exercise a strong lever action, thus trebling or quadrupling the strain upon the attachment above that which would occur were the support underneath the force applied.

The natural and inevitable result is

that they either become very painful or absolutely come out; and we have removed many a bridge, teeth and all, for which the patient had paid a fabulous fee but a year or so previously.

When therefore considering the question of resorting to a bridge, or to some other appliance, the first thing is to consider how the strains will come, and whether it is reasonable to expect the teeth which have to bear them to do so.

And it should be borne in mind that the roots of a dead tooth are apt to be already below a normal standard of health, and that it is therefore better, so far as this mechanical matter of strain goes, to cap over a live tooth than a dead one.

It must be remembered that a tooth will bear considerable and repeated applications of force in a vertical direction, and but to a very limited extent in lateral directions, the ordinary excursions of the jaw in mastication not tending to displace teeth laterally, except to a very short distance. An excellent example of the inability to tolerate lateral thrusts is seen when the back teeth have been lost, and the lower incisors strike upon the backs of the upper teeth—a condition which speedily results in their being loosened. Hence it is necessary to carefully consider the directions in which force applied to the bridge will act upon the teeth which serve as its attachments, lest we be subjecting them to strains which will destroy them; and it is never reasonable to insert in the form of bridge work a large number of teeth to be carried on two or three roots or entire teeth. This practically amounts to a condemnation of large bridges, except where a good many teeth or very sound roots remain. But for some few selected cases small bridges serve a very useful purpose; removable bridges, such as those designed by Mr. Gartrell, are, in cases that lend themselves to their application, to be preferred to fixed bridges, as they admit of complete cleanliness, a result which is oftentimes hardly attainable with the fixed bridge.

And it need hardly be said that the employment of a bridge is quite unjustifiable where the patient's teeth are loosening.

The author was consulted in a case where bridges, which had been inserted less than a year previously, were already failing from this cause; and it was obvious from the depth of the gold crowns on the molars and bicuspids that the teeth used for attachment had already gone far on their way towards coming out at the time when the bridges were inserted. It is hardly possible to suppose that the practitioner who inserted them can have done so with any other view than the securiug of a large fee ; one of the bridges had no opposing teeth whatever, so that it could hardly have been expected to be of any use to the victimised patient.

TREATMENT OF EXPOSED PULP.

It may with some truth be said that when the pulp is nearly or actually exposed the really favourable time for filling the tooth has run by. But it will happen sometimes, even in the teeth of those who are careful, and present themselves for examination at regular intervals, that a cavity in a hidden situation will escape notice until it is of considerable depth, and this will be almost the rule amongst the less careful of our patients.

When, after the removal of all the softened dentine (of which, perhaps, we have left a trace at the floor of the cavity rather than go any deeper), the pulp has been somewhat nearly approached, it will be advisable to place some substance which conducts changes of temperature less freely than any metallic filling on the floor of the cavity. If no pain has been felt otherwise than under the provocation of large alternations of temperature, or the access of such substances as sugar, etc., it may be presumed that the pulp is healthy, and so without further treatment we may proceed to protect it; a layer of zinc phosphate with a small quantity of oil of cloves or thymol incorporated with the fluid before mixing, may be inserted, and so cut away when partially hardened as to leave the residue of the cavity of good form for filling; if, however, it appears that the dentine remaining between the pulp and the future filling is exceedingly thin, a less irritating capping is formed by mixing zinc oxide into a very thick paste with oil of cloves, and then with sufficient zinc chloride solution to make it into a very thin paste. This, which sets rather quickly, is spread over the floor, avoiding any pressure, and allowed to harden; this mixture seems to be tolerated where the simple salt would cause severe pain which is not always transient.

Caries with perforation of the pulp-cavity, the pulp being healthy, is a condition that is but seldom seen, excepting as the result of an operation. The dentine in contact with the pulp, having been softened by disease, is removed when the cavity is prepared for filling, and the pulp thereby exposed. Perhaps it would be wrong to assume that in such a case the pulp is absolutely sound, but there may be nothing to show that it is diseased, and nothing to warrant the adoption of any other treatment than that which would be pursued if its healthiness were unquestioned.

We are not prepared to say that we never find the pulp of a carious tooth, the cavity of which has been laid open by the disintegration of its walls, free from disease; but cases exhibiting such conditions must be very rare, if indeed they occur, whereas the exposure consequent upon the removal of carious dentine is not very uncommon. It is an unfortunate accident which cannot always be avoided—unfortunate, because it would have been better to have retained the softened tissue, the removal of which occasioned the exposure of the pulp, and to have protected it from further decomposition by mopping it freely with oil of cloves, or carbolic acid, and by plugging the cavity. Had this treatment been adopted, we should, if fortunate, after the lapse of a few months, have found that the pulp itself had become calcified at the point corresponding to the disorganised dentine. The presence of a filling stays the further progress of the disease, and prevents the fluids of the mouth from penetrating through the defective wall of the pulp-cavity, while the softened tissue retained as a covering to the pulp saves the latter from the effects of sudden changes of temperature, which would have been readily conveyed through a metal plug but for the intervention of the dentine. When, however, the exposure is produced during an operation, the pulp is usually wounded, and bleeds freely. The pain is commonly acute, but soon subsides; but sometimes no pain is experienced. After the bleeding has ceased the cavity should be syringed out with tepid water, and carefully dried with cotton wool. The actual state of the walls of the cavity, the size of the perforation into the pulp-cavity, and the condition of the dentine immediately around the hole, can then be examined. If it be found that the whole of the softened dentine had been removed, and that the aperture into the pulp-cavity is very minute and surrounded by sound tissue, we may proceed to plug the tooth in the usual manner, adopting the precaution of laying a small piece of sticking-plaster over the aperture. But should it appear that the opening into the cavity is of considerable size, or that, though small, it is surrounded by softened tissue, the removal of which would increase its size, a different mode of proceeding must be adopted, as indeed is generally preferable.

As much as possible of the disorganised tissue, short of enlarging the aperture, should be carefully cut away, taking care that the walls of the cavity are reduced to a suitable form; an artificial substitute for the missing portion of the wall must be provided, in the preparation of which two conditions should be observed. Like the dentine, it should be a non-conductor, and also, like it, be capable of protecting the pulp from pressure. To possess the latter quality the material must have a certain degree of strength, and be slightly concave on that surface which is presented towards the pulp.

It is usual to speak of the operation under the title of **capping the pulp or nerve,** and the substance shaped to cover the pulp as the "cap." Gold, ivory, quill, horn, cork, and many other substances have been used.

A piece of suitable size cut from the barrel of a stout quill, being readily produced, was formerly often used. In determining the shape and size of the cap, it must be remembered that there is no objection to the whole of the floor of the cavity being covered; at all events, the cap should be sufficiently large to ensure its edges resting at some little distance from the margin of the aperture by which the pulp is exposed, otherwise it will fail to protect the latter from pressure during the operation of plugging, and subsequently perhaps from that consequent upon the tooth being used in mastication.

While it is necessary that the exposed portion of the pulp should be perfectly protected from pressure, it is perhaps equally desirable that a space should not be left in the concavity of the cap into which the pulp could be received, were it from any cause to protrude through the aperture in its proper cavity.

These requirements are very well fulfilled by the use of little stamped-up concave disks of platinum which are sold for the purpose, their concavity being filled up with a slight excess of a paste of oil of cloves and zinc oxide; or a piece of thin card smeared with the same preparation may be used in cavities so shallow that there is but little room for a bulging cap; but after all, the paste containing both oil of cloves and zinc chloride, which itself sets quite hard enough for the protection needed, is here also about as good as any more elaborate appliance, but it should be mixed so soft that it almost flows over the exposure, and no kind of pressure should be put upon it until it has set quite hard. For it is pressure which is one of the most frequent stumbling-blocks in the way of successful capping of presumably healthy pulps.

But whatever form of capping be adopted, the success of the treatment can never be absolutely assured until after the lapse of a considerable time, and so no filling which is put in can be considered as a permanent one; hence it is better to at once accept this fact and insert a white plastic filling, or gutta-percha plug; but this latter we hardly regard as a very perfect protection to a living pulp which has been very nearly exposed, excellent filling as it is from the point of view of resisting caries.

Our object being to promote the formation of a little secondary dentine to repair the damage done at the surface of the pulp, it is not good practice to use any very potent or caustic medicament; thus if we wish to use carbolic acid, it must be in very dilute solution, lest by the application of anything of caustic strength we destroy the formative odontoblast-layer.

The case of calcification of a widely exposed pulp, about to be described, seems however to indicate that we should do wisely not to wipe away any effused blood, but to leave it, and the exudation which almost at once takes place, undisturbed, to form the immediate covering of the pulp, merely protecting this by a cap of some indifferent material preserved against decomposition by a non-irritant antiseptic. Gelatine softened and impregnated with sublimate solution (1 in 2,000) has appeared to answer well in a few trial cases.

And the patient should be taken into our confidence and made to understand that the tooth must be carefully watched, for a material failure of the temporary plug may undo all that has been gained by the whole capping and filling.

The capping of apparently healthy pulps is a very fairly successful operation ; we say very fairly only, advisedly, as although a large proportion seem to do well and no pain follows the operation, yet a certain number of these teeth examined after the lapse of a year will be found to have dead pulps, even though there has been little or no discomfort.[1]

But whatever may be the ultimate issue, there is practically not much uncertainty attending upon the treatment of a healthy exposed pulp for the time being, whatever be the mode of capping preferred, so long as no violence is done to it; the case is far different, however, when we have to deal with an unhealthy pulp, as is far more often the case, even when there has not been any actual visible exposure.

Unfortunately, we have not much means of judging of the actual condition of the pulp except by inquiry as to the amount of discomfort which it has caused, and, as this varies not a little in states of the pulp which appear to be identical, our estimate of its degree of departure from health is very often erroneous.

Mr. Arnold Rogers had a preparation which throws light upon the question. A patient applied to have the roots of a first molar removed, the crown having been broken off many months previously, when, for the relief of pain consequent upon caries, the extraction of the tooth was attempted. The pain ceased after the fracture, and the roots of the tooth were allowed to remain. After the lapse of some months, the remains of the broken tooth caused annoyance, and they were removed. The specimen (Fig. 187) shows that the tooth was broken through about the middle of the pulp-cavity, projecting from which we now find a mass of secondary dentine. It not only projects from the cavity, but hangs over and conceals the sharp edges produced by the fracture. It is obvious that in this case the vitality of the pulp was maintained, that it became enlarged subsequently to the unsuccessful operation, and afterwards calcified.

In this case the secondary dentine passes out of and over

[1] Papers to which the reader may be referred are those of Mr. Thos. Rogers, Trans. Odont. Soc., vol. i., and Dr. Louis Jack, Dental Cosmos, 1873 ; much has been written since, and will be found scattered through the pages of the dental journals, but the principles of practice remain much as when laid down in these earlier papers.

the normal boundary of the pulp-cavity; we are therefore justified in assuming that the pulp itself became enlarged. Now, the tooth had ached badly before the primary operation was performed, and it may therefore be taken for granted that the pulp was at that time more or less inflamed. These facts, although taken from a single case, warrant the conclusion that there are circumstances under which the dentinal pulp, although it has been diseased and exposed, may be converted into secondary dentine.

In the case cited the secondary dentine was exposed to view when the patient applied to Mr. Rogers, but the pulp, during the process of calcification, must have been protected

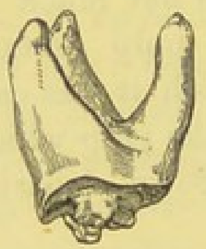


FIG. 187.—Shows the roots and neck of an upper molar tooth, the crown of which has been broken off in attempting its extraction. Some time afterwards the roots were removed, and it was then found that a mass of secondary dentine projected from and overhung the margins of the remaining portions of the pulp-cavity. A similar specimen is placed by the side of this in the Odontological Society's Museum, the history of which is precisely similar. The gum in this latter case was believed to have healed entirely, or almost entirely, over the roots and the exposed pulp, thus affording it protection.

in the first instance by a coagulum of blood, and subsequently by a perfect covering of organised tissue. Had it been otherwise, the pulp would probably have been injured and ultimately destroyed by mastication.

In a similar specimen, which has been fully figured and described (Trans. Odont. Soc., 1896), the patient had retained the tooth for three years after the attempted extraction; it had been from time to time painful, then became fairly comfortable, but for a few weeks prior to being seen, paroxysmal pain of a neuralgic type had come on, recurring most days. The gum had healed over and looked perfectly healthy, but there was a pinhole opening in it leading down to the tooth, which felt hard and was free from tenderness. On reflecting the gum and extracting the tooth (a lower molar) it was found to present an appearance similar to that of Fig. 187, the cauliflower excrescence being polished and of a rather translucent appearance. A vertical section is represented in Fig. 188, which presents features of extreme interest.

The amount of secondary dentine is very large, and in its deeper portion approximates closely to normal dentine; but its upper surface, or that first formed, is almost structureless,

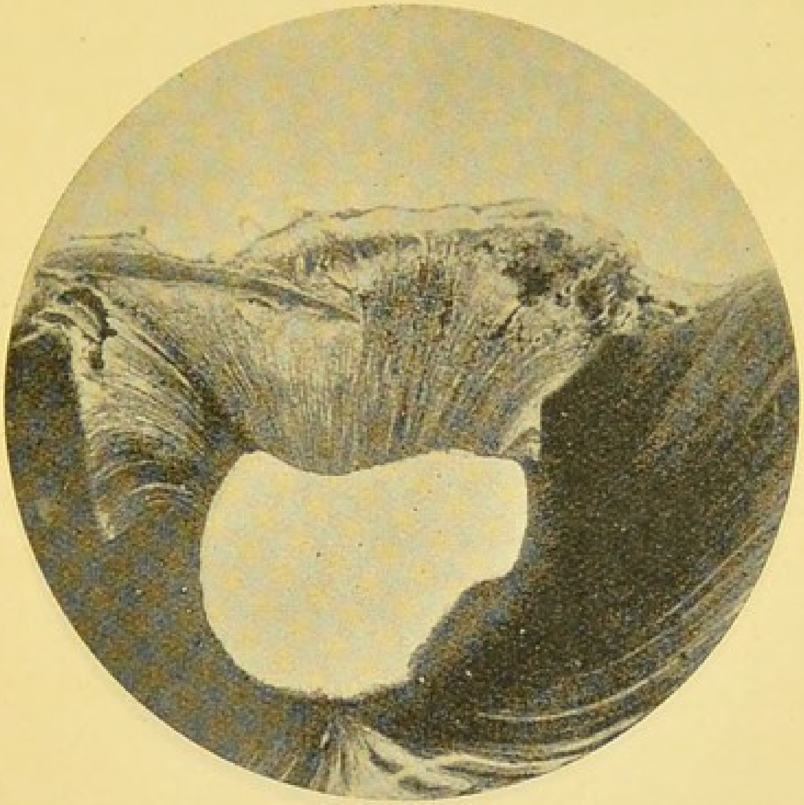


FIG. 188.—General view of the mass of secondary dentine which has roofed over and partly filled up the widely exposed pulp chamber.—From the Trans. Odont. Soc.

though laminated; then it becomes full of lacunal spaces, and finally merges into comparatively well-formed dentine.

On the fractured surface it is seen to have overflowed the whole area in places, and a material portion of it in other places; from a study of its relations and of the manner in which it has entered certain irregularities in the surface, it seems evident that the laminated layer of calcification did not take place in a pre-existent swollen pulp, but rather in an exudation from its surface which flowed over the fractured surface of the tooth. It might be suggested that this was blood, but from what we know of healing processes elsewhere, it seems more likely to have been a plastic exudation.

The practical importance of this fact, and its application in treating a traumatic exposure of the pulp, is obvious, and has already been alluded to.

Underneath this comes a layer like a coarse and irregular granular layer, and then tube formation is taken on, and finally in the lower portions dentine almost as good as normal

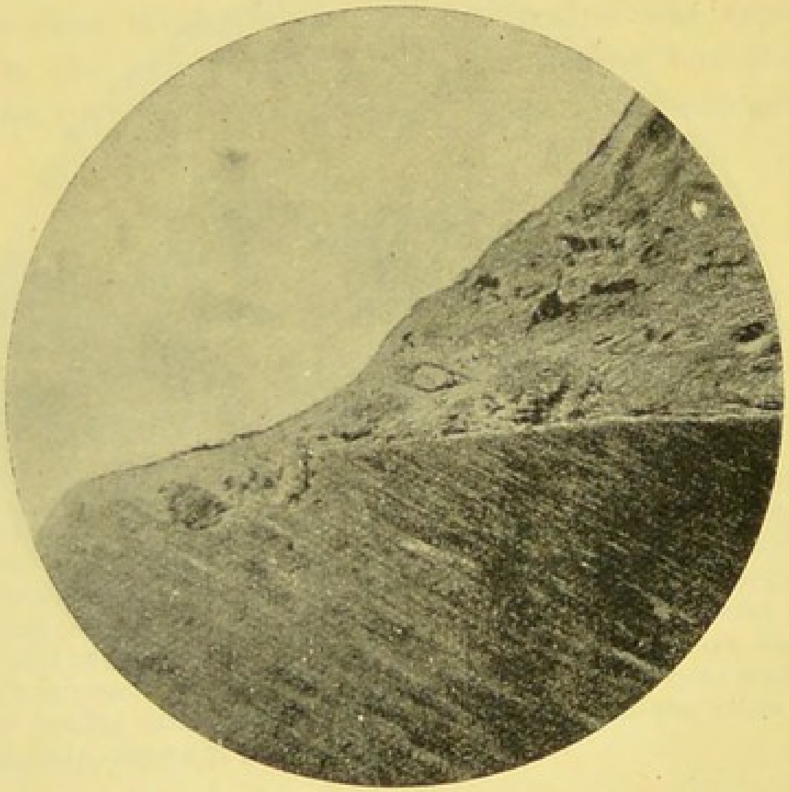


FIG. 189.—In the lower part of the figure is the original dentine, fractured across its upper surface. Upon this lies the outer part of the secondary dentine, showing the "overflow" and a filled up absorption space.

dentine is formed, and formed in normal relation with the pulp. The question arises, were the odontoblasts left behind on the pulp, or were they torn off with the roof and sides of the pulp-chamber and subsequently reformed?

Another very interesting fact in the specimen figured is that loose fragments of dentine were left at the time of the early attempt at extraction, some lying upon and some driven into the pulp. These seem to have set up no irritation whatever, but to have become enclosed solidly in the subsequent calcification.

Where these lay on the surface the tube formation begins below them, indicating that the odontoblast surface of the pulp was there, and that all the calcification above was in plastic exudation.

The lessons to be learnt from this very interesting specimen are these :—

That a pulp not rendered septic is very tolerant even of a foreign body (for such an entirely displaced piece of dentine must be).

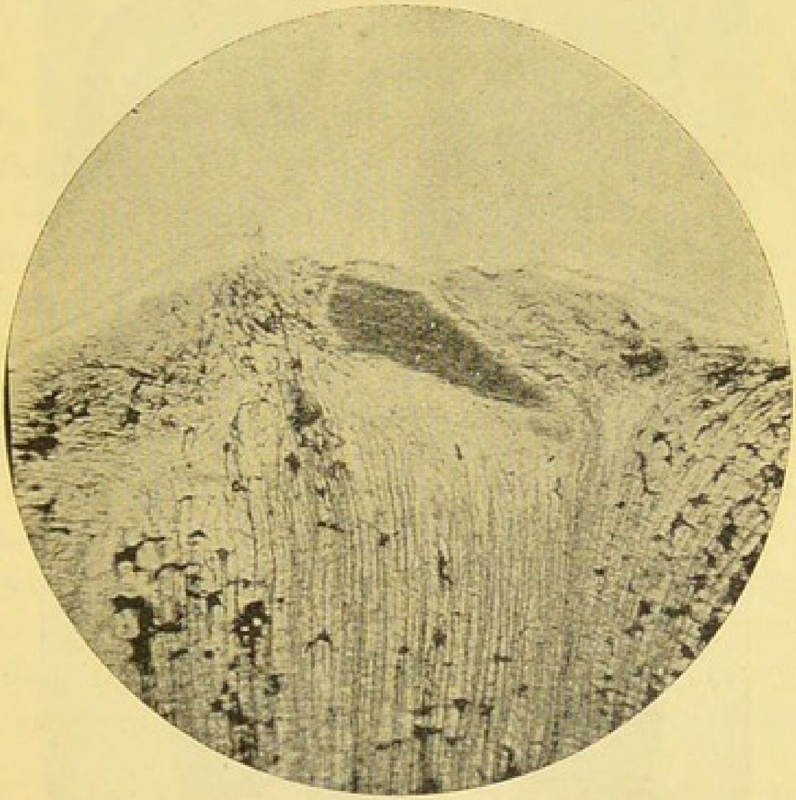


FIG. 190.—Shows a detached fragment of old original dentine which has become included in the new secondary dentine near its edge.

That under a film of plastic exudation (and, presumably, a thick blood-clot also) a phenomenal success in secondary calcification was attained.

That a pulp, whose surroundings in the way of dentine had apparently become just those of a normal pulp, is not necessarily comfortable, but may become a source of neuralgia.

Perhaps no better place will be found for inserting a figure of an interesting case of united fracture met with by Mr. Harding, and described by Mr. Bennett in the Trans. Odont. Soc., 1896. In this case an oblique fracture had run through the crown of the tooth close to the top of the pulp-cavity, which it may or may not have exposed at some points. The uniting mass shows no dentinal structure, and may have been derived from the pulp, or more probably from the alveolar periosteum, the

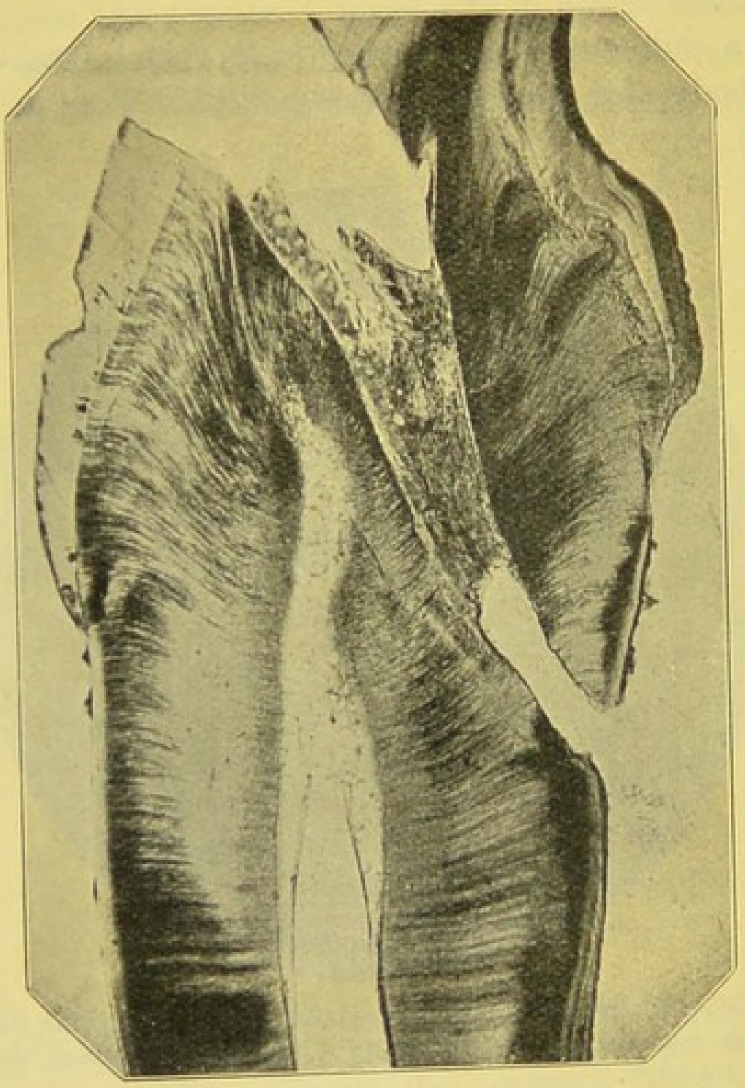


FIG. 191.—Mr Harding's case of united fracture. The uniting material is of coarse osseous structure, with numerous large lacunal spaces.

fracture being (to the right of the figure) far below the margin of the gum.

Irritation of the Dentinal Pulp.—It is highly probable that there is no justification for distinguishing between irritation and inflammation of the pulp, and that the former is merely a slight degree of the latter ; at all events, we cannot pretend to differentiate the pathological differences of the two. But in practice the term is useful, so it has been retained.

A diseased condition of the pulp, whatever may be the nature of the disease, is, in the majority of instances, consequent upon the pulp-cavity being approached either by the destruction of its walls by caries, or by injury of the crown of the tooth from mechanical violence. But a few cases will be met with in which the tooth becomes painful and highly sensitive to the effects of sudden changes of temperature induced by the contact of hot or cold fluids, and even to pressure upon the crown or upon the neck of the tooth, while the walls of the pulp-cavity are apparently free from injury. In such cases the patients will complain that the tooth is incapable of bearing with comfort the pressure exercised in mastication. And care must be taken not to be misled by this into the belief that there is periosteal inflammation. Careful examination usually leads to the detection of caries or to the loss of a portion of the crown of the tooth, either from wear or fracture. A certain degree of pain is produced by pressing a steel instrument upon the injured spots, but the degree of pain will not correspond to the amount of force exercised; indeed, slight contact seems to give quite as much pain as firm pressure.

But we may fail in detecting any structural change in the indicated teeth. The earlier stages of cold, pregnancy, rheumatism of the jaw, or the presence of mercury in the system, are frequently accompanied by an irritable state of the teeth.

When the foregoing local symptoms are present, it is very difficult to determine whether the sense of pain in the tooth is confined to the dentinal fibrils, or whether it is situated in the pulp, the susceptibility of which has become abnormally heightened. There is no reason for assuming that the fibrils are incapable of assuming a condition of excessive sensibility, and that the morbid state may not for a time be confined to them. But on the other hand, it is equally possible that the increased susceptibility may originate in and be limited to the pulp itself, which becomes painfully affected by causes which otherwise would not produce uneasy sensations.

That a state of irritation may be assumed by the pulp is sufficiently proved by the fact that the irritable condition of the tooth may be succeeded by obvious inflammation of the pulp. Examples of the sequence of the one to the other condition may be seen in teeth, small portions of which have been broken off without injury to the pulp-cavity. When so injured they become gradually sensitive to changes of temperature, and the pain, which at first was transient, at last endures after the exciting cause has been removed. The amount of pain is gradually increased, and eventually terminates in a severe attack of toothache, occasioned by acute inflammation of the pulp. If the aching tooth be removed, it will be found that although the pulp-cavity is entire, the pulp is passing into a state of disorganisation. A similar course of symptoms will sometimes follow the operation of filling a simple cavity in teeth which have been in an irritable condition prior to the operation. For example, in a patient lately under treatment, gold fillings were placed in two mesial cavities in the right and left lower molars; the cavities were fully exposed to view, and no indication of exposure of the pulp was to be seen; in fact, the cavities were so shallow that the introduction of a filling was difficult. In the course of a week the gold had to be removed; too late, however, to prevent the spontaneous death of the pulps. In this same patient it had been necessary shortly before that time to remove a crown filling, where the cavity was both small and shallow, on account of the irritability of the pulp.

In a certain number of people the dentine will not tolerate immediate contact with a metal filling, even in shallow cavities. In such cases it will be found to be extremely rare for any subsequent discomfort to occur if the cavities be lined with an oxyphosphate and filled with amalgam, wherever appearance does not suggest the advisability of inserting a non-irritant porcelain inlay.

The susceptibility of a pulp to irritation varies greatly in different persons; it is far greater in youth than in adult life, and there are some few for whom it is next to impossible to successfully perform the operation of filling without setting it up.

No doubt the pulp of a tooth may pass into a state of irritation, independent of injury sustained by the hard and protecting tissues, just as in certain states of the system the susceptibility to disease of any other organ of the body may be increased. But in those cases in which the crown of the tooth has suffered, there appears good reason for supposing that the abnormal state begins in the dentinal fibrils, and extends through them to the pulp. This view is, we think, supported by the results which follow careful treatment. If, in a tooth the crown of which has been injured by caries to a slight depth only, but in which the dentine is highly sensitive, nitrate of silver be applied to the affected part, the susceptibility to pain will in a few minutes be greatly reduced. A similar result will follow the application of other forms of escharotics, unless the walls of the pulp-cavity are sufficiently reduced in thickness to allow the application to pass through to the pulp. The effects with these active agents are rapid, but their use is not free from danger; for it is not always easy to discover how much or how little sound tissue may intervene between the pulp and the sensitive surface. Excepting as a matter of experiment, or when a sufficient length of time cannot be allowed for the application of less active remedies, it will be well to employ vegetable astringents, such as tannin, or solution of gum-resins in alcohol, and to continue the treatment till the tooth regains its normal state.

In a previous page it was stated that the dentine loses sensation on the pulp being destroyed, and it is now shown that a sensitive surface of dentine loses its power of feeling or transmitting pain after treatment with nitrate of silver. The fact that in irritation of the pulp the whole tooth becomes hyperæsthetic, so that cold or heat applied to its exterior causes a shock of pain, seems to indicate that the fibrils themselves participate in the change, or at least that their conducting power is exalted.

Secondary Dentine and Pulp Stones.—Irritation, if long continued, is usually, but not constantly, productive of certain changes in the pulp itself; examples of these changes may be seen on examination of teeth removed after a long-continued state of uneasiness has been succeeded by active aching.

Mr. Hopewell-Smith ("Histology and Patho-histology of the Teeth," page 505) writes:—"Under low powers one observes small solid rounded highly stained masses occupying the centre of the tissue, placed between the vascular and nervous systems. They inconveniently crowd on the nerve bundles, and if allowed to increase by fresh external depositions, will gradually cause a mechanical lateral pressure on these nerve bundles and induce

FIG. 192.—Showing the pulp-cavity of a first permanent molar of the upper jaw perfectly filled with a mass of secondary dentine, produced by calcification of the pulp induced by caries of the crown of the tooth.

FIG. 193.—Section of a tooth, showing the local thickening of the wall of the pulp-cavity consequent upon irritation produced by advancing caries.

pain." He thinks that they are formed by a secretion or conversion of the small round cells of the pulp. In some the pulp will be found to contain numerous nodules of dentine; in others the greater part of the pulp will be found converted into secondary dentine (Fig. 192). Or the calcification of the pulp may be

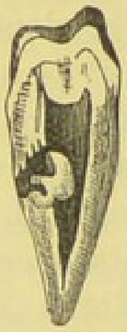


FIG. 194.—Bicuspid in which a formation of secondary dentine has failed to obviate perforation of the pulp-cavity. — From Tomes's Lecture on Dental Physiology and Surgery.

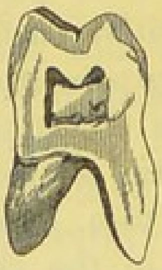


FIG. 195.—A first permanent molar tooth of the upper jaw, the pulp of which was calcified, excepting at its upper part and at the exposed side.

limited to the production of a patch of dentine added to the wall of the pulp-cavity (Fig. 193 and Fig. 194). Miller is of opinion that pulp stones are always formed within the pulp tissue, but as the latter recedes by calcification of its periphery, the pulp stones may become attached to the walls of the pulp-cavity. (Odonto. Soc., May, 1905.)

In neither of the preceding cases can the calcification have been effected during the day or two of acute suffering in the tooth, consequently it may be inferred that the production of secondary dentine took place when the irritable condition prevailed. It must not on this account be assumed that calcification of the pulp invariably follows upon irritable conditions of the tooth, for cases will be found in which the presence of secondary dentine cannot be recognised, and others in which a large portion of the pulp has undergone calcification without its being preceded by irritability in the tooth. Moreover, it seems possible that the mere presence of these isolated nodules in the pulp is capable of exciting great irritation, instead of being itself a result of previous excitation of the pulp. On the other hand, it must also be remembered that small isolated calcareous globules are to be found in perfectly healthy developing teeth, both in man and in lower animals. Miller has also found them in the pulps of the temporary teeth.

Dentine in the globular form may be found in semi-detached masses adherent to the surface of the pulp-cavity, and in perfectly detached spherules in the substance of the pulp itself, in the teeth of adults. In the latter situation these bodies are very abundant in teeth which have been attacked by caries; and Mr. Salter appears to consider the presence of the detached masses of dentine in the pulp as the consequence of disease. This view does not appear to be quite correct, for in three out of five specimens of perfectly sound molar teeth removed from subjects in the *post-mortem* room globular masses of dentine were found within the substance of the pulp. Again, in the developing teeth of ruminants, these globular masses are scattered freely through the dentinal pulp, and as ossification advances, become surrounded by, and lost in, the general mass of the dentine. If the surface of the pulp-cavity of a partly-formed tooth of a ruminant be examined, the globules will be found embedded to various depths in the substance of the dentine. Messrs. Robin and Magitot call attention to the existence of small isolated calcareous granules of spheroidal form, which are to be found in considerable numbers scattered through the substance of the pulp at an early period of dentine development; they have also been described by Henle and others in the teeth of man, as well as in those of ruminants and rodents, and they may be found at all periods of development, as well as in adult teeth.

The pulp may remain long alive and in a state of chronic inflammation without any calcification taking place in teeth broken off in the attempt to extract them. For example, a patient applying for an opinion on account of long persistent and severe neuralgia was found to have nothing abnormal in the mouth save a slight papilliform elevation over the site of an upper wisdom-tooth which she alleged had been extracted some two years previously; no opening could be detected in this little elevation, but a sharp probe thrust through it struck against tooth substance, so the gum was divided and the subjacent stump removed, when it was found that the pulp had remained alive in it, and projected slightly from its fractured surface, the protruding portion being of a deep claret colour.

With the advance of age, the area of the pulp cavity becomes gradually diminished by the slow addition of dentine to that which was formed when the tooth was in a state of active growth; and this condition is still more strongly marked in those teeth which have been worn by mastication; indeed, in some cases the cavity is almost, in others perfectly, obliterated. In either case the effect is, as respects the contraction of the cavity, general, but the local development of dentine continuous with the pre-existing tissue, is very often coincident with caries. When the crown of the tooth is attacked, the pulp very commonly resumes its formative functions at a point corresponding to that towards which the disease is advancing, and adds as it were a patch, or plate, of new dentine (or secondary dentine, as it is commonly called), the tubular and intertubular substance of which is continuous with that of the older tissue, and thus the tubes of the two parts are continuous, although at the point of junction there are often bends or slight dilatations. When the tooth is strengthened by additions made upon the walls of the pulp-cavity, in consequence of the tooth becoming weakened by disease operating upon the outer surface, we have a remarkable example of the manner in which Nature attempts to remedy a defect. But the reparative efforts are not always productive of favourable results. In the place of additions being made to the pre-existing dentine by the calcification of the superficial part of the pulp, several, or even many, independent centres of calcification may be established within its substance. In some cases, we find numerous irregularly globular masses of dentine; in others, one or two nodules sufficiently large to occupy nearly the whole of the cavity. It seldom happens that the larger masses are developed from a single centre. They appear to have been produced by the aggregation and coalescence of a number of lesser globules. This secondary nodular dentine may or may not be adherent to the walls of the pulp-cavity; it is, however, more frequently free than attached, and in that case fails to answer the useful purpose of protecting the pulp from exposure.

Mr. Salter speaks of the calcification of the pulp when it occurs upon the surface, producing new dentine continuous with the older tissue, as extrinsic calcification, and the new tissue as dentine of repair.

Dr. Bödecker, in a careful paper (Dental Cosmos, August, 1879) in which he summarises the views as to the nature and structure of secondary dentine, divides it into three varieties: (i.) secondary dentine resembling primary dentine; (ii.) secondary dentine with a laminated structure; (iii.) secondary dentine with forms analogous to Haversian systems. This latter variety has been termed "Osteo-dentine." He further points out that it is exceedingly common to find that the surface of the secondary dentine looking towards the pulp is excavated by absorption spaces, showing that coincidentally with its formation inflammatory conditions have existed in the pulp. "The pulp-tissue exhibited all the features of inflammation, to which also the bay-like excavations in the secondary dentine were doubtless due. If you consider the formation of secondary dentine as the result of slight but long-continued irritation, we readily understand that such an irritation may occasionally terminate in an inflammatory process—pulpitis.

"The newly-formed dentine, partly at least, will be destroyed by the inflammation, and thus produce a combination of both formative and destructive processes, so common in inflammation of bone-tissue. The presence of inflammation would also explain the pain which sometimes accompanies the formation of secondary dentine."

Treatment.—When the irritability of the tooth is consequent upon the presence of simple caries, our aim must be to introduce a temporary filling; some little caution must, however, be used, otherwise the remedy will but serve to increase the disease. The patient may have sufficient endurance to allow the excision of the whole of the affected dentine, and the subsequent introduction of a gold or other metallic filling, but the presence of metal, from the rapidity with which it transmits changes of temperature, serves, when the tooth is highly sensitive, to increase rather than mitigate the evil. The sensitiveness would, however, in many cases, gradually subside; in others, we should be required to remove the metallic filling, and substitute a non-conducting material. The white plastic fillings will be found extremely useful in the treatment of such cases. Indeed, whenever we find that greatly increased sensibility is established, we shall do well to introduce a temporary plug of this material, taking care to substitute gold or other permanent filling when the tooth has recovered its normal condition. In many cases, however, the pain occasioned by the excision of the decayed dentine is perfectly intolerable. The application of chloroform, creosote, or camphorated spirits of wine will lower the sensibility slightly; but no agent is so immediate and complete in its action as a fragment of nitrate of silver introduced into the cavity, and allowed to remain for five or six minutes. Of course, in the front teeth lunar caustic cannot be used, owing to the discoloration which it occasions; but in the back teeth the dark stain is of less consequence. The natural colour of the tissues, even in the molar teeth, should, if possible, be preserved, but not at the risk of losing them altogether. There is another advantage which attends the use of nitrate of silver: it has a power of arresting the progress of decay.

In connection with a generally heightened sensibility, we sometimes find a ring of decomposing and extremely sensitive tissue encircling the necks of several, or perhaps all, of the front teeth. The operation of filling is quite out of the question, and the complete destruction of the teeth is therefore reduced to a mere matter of time. Owing to pregnancy or some other cause, it may be desirable to adopt means for allaying the susceptibility of the teeth, and at the same time to preserve them, if possible, for a few months. In the treatment of cases of this description, nitrate of silver has proved very valuable. We can call to mind many cases in which, by the application of lunar caustic, great discomfort was removed, the presence of hot or cold fluids rendered tolerable, and the teeth, although blackened at the necks, were kept from further deterioration for many years.

It may be said that the foregoing treatment bears rather upon an abnormal condition of the dentine than upon an irritable condition of the pulp; and the objection may, in some cases, be valid, but it will be almost impossible to distinguish between pain felt in the dentinal fibrils and in the pulp, and the distinction in respect to the treatment is unimportant, as the conditions run into one another.

Irritation of a pulp which has not been exposed seems most prone to arise in cases where the progress of the caries has been very rapid, and there will often be found in the cavity a large thickness of softened dentine, which has not yet crumbled away, and still preserves a certain degree of consistence. The surmise may be hazarded that, in such cases, the dentinal fibrils have remained alive through a considerable distance in the softened dentine and have not perished *pari passu* with the progress of the softening; this idea being suggested by the great tenderness of the affected tissue.

It is a safe rule to defer the filling of teeth with irritable pulps until all sign of irritation has subsided; and so it is best to dress the tooth with soothing applications for a while, such as oil of cloves, or creosote, which latter is by many preferred to carbolic acid, though others doubt if carbolic acid diluted till it about corresponds in strength with creosote has not precisely the same effect without the unpleasant taste of the former drug. Strong carbolic acid may itself be used, especially when there appears to be some little thickness of dentine between the cavity and the pulp.

So far it has been assumed that no defined structural lesion has been present, at least no coarse lesion, for it is probable that in all cases of pulp irritation there is structural alteration, were we able to recognise it.

Counter-irritation, in the form of pepper-plaster, applied to the gum over the roots of the tooth, or even strong painting with iodine, will sometimes be successful in quieting pulp irritation, but occasionally all remedies prove futile. One of the most characteristic symptoms of irritation, or of chronic inflammation of the pulp, is the occurrence of sudden darts of severe pain, occurring capriciously, and leaving in the intervals no sensation whatever.

Inflammation of the Dentinal Pulp.—The occurrence of inflammation of the pulp is usually consequent upon its exposure, brought about either by caries or the accidental fracture of the tooth. Not that the pulp is more exempt from the occurrence of inflammation than some other soft tissues, but still the cases of idiopathic disease are not very frequent. In ninety-nine cases out of a hundred the diseased action is consequent upon the perforation of the pulp cavity. The following is the usual course of events:—A hole is discovered in a tooth, food and other matters collect in it, and are from time to time removed. The presence of foreign bodies at first produces no inconvenience, but after a while certain substances, such as sugar, or salt, or acid matters, when lodged in the tooth, occasion considerable uneasiness, which is, after a while, exchanged for positive pain. The removal of the irritating matter is soon followed by the restoration of comfort. This state of things may go on for some time, but, sooner or later, the pain, instead of passing off, steadily increases, assumes a throbbing character, becomes still more acute, extends from the faulty tooth to the neighbouring teeth, and to the side of the face, the tooth forming the centre of its intensity. After the lapse of some hours the pain usually subsides, to return again on the slightest provocation, or on the patient assuming the horizontal position. If a tooth be examined subsequent to two or three, or perhaps even after one, severe attack of throbbing pain, the pulp will be found to have lost its vitality, and to have passed, or to be in the process of passing, into a state of decomposition. With the death of the pulp there comes a period of remission of pain, prior to the occurrence of alveolar inflammation and abscess.

Such, then, is the usual course of events, when the pulp of a tooth becomes inflamed. The results of inflammation may, however, be modified by the constitutional condition of the patient; the symptoms may be less severe, or they may be greatly aggravated. In some cases the pain lasts but for a short time, and is comparatively moderate in degree, while in others it is continued for days with great intensity. Again, in one case the alveolar inflammation is absent, and in another the whole mouth becomes affected. Independent of the constitutional state, these differences in effect will no doubt depend upon the condition of the pulp prior to the advent of active disease. The size of the pulp will exercise a very material influence; and the number and size of the globules of secondary dentine within its substance may perhaps also tend to modify the severity of the symptoms. Generally, the smaller the amount of vascular tissue involved in the disease, the milder will be the symptoms; it is, consequently, seen that in young people in whom the pulp is relatively large, and the amount of secondary dentine within its substance comparatively small, the suffering is greater, and the inflammation more extended than in older subjects, in whom the pulp may have undergone some amount of fibroid degeneration. The size of the aperture by which the pulp is exposed, will also influence the amount of suffering which attends inflammation of that organ. Local constriction of an inflamed part, under all circumstances, greatly aggravates the pain. In a tooth the pulp is uniformly confined, excepting at the point where the wall of the cavity has been perforated; when the vessels become distended, and the more fluid portions of the blood are effused, the pulp will enlarge at any point where enlargement is possible, and it is consequently protruded through the aperture in the walls of the pulp-cavity. The hole in the body of the tooth is always much larger than the opening into the pulp-cavity, consequently that part of the pulp which has been protruded through the narrow opening into the larger space may there become enlarged, while the part which connects it with the pulp is constricted.

There are but few of us who do not know something of the pain which results from drawing the air from a carious and aching tooth—or, in other words, sucking it—whereby the atmospheric pressure is taken off the exposed portion of the pulp, leaving the vessels unsupported to withstand the force of the circulation. The immediate result is, that the pulp is forced against or through the opening, and in some cases its vessels are ruptured. The bleeding so produced not uncommonly relieves the distended vessels, and the inflammation is for the time checked. That which we can produce at will occurs, in a greater or less degree, without our intervention; and the amount to which the pulp is protruded, and the degree of strangulation which is induced by the form and size of the exposure, will largely modify the amount of pain. It must never be forgotten that the dental pulp has but little power of recovery when once it has passed beyond the stage of irritation, and it might almost be laid down as a rule that *a pulp which has once ached very severely is sure to die sooner or later*, and most probably at no distant time. It is a bad symptom when cold is found to give relief, and heat or even moderate warmth to aggravate the pain. When we find that a patient holds cold water in the mouth, and will hardly allow of adequate examination, because, as the tooth rises to the temperature of the body the pain increases, we may be sure that the pulp is in a state of acute inflammation and far past any treatment save its speedy destruction. On the other hand, a pulp which is merely irritated will dislike cold as much, or almost as much, as heat.

Merely premising, then, that acutely inflamed throbbing pulps are practically sure to die, their manner of death being probably by plugging of their vessels, and the aching thus oftentimes stopping with singular abruptness, and that therefore it is rarely if ever well to attempt any other treatment than destruction, we may pass to the consideration of the more chronic forms of pulp disease.

During the absorption of the roots of temporary teeth, their pulps undergo a degenerative process by which they are robbed of their extreme tenderness; in advancing age also a somewhat similar change takes place, so that the pulps come to contain oil globules in abundance, and are much less intolerant of irritation.

By a **chronic inflammation** of the tooth-pulp that which is generally meant might perhaps have been better called a local inflammation rather than one affecting any large area of the pulp; but, on the other hand, in many of the cases which would be called acute, it is not always the whole which is involved, so that this distinction somewhat fails us.

Dr. Arkövy has endeavoured to classify the diseased conditions of the pulp, and other writers have followed upon the same lines. But whilst the endeavour is praiseworthy, and some day may become an accomplished fact, the classification is hardly sufficiently established for adoption in a text-book. It should, however, be noted that the inflammation of a pulp does not always lead to gangrene of its whole mass, and such conditions are grouped under the head of chronic inflammations of the pulp.

These may perhaps arise independently of caries, or of the mechanical injury of a tooth, but practically their occurrence may be assumed to be consequent upon, and almost invariably coincident with, the presence of an opening into the pulp-cavity. It differs from the acute form of the disease in the less active character of the symptoms, and also in the results to which it leads. The pain is seldom long continued, or very intense when present. It generally comes on at irregular intervals, a periodical character being observed in exceptional cases only, although these partial inflammations of the dental pulp are specially prone to set up wandering neuralgic pains, the true origin of which may be obscured by the complete absence of local toothache. A sudden change of temperature, the application of an irritating substance, such as salt or sugar, will generally bring on a paroxysm of pain, which may endure but for a few minutes, or may last for several hours.

On carefully examining a tooth which gives rise to the foregoing symptoms, it will be found that the pulp at the exposed point has assumed a deep red colour, is extremely sensitive when touched with an instrument, and bleeds very readily. If the tooth be removed, and the crown broken through so as to expose the pulp, it will then be seen that the inflammation has been limited to that part which was, so far as naked eye examinations can discover, exposed, the remaining portion of the organ having retained the normal pale colour. Had the disease assumed the acute form, the greater part of the pulp would have been injected with blood, the exposed part being distinguished by the greater intensity of its colour.

In tracing the several consequences of chronic inflammation, the first which should attract attention is the change in the character of the exposed portion of the pulp. It becomes for the time being a secreting surface ; purulent or serous fluid is poured out from its surface, the amount and character of the discharge varying perhaps with the general health of the patient, but more certainly with the degree of irritation to which the diseased part has been subjected.

Supposing this abnormal condition to be established, the presence of pain is not a necessary consequence ; and it is important that the fact should be kept in view, for should it be assumed that the pulp is not exposed because the patient has not suffered from toothache, and a plug be introduced, it is highly probable that the tooth will be lost. The discharge will be blocked in by the plug, and its accumulation will, in the course of a short time, bring on an attack of acute inflammation of the whole pulp. It is therefore of great consequence, before proceeding to treat a carious tooth, to ascertain whether the pulp be exposed or not. The history of the case will not always determine the question, and the position of the tooth, or of the cavity in it, may be such as to render a satisfactory inspection difficult. The presence, however, of that peculiar phosphatic odour, to which allusion has been already made, is a tolerably sure indication that the pulp is exposed, and that a secretion escapes from its surface ; and it is, moreover, a sufficient warning to abstain from the immediate introduction of a permanent plug.

A second result of chronic inflammation is the formation of an ulcer, of a very painful and irritable kind, upon the exposed surface ; and a third consequence is the development of granulations, which may grow until a mass is formed exceeding the size of the pulp itself, and, in some cases, completely filling up the cavity produced by the destruction of the enamel and dentine. This condition is usually described as polypus of the dental pulp. The morbid growth is not necessarily very sensitive. It bleeds readily, and emits a very offensive secretion.

There are other results which attend chronic inflammation of the pulp. One consists in the gradual disappearance of the pulp by suppuration without pain, and consequently without any symptom which attracts the attention of the patient. The practitioner finds the pulp-cavity empty, and the root canals may also be empty, or may contain living pulps.

The foregoing conditions are inflammatory, and probably always produced by infection, but the pulp of a tooth (generally an incisor) may be killed by a blow without any breach of continuity in the tooth substance.

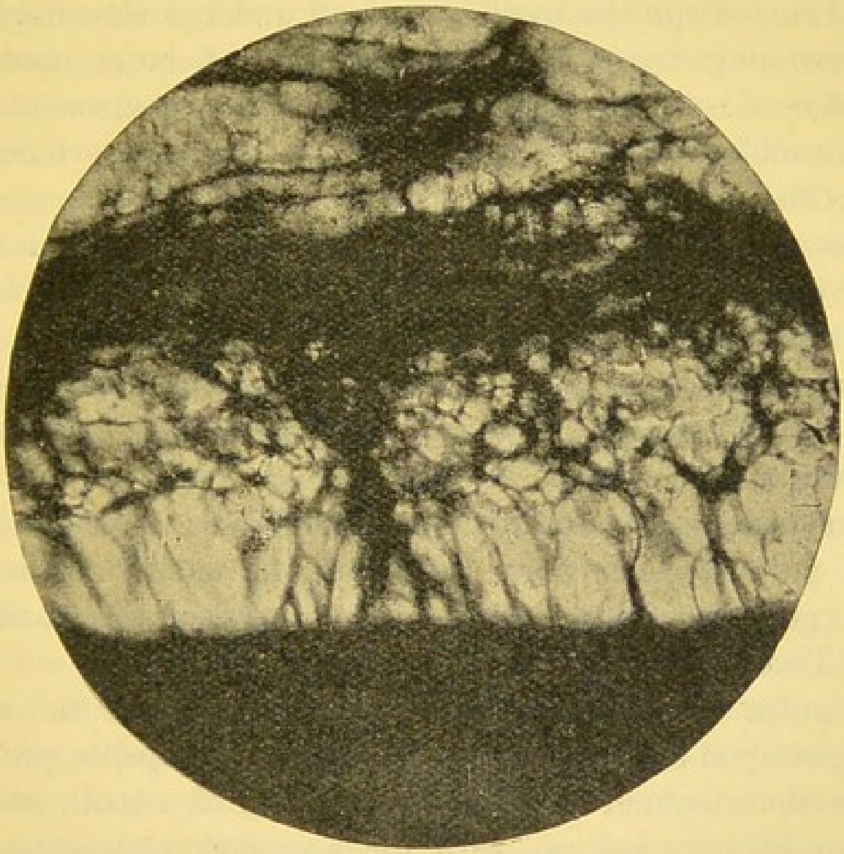


FIG. 196.—Mr. Hopewell Smith's example of degenerated pulp.

When this has happened, the tooth sometimes assumes a red colour, which after a time darkens to a dirty colour: this is believed to be due to a solution of the hæmoglobin contained in the pulp.

Subsequently it sometimes seems to dry up without giving rise to any symptoms, and sometimes decomposes with the production of very stinking material, which sooner or later gets out at the apex and produces a violent abscess.

By what agency this putrefaction is effected remains uncertain: the writer has examined several such cases without finding any bacteria, but it is improbable that a stinking putrefaction can take place without the presence of organised ferments, which therefore must have been contained in the blood, or must have got in from the tissues or the blood about the apical foramen, and have obtained a nidus in the dead tissues of the pulp. This matter, however, requires further investigation; but the rule of treatment should be to at once open up and cleanse a tooth so killed without waiting for symptoms to arise.

In advanced age the tooth pulp may undergo slow degeneration, becoming transformed into a mass of large meshes of connective tissue, in which cell elements are inconspicuous, the odontoblasts have disappeared, and nerves are hardly to be identified.

A beautiful example of such a pulp was given to the writer by Mr. Hopewell Smith, taken from a tooth extracted because it was loose, of which a figure is appended (Fig. 196).

Such pulps are generally tolerant of exposure, and probably would be of capping, but we have no means whatever of diagnosing the condition.

Other observers, notably Wedl and Black, have described similar pulp degenerations, and the first-named author has figured good examples of it in his "Atlas of the Pathology of the Teeth."

The pulps of elephants' tusks and molars have thrown no little light upon the changes of which a pulp is capable, probably because the elephant is unable to get rid of a tooth which a man would not put up with for a period long enough to complete the pathological processes. Thus a remarkable specimen in the museum of the Odontological Society, figured and described in the Transactions for 1877, shows reaction after injury by a bullet, which remained imbedded in the tooth. Whilst calcification has taken place in some directions, in others the pulp has largely absorbed the dentine, almost removing it from some of the plates, and I have long been under the impression that the human tooth pulp sometimes does the same thing.

Thus I have sometimes seen a small exposure capped: after a time it has become necessary to remove the filling, and it has been found that the inflamed pulp no longer presents a small exposure, but a large one, which no one would have thought of capping. In such cases no doubt the pulp has eaten away the edges of the aperture.

The apical foramen also sometimes becomes enlarged by absorption, and specimens like figure 206 show a large amount of absorption effected by the pulp. In elephants' tusks, being teeth of persistent growth, cavities are sometimes met with in the solid ivory which contain apparently dried up pus, and which have a distinct calcified capsule. These are believed to have been localised abscesses in the pulp which have had their boundary walls calcified, and have eventually, with the conversion of the surrounding pulp into ivory, become enclosed in solid dentine. Mr. Mummery has a specimen, somewhat egg-shaped, and with a smooth exterior, the whole interior of which is filled up with a sort of stalactitic growth shooting inwards towards the centre, somewhat as though a fibroid or a sarcomatous tumour in the pulp had become calcified from without inwards.

The pulp is also said to be subject to a fatty degeneration in which the nerve sheaths and the vessels are degenerated, and the cellular elements, especially the odontoblasts, almost disappear.

It cannot be said that our knowledge of the pathology of the pulp rests upon a very satisfactory basis, its histological changes having been insufficiently studied. We know, however, that, like other tissues, an inflamed pulp becomes infiltrated with abundant leucocytes, and that it breaks down in parts with pus-formation, sometimes on the surface, and sometimes deeper in its substance. And Professor Miller has found that it can become infected with organisms even through quite hard dentine of $\frac{1}{8}$ mm. or more ($\frac{1}{200}$ to $\frac{1}{100}$ inch) thickness, although this does not often occur.

As might be expected, a large variety of micro-organisms are found in diseased pulps, those of the coccus form occurring more abundantly than rods; indeed, he concludes that small round and oval cocci are constantly present, and that the other forms are accidental.

In his experiments he selected generally pulps which were still covered by some dentine, whether softened or not. He found that the bacilli, when isolated in pure cultivations, did not cause suppuration in mice, but that the cocci very generally did; nevertheless, *Streptococcus pyogenes* was only occasionally met with, and *Staphylococci pyogenes aureus* and *albus* also only a few times.

But the cocci which were found were just as efficient in producing suppuration as these well-known forms, and they also seem to be the agents by which the singularly offensive putrefaction of a tooth-pulp is effected.

Infection of mice with emulsions of putrid pulp produced very severe effects, possibly from ptomaine poisoning and from bacillary infection; so that a putrefying pulp must have considerable powers of mischief, which are apt not to be sufficiently considered.

It is interesting to note that the coccus of sputum septicæmia was never detected in a tooth-pulp (Miller, Dental Cosmos, July, 1894).

Professor Crookshank gives in his list of bacilli one to which he gives the name of *B. pulpi pyogenes*, which is cultivable in gelatine.

According to Miller, there are several kinds of bacteria found in the diseased pulp which are not cultivable on artificial media; and spirochæte and spirilla have been found in dental abscesses in almost pure culture.

As to the occurrence of *Diplococcus pneumoniæ* (= Sternberg's micrococcus, micrococcus of sputum septicæmia), there is some difference of opinion. Miller, as has already been stated, did not find it; but Shreier considers that he did do so in many instances. Miller, nevertheless, from an examination of the phenomena recorded, doubts whether it was really the pneumococcus with which he had to deal.

Treatment.—There are some practitioners who claim that a vast majority of unhealthy pulps may be rendered healthy, and subsequently capped, even when suppuration has proceeded to the destruction of a considerable part of the pulp, so that the pulp-chamber is only half full; they hence discard the use of arsenic or other means of destroying the pulp, and adopt in all cases a conservative line of treatment. The late Dr. Belisario, of Sydney, for some years had discarded the use of arsenic, and found that he could get on quite well without it, though of course such pulps sometimes die subsequently spontaneously.

Miller is of opinion that an endeavour should be made to save all exposed pulps, provided that no suppuration has occurred. Dr. Witzel, in his treatise upon the antiseptic treatment of the pulp, retains even small portions of pulp alive, and Mr. Henry (Trans. Odont. Soc.) advocated the same course.

The opposite extreme of practice is represented by those who, like ourselves, believe that the power of the tooth-pulp to recover after once it has been seriously diseased (as evidenced by its having ached badly) is so poor that it is morally sure to die, and therefore would prefer to at once destroy the pulp and fill the roots, lest by its subsequent spontaneous death an alveolar abscess supervene, and require lengthy treatment to effect a cure.

Many practitioners think that the safer course lies between these two extremes. If, on the removal of the soft dentine from a cavity, we find that perseverance to the point of the excavation of all that is affected would bring about an exposure of the pulp, and the previous symptoms point only to a moderate degree of pulp-irritation, a thin layer of the soft dentine should be left at the deepest part, and dressings applied; it will very likely be found, on changing these, that there has been a slight oozing through this layer of dentine, and that the wool is a little stained. The repeated application of creosote, of tannin, of oil of cloves, or of camphorated spirit, will after a time result in the dressings remaining clean, and this same result will sometimes be obtained even where there has been a small exposure.

So soon as this result has been obtained, the tooth should be filled without delay, lest the ground gained be lost again by the supervention of some new irritation, and the deep portion must, of course, be given protection by the insertion of a capping; a rigid material like the oxychloride with oil of cloves, is to be preferred to a yielding one, such as a layer of gutta-percha or of card.

It is sometimes a matter of difficulty to decide whether there is an actual exposure without running the risk of making one by our explorations. The occurrence of a phosphatic odour means that there is a discharge from the pulp, and that it is presumably exposed ; but it must not be forgotten that an oozing through a thin layer of dentine is quite easy, that structure being tubular. If a jet of suitably warm water thrown into the cavity causes pain, the pulp is probably actually exposed ; and if the pressure of a small pledget of wool has the like effect, the same inference may be pretty safely drawn ; but the treatment already indicated will generally suffice if the exposure be so small as to leave its existence in doubt.

If the exposure be larger the tooth should be very carefully cleansed by jets of warm water, and powerful escharotics avoided, the tooth being dressed with dilute carbolic acid, or oil of cloves, or camphorated spirit ; thymol also answers well. The exposed pulp having been brought into a healthy state so far as is evidenced by the cessation of discharge, some writers recommend its being flooded first with creosote and then, without wiping this away, with oxychloride mixed very thin ; we prefer, however, the less irritating oxyphosphate mixed up with at least equal parts of oil of cloves.

Upon the whole the result of extended experience, and the careful treatment of many suspected pulps, renders us less and less inclined to attempt the preservation of pulps which have once decidedly ached. Pain, though a symptom varying much in its significance in different individuals, is after all almost the only indication upon which we can form an opinion as to the state of a pulp, and we must once more repeat that an infected pulp has hardly any power of recuperation, and if it is to die, it is better to destroy it than to leave it to die and decompose and infect the socket.

When a pulp has ached obstinately, notwithstanding all efforts to soothe it, or is found to be largely exposed and to have lost some part of its substance by suppuration, the ordinary treatment is to anticipate its probable, if not certain, death by destroying it with an escharotic, the only one which has proved reliable being arsenious acid. (Arsenic acid, which is more soluble, has been preferred by some few, but as arsenious acid is quite efficacious, it is at least doubtful whether a greater degree of solubility is to be reckoned an advantage or the contrary.)

In making an application of arsenic there are three points
rsenic to be observed : one is to use as little as possible, a sixteenth of a grain being quite sufficient ; another is to seal it in so

that none shall leak out upon the gum, where it would produce sloughing; and the third is to get it into thorough apposition with the pulp without pressure. Preparations containing a sufficiency of arsenic such as devitalising fibre, or paste, are possibly more convenient and safer to use.

Even if pressure is avoided, some degree of pain is likely to accompany the destruction of the pulp, but this pain is apt to stand in an inverse ratio to the completeness of the contact of the drug with the pulp, the most severe pain being generally met with when the exposure is imperfect. The addition of a sedative to the arsenic, such as morphia, does not appear to have any definite effect; the drug may be applied upon a tiny pledget of dry wool, or this may be moistened with oil of cloves, so as to pick up the powder better.

The arsenic should be left for one or two days, and the pulp then examined; if its sensitiveness is not nearly abolished a second application will be necessary, but it will usually be possible prior to making this to enlarge the opening, and perhaps to remove some portion of the pulp. It is an advantage when the sensitiveness is nearly gone to insert a dressing of tannin, and to leave this for several days; this will have the effect of hardening the pulp so that it will be easier to pull it out in one piece.

The root canals should almost invariably be permanently filled immediately after the pulp has been removed from them. Cases do occur, however, in which it may be inadvisable or impossible (owing to old age, etc.) to adequately "open up" a tooth for root-filling; in such cases the arsenical dressing should not be left in the cavity for more than twenty-four hours. The pulp chamber is then cleared of its contents, and a paste containing an essential oil, tannin, and iodoform applied on wool and sealed in; or a so-called mummifying paste may be employed. Dr. H. Bönnecken suggested the following formula:—

℞. Cocainæ ⎫
  Thymol ⎭ ā ā ʒj.

Misce et adde.

Formaldehyde solution (40 p.c.) ♏ 40;
Zinci oxidi, ʒij.;
Misce Fiat Pasta.

It would appear that there are a few persons who are especially susceptible to the action of arsenic, just as there are others who are salivated by a single dose of blue pill.

Mr. Harding has placed upon record (Trans. Odont. Soc., 1881, p. 38) the case of a lady who thrice presented the symptoms of arsenical poisoning, slight gastritis, diarrhœa, a rash, etc.; the first time after an arsenical dressing applied to a tooth, the second after a few doses of liq. arsenicalis, the third after a careful application of arsenic to a tooth, there having been no appearance of its having leaked out.

It has been alleged that very disastrous results have in some very few instances followed upon the use of arsenic; the

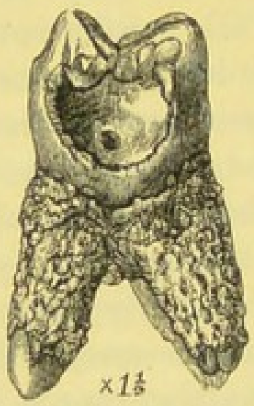


FIG. 197.—Molar tooth, in which the bone immediately embracing the roots had exfoliated. The reddish colour of the dentine suggests that arsenic had been applied, but there is no history with the specimen.

sloughing which it will produce if it leaks out upon the gum has already been alluded to, but this will at times go farther, and a small piece of the subjacent bone will exfoliate. This is an accident which will have come within the experience of most practitioners, and it is not usually productive of anything beyond temporary inconvenience, but in one instance a canine tooth was lost by exfoliation of a thin piece of bone which constituted the whole lining of its socket; this was accompanied by very little inflammatory disturbance.

A similar accident occurred whilst treating a molar, but in this latter case the application appeared to have been made with the utmost carelessness, which had not been the case with the canine. And in the American journals some years ago a case was reported in which death resulted from extensive ostitis and suppuration following after the destruction of a nerve by arsenic. It so happens, however, that the account of the case serves to fully disprove the conclusion of its reporters, for the thoroughly characteristic septic inflammation which occurred was obviously, if it was indeed referable to the tooth at all, due to abscess resulting from inappropriate treatment of the roots of the tooth, which was shut up when it ought to have been left open, and left in long after prudence of the most ordinary kind would have dictated its removal. Dr. Arkövy, in a paper read before the International Medical Congress in London, adduced experiments to show that even with all precautions, when arsenic was left in a tooth it travelled very speedily right down to the end of the pulp, and even out at the end of the tooth; but these experiments, looked at in a purely practical bearing, prove too much, for whereas he believed that its reaching to the periosteum, *i.e.*, the apex of the root, was a usual thing, we know by clinical experience that its doing any harm at all is an exceedingly rare thing.

The dental pulp may often be painlessly removed after anæsthetising it and rendering it bloodless by the following method :—Take up between the points of the conveying forceps one or two drops of adrenalin chloride solution 1 : 1,000, and release the fluid into the dried cavity, then add to this about one-fifth of a grain of powdered cocaine, and a drop of a 40 per cent. solution of formaldehyde (the latter is not essential). Over this place a sufficiently large piece of unvulcanised rubber, and apply a gradually increasing steady pressure for about one minute, and finally knead the rubber into the cavity. A barbed Donaldson bristle is then passed slowly to the end of the root canal, rotated, and the pulp removed. By this method a healthy or fairly healthy pulp may almost invariably be painlessly removed in a few minutes; it is, however, unreliable in cases of chronic inflammation of the pulp.

The pulp having been devitalised, before any attempt is made to remove it the mouth of the pulp-cavity should be freely opened out so as to give access to the root in nearly or quite a straight line, and a barbed nerve extractor gently passed through by the side of the pulp in the root canal as far as it can be got to go; it is then rotated for a turn or two so as to entangle the pulp; it is then withdrawn, the result being, that if fortunate, the operator breaks off the pulp at the apical foramen and withdraws it entire. When a pulp is destroyed, and thus got out entire, we do not start with any septic condition, and our great aim is to prevent such contamination arising in the course of manipulation, so that it is a very good plan, where the shape of the cavity renders it possible, to accomplish this part of the operation under a pool of eucalyptus oil, of creosote, or of oil of cloves, these antiseptics running down into the canal as the nerve comes out and leaves it vacant.

FIGS. 198 AND 199.—Nerve extractor, and Broach holder.

If this be impossible, a Donaldson's nerve bristle should be ready, carrying a wisp of wool charged with an antiseptic, and this should be instantly inserted and left in the root whilst the other roots are being cleared.

And as we start fair in respect of septic contamination whenever the pulp comes out entire, and the root is of such form and dimensions that there is no uncertainty in reaching to the end of it and in making a thorough root filling, there is not the least object in deferring the operation; on the contrary, things will never be in a better state, and they may afterwards be worse, so that the root filling may with advantage be done then and there. When, however, it is not possible to get a barbed nerve extractor up, and the root pulp has to be removed piecemeal with a slightly hooked bristle, or by the repeated rotation of fine watchmaker's broach, then, lest some little fragments have remained behind, it will be safer to leave an antiseptic dressing up the root for some days, and even to repeat it several times.

In the case of single rooted front teeth the pulp may be removed without previously killing it, a nerve extractor or a broach being boldly thrust up quite to the apex, and given a turn or two so as to cut or break across the pulp at this point; this may often be very advantageously done when front teeth have been broken across their pulp-cavities by a blow, but an anæsthetic is desirable in order to spare the patient the very severe though brief pain which the operation would otherwise cause.

A hand drill of the form here figured was formerly a favourite instrument for enlarging the orifice of the pulp-cavity with a half dead nerve, and it remains in use with some practitioners, though most will prefer a bur in the engine used cautiously.

A difference of practice obtains in respect of enlarging or not interfering with the root canals, some being very averse to drilling them out, and others advocating free enlargement of almost all.

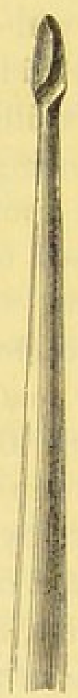


FIG. 200. — Hand Drill for enlarging the orifice of exposure: it will not slip suddenly into the pulp chamber.

In a rough general way it may be said that the orifice of a canal should be opened up with a tapering bur, and if the root has contained septic matter it is advisable after drying to ream it out with Beutelrock or Gates' drills. Small root canals may also in many cases be reamed out to facilitate efficient filling; but in larger canals, which have never been septic, there is no object in drilling them out. Buccal root canals of upper molars are sometimes too small to admit the finest instruments, and are better left alone after their orifices have been treated antiseptically and thoroughly dried. All root canals must be perfectly dry before they can be filled; for this purpose the canal may be wiped out with absolute alcohol, all free moisture rapidly removed with paper fibre points, followed by a blast or two from the hot air syringe.

No root can be held to have been made as safe as possible unless its apex can be pretty easily reached, and the attempt to judge of its length and curvature by means of fine bristles having been made, it should be cautiously reamed out, the safest instrument to commence with being a flexible watch-maker's broach, the temper of which has been lowered, this being followed by a Gates' or Beutelrock's drill in the engine.

It is useless to attempt to fill roots unless they are accessible, and this will often involve cutting away a good deal of tooth substance, so that sometimes it will be found easier and better to drill an entirely fresh hole in the axis of the roots through the crown of the tooth ; this will be found specially advantageous in the case of distal cavities in the molars through which thorough root filling is all but impossible.

Root fillings.—This much premised, a choice has to be made of the various materials available for filling roots.

The condition of a root is sometimes such that it may be filled with a very tolerable certainty that no inflammation will follow, and that there is not the least likelihood that the root filling will ever want to be removed ; under such circumstances, and provided that the canals are accessible and of fair calibre, no root-filling is better than gold or tin, and the method of introducing these may first be described.

The root, having been thoroughly cleansed with dry wool, is wiped out with a wisp of wool dipped into creosote or absolute alcohol or camphorated spirit; this done, four or five broaches which have been previously prepared by winding a very small portion of gold or tin foil round them for a short distance from their tips are successively taken and gently passed up to the apex of the root, the foil when there being slid off by rubbing it against the sides of the canal, and then impacted down by pressing with the end of the broach, which, of course, must be blunt-ended. The three or four broaches will have introduced enough foil to plug the immediate apex, and then very small ropes or strips introduced upon any blunt-ended instrument of suitable form and thickness will serve to complete the root-filling.

One of the dangers in filling roots is the occurrence of a piston action, by which any septic contents of the canal might be forced out at the end ; but foil introduced in this way minimises this danger, and most thoroughly satisfactory results are attainable in easy roots, though it may be questioned whether it is really better than any other method, for it certainly takes more time, and is hardly applicable to difficult or very minute roots.

And if in spite of due care and apparently favourable conditions inflammation should arise, it is exceedingly difficult to get foil out of a root which has become very tender under pressure.

An ideally perfect root-filling should seal the canals absolutely, be easy of introduction, be non-irritant in case a trace gets out at the end, and also be easy of removal; nothing seems to quite fulfil all these requirements.

A favourite material with many is zinc oxychloride mixed very thin, and carried up on small filaments of wool, which, of course, are allowed to remain; but it is difficult to remove, and also difficult to introduce with certainty down a small root. Another material, largely used in America, is a solution of gutta-percha in chloroform, which is pumped up the root, and the chloroform allowed to evaporate as much as it will; no harm is done if some filaments of wool are left behind in this, but it is rather easy to get it through the apical foramen, and it is not always well tolerated if this happen. This may be combined with the use of gutta-percha points. Gutta-percha points, dipped a few minutes previous to inserting in eucalyptus oil, and carrying down with them a little iodoform, make excellent root-fillings in the vast majority of cases.

For some time we were in the habit of using a paraffin, solid at the temperature of the mouth, but melting only a little above it; this, which was carbolised, was easily got down by the repeated introduction of hot bristles through it, a pool of melted paraffin occupying the pulp chamber during the process, through which bubbles of displaced air passed as the broaches went in and out of the canals.

Excellent results seemed to attend the employment of this process, and irritation was most rare, as nothing approaching to a piston action could occur; but on opening up such teeth after the lapse of months or years, the pulp canals were sometimes found to be sweet but empty, the semi-solid paraffin having apparently been soaked up by the dentine, and it has therefore been abandoned in favour of wax with a higher melting point: an antiseptic such as iodoform may be incorporated with the wax.

Dr. Morrison, of St. Louis, has advocated the use of very soft gold wire, with which he claims that the apical foramen may be very exactly sealed, and it is an advantage to combine the two processes, pumping in the melted wax and then introducing a suitable wire made very hot and leaving it there.

This gives a root-filling at once complete and easy to remove in the event of irritation coming on.

Yet another useful material is shellac, with a small quantity of wax melted with it ; this can be drawn out into exceedingly fine threads, of which a number are introduced side by side, till no more will go in, and then they are melted by allowing a drop or two of absolute alcohol to run in, or by repeatedly plunging in hot wire. In this case also, if it is thought fit, a wire may be left in when it is finished ; this shellac root-filling is not at all difficult, and the results are very good, but it is not very easy to get out unless a wire be left in, in which case, with the aid of spirit, it can be softened and got out fairly easily.

Unless the root-filling selected is such that it cannot be got out at all, it is a good practice to defer the filling of the body of the cavity until a few weeks have elapsed, gutta-percha being introduced meanwhile.

For the filling of flattened roots an instrument made by grinding a piece of watchspring down till it is very narrow will be found handy.

But if a large number of molar and bicuspid teeth be examined out of the mouth it will be seen that there are a not inconsiderable number of teeth in which the roots are of such form and curvature that a perfect root-filling is absolutely impossible, nor could the roots be enlarged to a satisfactory shape; such roots cannot always be recognised while the tooth is still in the patient's head, and there is thus introduced an element of uncertainty against which no care can avail.

In a tooth possessing more than its normal number of roots, failure may result from overlooking the extra canal; this is perhaps most likely to occur in the case of a three rooted lower molar, though, of course, in many cases, it would be obvious enough that there were three roots, and all could be dealt with. As it may fairly be said that so soon as the pulp has once become involved in the advance of caries, an element of uncertainty has been introduced into the treatment, no matter what care be taken, it is a very usual and a good plan to postpone the insertion of a permanent filling which would involve not only the expenditure of a good deal of time, but also a considerably greater amount of handling to the tooth until the success of the treatment has been assured by the lapse of a material length of time, and so a temporary filling is generally inserted after root-filling ; for this purpose gutta-percha answers admirably, and no form of it so well as the red base-plate preparation.

So far those cases only have been taken into consideration in which there has been to start with no irritation of the alveolar periosteum, but this fortunate state of things by no means obtains in the majority of the teeth which require root-filling.

Iodoform has attracted some little attention as an antiseptic for the treatment of root-canals, and is in many respects admirably adapted to the purpose. It is a body obtained by the action of iodine on alcohol, solid, crystalline, and of heavy disagreeable odour. It is inimical to, but not absolutely destructive to, all forms of organisms, for micrococci have been found growing in a fluid smelling strongly of iodoform ; and it is not quite certain in what way it acts, though it is believed that it is by the setting free of iodine, itself a powerful antiseptic, and probably doubly powerful in a nascent state. It has the advantage of being non-irritant, and of being very lasting in its effects, for wool saturated with it is found to retain its smell, colour, etc., in the root of a tooth for years, while it is in the experience of every one that all trace of creosote or carbolic acid disappears in a comparatively short time.

In this country it has been generally used by being carried on a filament of wool moistened with eucalyptus oil, but Dr. Bödecker recommends the employment of an etherial solution, about a drachm to the ounce, with which the canals are mopped, and the apices treated, the roots being subsequently filled with gutta-percha solution, to which a little iodoform has been added.

Iodoform is capable of producing poisonous effects, though only when it has been applied in quantities vastly greater in amount than could be introduced into a tooth ; a drachm is the smallest quantity which has been known to produce any symptoms.

Hydronapthol and a number of similar bodies have also been used with considerable success, and it is a wise precaution to make use of some antiseptic prior to filling any root, healthy though its condition may be presumed to be.

The following diagram, copied from the "American System of Dental Surgery," and showing the years at which the calcification of the roots is completed, will be found useful in considering the question of root-filling in young subjects.

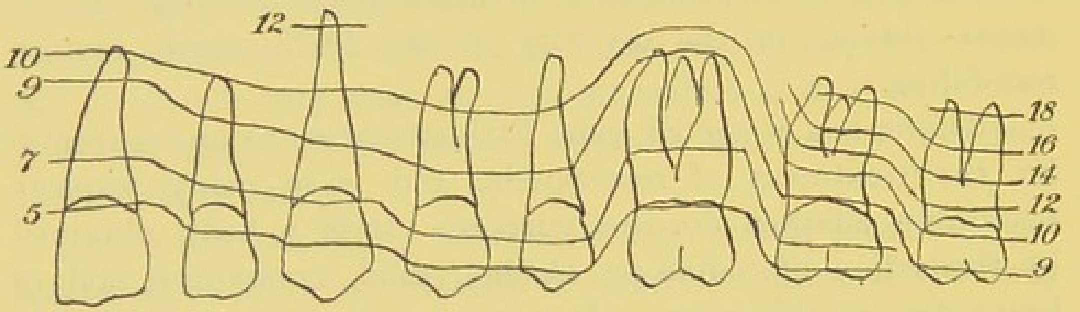


FIG. 201.

INFLAMMATION OF THE ALVEOLAR PERIOSTEUM.

The inflammatory affections to which the lining membrane of the sockets of the teeth is liable admit of division into the following groups:—

The first will include (i.) general inflammation of the alveolar membrane affecting the socket of each tooth, or at all events the majority of the teeth equally, and dependent for its origin upon a constitutional condition, such as rheumatism, scurvy, the presence of mercury or some other agent in the system, etc., etc.

(ii.) Local inflammation involving the sockets of one or two teeth, and dependent upon a local cause.

The causes of periostitis about the jaw are various. Thus it may be set up by the inhalation of phosphorous fumes, and ultimately give rise to phosphorus necrosis. Or it may arise in a scrofulous person; or, again, as a result of syphilis or rheumatism. In any case, proliferation of cellular elements takes place in the periosteum; they may disappear, or soften down into pus, or become organised into bone. It was pointed out by the late Mr. Wood that the hardening is more common in a rheumatic than in a strumous or syphilitic node, on account of the greater readiness of the fibrine to organise in the former disease, and, as a consequence of this, necrosis is made less likely to ensue than in the latter.

Intense toothache is an early symptom of rheumatic periostitis, which is, like other rheumatic ailments, greatly affected by the weather; there is not much tendency to swelling or to suppuration, whereas in scrofulous periostitis the pain is often slight, and the swelling is usually considerable.

At the outset of general inflammation of the intra-alveolar periosteum, the first indication of the presence of disease is found in the teeth. The uneasiness in the first instance is of that kind which provokes a disposition to grind them forcibly together. For the moment the pressure of the teeth into their sockets gives relief, but the feelings of discomfort speedily return, and in the course of time they become unpleasantly sensitive to pressure. This is succeeded by a tendency to ache slightly on their temperature being disturbed by a current of cold air passing over them, or by the presence of hot or cold fluids. As the disease progresses, each tooth feels lengthened and loosened, and can no longer be used in mastication without producing a considerable amount of pain. The patient restricts himself to soft food, and takes even that with some degree of caution. If the state of the mouth be examined, we shall find that the disease has extended from the inner to the outer covering of the sockets, and to the gums; that the latter are of a dark colour, thickened and vascular, with the free edge thickened and more deeply coloured than the surrounding parts. Each tooth may be moved slightly from side to side with the thumb and finger—a condition due to the thickened state of the lining membrane of the socket, and the consequent elevation of the tooth from its proper level. The severity of the symptoms will vary from day to day as the general condition of health is better or worse. When the disease is essentially rheumatic in character (and it is to the disease when so modified that the foregoing description is more especially applicable), the inflammation seldom advances beyond a congested state of the vessels, with effusion into the surrounding tissues. It is only in extremely severe cases, if ever, that suppurative action is established, and in them the secretion of pus is limited to that portion of the alveolar membrane which merges into the mucous membrane at the necks of the teeth. The purulent discharge oozes up between the gums and the teeth, and may generally be rendered visible by making pressure upon the former. But it may be doubted whether these suppurative cases really belong to the rheumatic category.

Prolonged inflammation of the alveolar membrane may lead only to the absorption of the alveoli, as in scurvy or in mercurial salivation; and this, with the consequent loosening and loss of the teeth, is a common result. But examples are not wanting to show that the suppurative state may, in enfeebled and strumous subjects, be succeeded by ulceration of the soft parts and necrosis of the alveolar margin, involving, perhaps, the loss of a considerable portion of the jaw.

We have seen a few cases in which the inflammatory action has ultimately led to the production of large florid granulations. They have sprung up close to the teeth, the crowns of which have been in great part overrun and obscured by the morbid growth. The patients complained of pain and tenderness in the teeth, and perfect inability to use them in the mastication of food.

When inflammation of the alveolar periosteum is connected with a rheumatic state of the system, the principal indication of the presence of that disease may at times be confined to the state of the teeth and gums ; but the abnormal condition of these parts, when so affected, can scarcely be said to present a specific character. The patient will attribute the visitation of disease to exposure, to a draught, to having taken cold, and will tell you that the feeling of comfort will now, as heretofore, be restored in the course of a few days.

There are, however, cases of inflammation of the alveolar periosteum which present a specific character, have a specific cause, and follow a specific course. One of the effects produced when the system is falling under the influence of mercury is a congested state of the vessels of the alveolar periosteum. The teeth become tender, elongated, and loose, and the breath tainted with the mercurial fœtor. Let the exhibition of the metal be continued, and large sloughs will be formed upon the inflamed parts, and portions of the alveoli, with the contained teeth, will be lost. If, on the contrary, the mercury be discontinued when the inflammatory action is, although well marked, moderate in amount, the induced disease will gradually subside.

The following substances are enumerated as occasionally producing ptyalism. Preparations of gold, of copper, of antimony, and arsenic ; also castor-oil, digitalis, iodide of potassium and opium, croton-oil given internally, and nitro-muriatic acid applied to the surface of the body.

Moderate salivation, induced once or twice only, may cause but little permanent mischief ; but if the ptyalism be kept up for a long time, or if it be frequently induced, a permanent injury will be inflicted upon the organs of mastication.

The degree of mischief will depend upon the length of time the system has been kept under the action of mercury, but the idiosyncrasy of the patient will exercise a still greater influence. There are those in whom a single dose of calomel, or even of blue pill, will produce salivation, and the second or third induce the formation of large sloughs, with necrosis of more or less of the alveolar processes. There are others, again, in whom it is extremely difficult to produce ptyalism.

The destruction from sloughing of the soft parts in the alveolar region of the mouth, consequent upon inflammation commencing in the gums and intra-alveolar periosteum, is sometimes so extensive that the cicatrices which follow drag down and fix the cheeks firmly to the maxillæ, and limit the motion of the jaw, depriving the patient of the ability to open the mouth sufficiently for the ready introduction of solid food.

The **treatment** in general inflammation of the alveolar periosteum must, in cases dependent upon a bad state of the system, be addressed to the improvement of the general health. If the local disorder depends upon rheumatism, the usual remedies for the relief of that disease should be administered, such as salicylates, alkalies, or fomentations or steaming of the mouth, and abstinence from malt liquors; in some cases iodide of potassium in large doses will have a most marked effect in cutting the disease short. If the malady assumes a strumous type, diet should be closely attended to, which is far more efficacious than any treatment by drugs. If the disease be dependent on an enfeebled state of the body, a generous diet, with quinine, or some other equally active tonic, will prove advantageous.

In aiding the general treatment, local remedies will be found useful. During the stage of congestion, finely-powdered tannin may be rubbed upon the gums night and morning, or even more frequently; or the gums may be painted with tincture of iodine (double strength). If the secretions of the mouth are offensive, or if pus be formed between the teeth and gums, a wash composed of eight or ten grains of chloride of zinc to an ounce of water will afford relief if held in the mouth for two or three minutes at intervals of four or six hours. When the inflammation is slight, a solution of borax in eau-de-cologne forms an agreeable and efficient application; but when suppuration has been established, or when sloughs have formed, the solution of chloride of zinc (the strength of which should be varied to suit the case) will be found to produce a much more rapid and beneficial effect. The fœtor which attends such cases is at once removed by the zinc, and the parts undergoing suppuration, if the general health be improved, are brought into a more healthy state. A state of inflammation having been established from a general cause, is sometimes kept up by two or three defective teeth. Now, whatever may be the nature of the defect, in the absence of a speedy and complete improvement the teeth should be removed.

Local Inflammation involving the periosteal investment of the roots of one or two teeth.—It may be convenient to consider this subject under the two heads of chronic and active or acute inflammation, though no sharp line of distinction can be drawn between them. Chronic inflammation may never go on to suppuration, or on the other hand it may be left remaining after an acute suppurative inflammation has run its course.

In chronic inflammation the periosteum becomes considerably thickened, and in association with this thickening additions to the cementum, more or less regularly disposed, may generally be found; on the other hand, evidences of absorption of the cementum are often present, the two processes of absorption and deposition frequently alternating—this is very characteristic of the condition. Teeth affected with chronic periostitis are usually slightly tender, and, owing to the thickened periosteum, give out a duller note than a healthy tooth when tapped with a light steel instrument, but they do not usually cause severe pain when not disturbed. The gum over the affected tooth is often of a dusky red, and is only slightly tender to pressure with the finger. The treatment differs little from that applicable to an acute inflammation after the most acute stage is passed, and may therefore be deferred till that is described; counter-irritants applied on the gum over the root are more useful than in acute inflammations, strong iodine tincture and capsicum plasters being amongst the best applications.

If allowed to run its course uninterruptedly, the inflammation may end in the loss of the tooth. The tooth becomes loose, the edge of the alveolus disappears, and the gum sinks down. By slow degrees the tooth loses its implantation and falls out. This will sometimes happen with teeth the roots of which have been successfully filled, so far at all events as the avoidance of active inflammation indicates success.

A chronic inflammation of the periosteum may be independent of any septic influence; thus pressure of an opposing tooth, if oblique, may set it up; a ligature about a tooth, a ring of tartar, or injury from a blow are also possible causes.

In rare cases acute inflammation appears in the sockets of teeth perfectly free from caries, and apparently from any other morbid condition; these cases are probably referable to one or other of the causes of general periostitis which have just been enumerated.

Acute inflammation of the dental periosteum, when confined to the alveoli of one or two teeth, usually arises in connection with, and as a distinct sequence of, pre-existing disease in the involved tooth or teeth, and in the vast majority of cases it is a septic process consequent upon the death and subsequent decomposition of the pulp. Whatever may be the exciting cause, the symptoms of the disease present but little variety, excepting as respects their intensity, the rapidity with which the different phrases of inflammation succeed each other, and the extent to which the neighbouring parts become involved.

The inflammatory action usually sets in with feelings of slight uneasiness and tension, sensations which excite a strong desire to press with the opposite teeth, or to shake with the fingers, the affected tooth in its socket. Slight, steady pressure of the root into the jaw gives relief, but the uneasiness returns on the pressure being withdrawn. The sense of uneasiness is soon followed by a dull, heavy pain, and the tooth feels to be longer than its fellows. The desire to move the tooth in its socket continues, till disease has rendered the parts so tender that pressure can no longer be borne, and even the other teeth cannot be firmly closed without pain owing to the elongation of the affected tooth.

The existence of disease within the socket is soon shown in the gum, which becomes swollen and tender opposite the root of the tooth whose periosteum is affected. In addition to this latter symptom, and often prior to its appearance, the free edge of the gum assumes a deep red colour, unaccompanied by pain, tenderness, or any swelling. The neck of the tooth appears encircled with a well-defined red ring. This symptom is usually present in the earlier stage; but as the disease advances the distinction is lost in the general inflammation of the gum. In health the gums near to the necks of the teeth are pale in colour, whilst opposite to the deeper portions of the root they are darker, and fine vessels are visible in them; in periostitis this distinction, termed by some American authors the "health line," is lost. The pain becomes more severe, but still preserves its heavy, wearing character, and though not always constant, is seldom absent for many successive hours.

If the progress of the disease be unarrested, the periosteum becomes detached from the cementum, and the point of separation usually commences at, and extends from, the apical foramen of the root. In the interval thus made pus is formed. The root at this part loses its vitality, and is bathed in pus, the quantity of which is gradually increased, space being gained in the alveolus for the dilatation of the abscess at the expense of the bone. The extent to which the alveolus becomes excavated will vary with each case. It may be hollowed out to a very limited extent around the apex of the root, or a large cavity may be formed, exceeding in dimensions that which has been made the subject of the following figure. The size of the abscess will depend upon the activity of the symptoms, the time the pus is pent up, and the state of health of the patient.

Mr. Lloyd Williams (Trans. Odont. Soc., 1887), pointed out that in inflammation at and near to the apex of the root, the new tissue which forms is very fibrous, the fibres lying parallel with the roots; if it goes on to suppuration, this is due to an infiltration of the tissue with leucocytes which break down the tissue, and pus is formed, not necessarily at first in immediate contact with the bare root.

So soon as suppuration is established a process is set up for liberating the secretion. Either the periosteum becomes detached from the neck of the tooth, and the pus finds its way by the side of the socket and passes out at the edge of the gum, or a perforation is made in the wall of the alveolus, through which the contents of the abscess pass into the substance of the gum. At this stage of the disease we have a kind of double abscess—an abscess with a constriction, one division of which is situated in the gum, and the other within the alveolus, the two being connected by a small opening through the alveolar plate. If the disease be left to run its own course, the contents of the abscess will sooner or later find their way to the surface and escape. But the time occupied in the process will depend upon the situation of the disease, upon the condition of the parts prior to the advent of disease, and upon the general condition of the patient. In

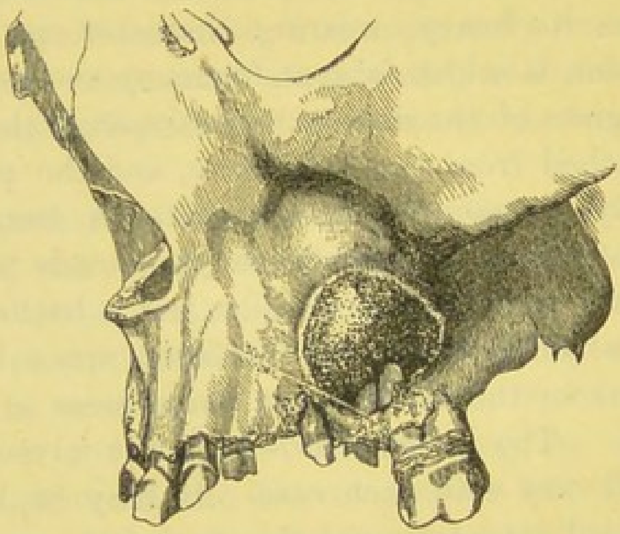


FIG. 202.—An upper jaw in which the effect of alveolar abscess in excavating the bone is shown.

those who are in strong health, the formation of an alveolar abscess is soon succeeded by swelling of the gum and the escape of the pus. But in patients who are in a debilitated condition the disease advances more slowly; the products of suppuration accumulate, and a large abscess is formed, at the expense, perhaps, of the sockets of several adjoining teeth. Considerable mischief may thus be produced before the natural relief by the spontaneous bursting of the abscess is obtained. The pus, instead of escaping into the mouth, may find its way to the surface of the face, or into the antrum. The latter result is, of course, only likely to occur when the disease has originated in the bicuspid or molar teeth of the upper jaw; a case, however, came under our notice in which, on the extraction of a central incisor in consequence of alveolar abscess, a perforation into the antrum was found to exist. The previous symptoms of abscess of the antrum had been but little marked. There is no tooth from the socket of which an abscess may not extend to the surface of the face. Instances are sometimes met with of an abscess connected with the root of a lower incisor tooth opening under the chin, and more rarely, opening in front of the chin.

Abscesses resulting from difficult eruption, or caries of the wisdom-teeth, occasionally pass forwards inside the mouth, and open near the canines or bicuspids; or they may pass backwards and burst into the fauces[1]; they are not uncommonly productive of very considerable constitutional disturbance, and are prone to cause trismus, of which one case is recorded as having lasted as long as nine months, and at the end of that time having been cured by the removal of the tooth.

When the lower molar or bicuspid teeth cause an abscess which finds exit on the face, the opening is usually below the attachment of the buccinator muscle, and collections of matter formed about the wisdom-teeth often pass between the muscles and bone, and escape at the angle of the jaw. It will generally be found that, in cases where the abscess bursts externally, the ends of the roots of the teeth pass beyond the level at which the mucous membrane is reflected from the cheek to the gums (Salter).

A collection of pus formed in the socket of an upper incisor will sometimes burrow along between the bone and periosteum of the hard palate, and open upon the surface of the soft palate; in other cases, the periosteum is separated from the one side of the hard palate, and forced downwards to a level with the crowns of the teeth by the accumulated pus. The pressure caused by the abscess, which often becomes chronic, may cause absorption of a portion of the palatine process of the superior maxilla, as occurred in a case recently under observation. For some reason not very apparent, abscess on the palate almost invariably proceeds from a lateral incisor. A case has lately been recorded in which pus dripped down behind the velum; it was found to proceed from an alveolar abscess about the root of a lateral incisor.

[1] Transactions of the Odontological Society, 1858, p. 53.

The pus of alveolar abscess, as might be expected from its origin, has been found to contain a great variety of organisms. Streptococci and staphylococci often abound in it, and sometimes it is almost a pure culture of spirilla or of spirochœtes.

The accompanying figure represents an abscess sac (or ? cystic abscess) of very unusual size; the figure is borrowed from the Trans. Odont. Soc., where it was described by Mr. Hern.

Extensive alveolar abscess not very rarely results in partial necrosis of the bone, and as a consequence death has

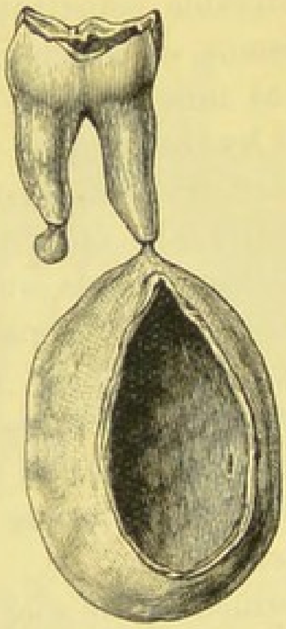


FIG. 203.—Exceptionally large abscess sac. Mr. Hern's case.

been known to ensue in several instances, but these can be more appropriately treated of under the head of Necrosis.

The opening of the abscess, whether effected by nature or by the hand of the surgeon, forms an epoch in the complaint. The symptoms from that time gradually subside, the pain dies away, and the swelling rapidly diminishes, leaving a small opening through which pus will continue to be discharged. The coats of the abscess gradually contract, and close upon the root from which they had become separated, but the separation of the two parts is probably permanently maintained. While the inner surface approaches the root of the tooth, the outer surface of the coats of the abscess becomes thickened, and occupies the space which would otherwise be left between the expanded alveolus and the collapsed abscess. In extracting teeth which have been the cause of alveolar abscess, the coats of the abscess are sometimes withdrawn entire, and an opportunity of observing the preceding conditions is afforded.

Such, then, are the events which, in the ordinary course of the disease, mark the progress of alveolar abscess. Exceptional cases now and then occur, in which the local are accompanied by severe constitutional symptoms, amounting perhaps to fever and delirium. Such instances are, however, of comparatively rare occurrence; indeed, it is wonderful how much mischief may be done to the alveolar processes without exciting any great amount of either local or constitutional disturbance. An abscess enclosed in the substance of any other bone, in the manner an alveolar abscess is at its commencement shut up in the jaw, would, instead of producing two or three days of toothache and a swollen face, confine the patient to his room for weeks.

Alveolar periostitis may, however, move more slowly through its various stages.

Thus it is not uncommon for an abscess on the hard palate to pass into a chronic condition, and remain almost unnoticed by the patient for months, or even years.

The suppuration of the inflamed tissues may be limited to the apex of the root, through the canal of which the pus oozes; but the relief is then only partial, and the periosteum continues to thicken, and the alveolus to enlarge, to make way for the increase in size of the diseased membrane. The pain is intermittent, and often simulates in its character tic-douloureux. The condition we have described is more frequently found associated with stumps than with teeth the crowns of which are but partially decayed; and it is common to find the extremities of several contiguous stumps similarly involved.

Again, it may begin so gradually, and advance towards suppuration so slowly and painlessly, that the patient is not aware of its existence until he discovers a tumour on the gum, or the contents of an abscess escape into the mouth; so little inconvenience is felt that the occurrence is forgotten, until, from some cause or other, the canal leading to the alveolus containing the remnants of the disease becomes closed, and pus re-collects. The contents of the abscess again find their way to the surface, and the comfort of the patient is restored.

Cases of this passive character are sometimes productive of sympathetic pain, and should not, therefore, be lost sight of. The gum, too, over the affected alveolus, frequently becomes thickened, minutely nodulated on the surface, and assumes a mottled hue.

The fistulous opening of a chronic alveolar abscess is sometimes situated on a long papilla-like process, projected out from the gum to the extent of a quarter or even half an inch. It may be flexible, and lie flattened upon the contiguous gum, or the character of a dense hard granulation may be assumed.

Several specimens in the author's collection show that active inflammation of the dental periosteum may arise in connection with a tooth without our being able to trace the cause—that a large alveolar cavity may be formed, the involved tooth and the neighbouring parts being, so far as we can see, healthy. In nineteen cases out of twenty, however, the disease follows or results from, or is an extension of, inflammation of the dental pulp, or is consequent on necrosis of the whole or a part of the root of a defective tooth.

alveolar abscess

The usual cause of acute alveolar abscess is the escape from the end of a root of putrid contents of the pulp chamber and of the root canals, thus inoculating with septic material the tissues external to the apex of the root.

The excessively acute inflammatory disturbance which sometimes results from the first interference with a dead tooth, when during a too energetic dressing of the canal, something is pumped out at the end, is an instructive example of this state of things, and necessitates great caution in the first dressings. These should consist of a mere wick of wool dipped in an antiseptic, and the cavity of decay should be only very loosely closed.

A point of the utmost interest and indeed of very practical importance is whether inflammation and consequent alveolar abscess is in all instances of a septic character. If we were sure that a root once thoroughly disinfected and filled was secure against all chance of abscess it would be a solid ground on which to go ; on the other hand, if inflammation can arise *de novo* at the end of such a root without the access of any external influence there is an element of uncertainty which we have no means of eliminating. Fortunately the balance of evidence seems to point to the vast majority of inflammations at the ends of roots being septic, that is to say, being due to the introduction of poisonous ferments, and in a very large percentage of cases a properly filled root will remain for an indefinite time healthy; on the other hand there are indications that it is quite possible for an inflammation to arise independently. Elsewhere in the body suppuration does occur in places which are apparently inaccessible to germs, and the frequent occurrence of gum boils after exposure to cold, to mechanical irritation, and such causes seems either to point to the introduction of germs not being an absolutely essential element in the process, or else to germs being able to lie dormant for long periods.

The writer's observations have led him to believe that pulps which have died under a capping after being exposed are generally found to be crammed with organisms of many kinds, and that the abscess ensuing is apt to be one of great severity and attended with much pain. But when pulps have died as a consequence of a blow, with no breach of surface, it is not uncommon for no abscess to ensue, though often a slight swelling is to be felt about the root. When, for purposes of treatment the tooth is opened up, it is not a rare thing for the slumbering abscess to be lighted up into an active, not to say violent, state, perhaps owing to the introduction of germs by the operator.

When such a tooth is opened for the first time the pulp will be found sometimes mummified, sometimes moist, white and sodden looking, but of its full size and free from all smell. Now this is just as it should be theoretically, for decomposition ought to be as impossible for it as it is for a piece of tinned meat.

But sometimes the pulp will be found liquefied and in a state of stinking decomposition, and, so far, we have failed to find any evidence of the presence of organisms. Here is a dilemma; on the one hand if germs are there how can they have got there; on the other, it is pretty generally believed that stinking decompositions do not take place without them, yet here we have one where germs have not only not been found, but where it is difficult to suppose that they can have got access. And further such teeth are capable of setting up the most violent abscess without ever having been opened, so that we have the whole train of events, putrefaction, apical inflammation, and abscess without any communication with the outside. It may be said that germs were there circulating in the blood, and that they only could grow and multiply when the vitality of the pulp was destroyed by the blow ; but so far they have, if this be the case, eluded discovery.

Moreover, if they are in the blood, ready to pounce down on any part at their first opportunity, root-filling can never hope to exclude them from the periosteum, but the most that it can do will be to leave them but little pabulum.

Treatment.—Whatever the stage of alveolar inflammation the first thing to be done is to clear out the pulp-cavity and the root canals, but a certain amount of caution must be exercised when an actual abscess has not yet occurred, lest the operations intended to avert it have the effect of inducing an inflammation of very virulent type. The utmost care must be taken lest septic matter be forced out at the end of the roots, and it is therefore best, if time be no object, to be content with freely opening up the pulp-cavity, thoroughly syringing it, and sponging it out with antiseptics, without doing more to the root canals than gently cleansing them, and leaving the antiseptic dressing in the general body of the pulp-cavity, the whole tooth being closed but lightly, and the root canals left empty until the next sitting ; when the contents of the tooth having been for a time exposed to the action of the antiseptic, the roots may be more thoroughly explored, and dressing left in them. For the first treatment of putrid canals we prefer iodine, permanganate of potash, or a half per cent. solution of mercuric chloride, and thymol forms a very good dressing to leave in the pulp-chamber ; for the subsequent root dressings eucalyptus oil and iodoform, or creosote. Camphorated spirit finds much favour with some, and its action would closely resemble that of thymol.

There are several considerations which have to be taken into account in the choice of the disinfectant or germicide to be used, and perhaps no more convenient place than this will occur for the insertion of a short notice of the several properties of a few of the most useful.

Though they may be divided into deodorants, disinfectants, antiseptics, etc., yet these divisions cross, as many, indeed most, of them have mixed properties :—

Hydrogen Peroxide.—This is a solution of hydrogen peroxide in water, and if of good quality should yield about ten volumes of oxygen when completely decomposed ; it however contains variable amounts, and should be kept cool and perhaps in the dark. It is valuable as not causing coagulation of albumen, and it is a powerful bactericide. It is also useful as a bleaching agent. Ozonic ether is somewhat more stable than the aqueous solution.

Sodium Peroxide.—Acts in the same way by giving up an equivalent of oxygen ; a solution in water can be made by adding it to water a little at a time. If exposed to the air it becomes inert by the formation of carbonate.

Potassium Permanganate.—This also acts by the giving up of oxygen and the reduction of the permanganic acid to manganese sesquioxide. It is not so powerful a germicide as some others, but is an excellent deodoriser.

The preceding three reagents all act by inducing the rapid oxidation of the matters with which they come into contact by means of nascent oxygen.

ANTISEPTICS.

These, some of them, act by killing, others by hindering the growth of bacteria ; some are also powerful deodorisers.

Mercuric Chloride.—May be used in solution in water or in spirits of wine (in the latter inert calomel is ultimately precipitated, and inert ethers of peculiar smell are formed). It coagulates albumen, and thereby becomes inert, so that it is not well suited for admixture with pus. It is poisonous. It is used in solution in strengths varying from 1 per cent. to 1 in 5,000 ; 1 in 100,000 has been found to kill the oral bacteria (Miller), so that it is one of the most powerful bactericides known. Its solubility is increased by the presence of sodium or ammonium chlorides, and it is said to coagulate albumen less strongly in such solution. Kingzett's bactericide, which contains also hydrogen peroxide in the same proportion, contains 5 per cent. of mercuric chloride, and is said not to coagulate albumen. It acts on steel, losing thereby its antiseptic properties; and its sulphide is black, so that it should not be used in foul roots of front teeth, else much discoloration may result. It also has the valuable property of travelling through a considerable thickness of soft tissues, such as a tooth pulp.

Cupric Sulphate.—An efficient germicide and slight escharotic, much used in powder in the treatment of pyorrhœa; coagulates albumen, and has a black sulphide. Is decomposed by and deposits copper on steel instruments.

Zinc Chloride.—An efficient germicide in the strength of 1 in 250; escharotic, so that it may cause irritation at the apex of a root; has a white sulphide. Rusts instruments.

Sodium Borate.—Efficient in strength of 1 in 200; non-irritant; does not act on instruments.

Iodine.—Efficient in strength of 1 in 5,000. Irritant in strong solutions, but diluted very useful for washing out sinuses, cuts, etc. Rusts steel instruments badly.

Absolute Alcohol.—Efficient as bactericide in proportion 1 in 10 of water. Exceedingly useful owing to its affinity for water (when used in full strength) for dehydrating and drying canals or cavities.

Phenol, Phenyl Hydrate (*Carbolic Acid*).—Powerfully antiseptic, escharotic and obtundent. Is used in full strength, and in solutions, 1 in 20 (saturated) and 1 in 40, and indeed in any lesser strength. It is a question whether in weaker solutions it is a bactericide, or only an inhibitor of their growth. In 1 in 20 it is somewhat irritant. It coagulates albumen, and freely mixes with fats; it is our most useful antiseptic on account of its great obtundent powers on the tooth pulp. A number of bodies of the phenyl series have antiseptic properties, but do not seem preferable to pure carbolic acid.

Salicylic Acid.—1 in 100 solution killed oral bacteria at once; 1 in 2,000 prevents their development. It is said to attack enamel, but this Miller doubts. It is not poisonous, is chemically related to carbolic acid, and is an ingredient in some mouth washes.

Benzoic Acid is only slightly less efficient than salicylic acid, but is free from the suspicion of attacking enamel. It is formed by oxidation of oil of cinnamon, and of several resins found in pine oils. It is not escharotic nor irritant, and is a useful ingredient in tooth powders, mouth washes, etc.

The compound tincture of benzoin is a pleasant application for the patient's own use; it is fairly antiseptic.

Creosote is sometimes merely an impure phenol; but there is a perfectly distinct body derived from the distillation of wood, which is that which should be used by the dentist. It is insoluble in water, and is much less escharotic than phenol; it is of oily consistence, and is powerfully antiseptic. It can be derived from guaiacum resin, and the resultant product, guaiacol, is practically a pure creosote.

Creolin (used as an emulsion) and cresylic alcohol (present in coal-tar creosote) are bodies of similar properties, as is also *izal*, an insoluble, non-irritant body used by some surgeons as an emulsion, and found to be a powerful antiseptic.

Iodoform (methyl biniodide) is in practice found more useful than laboratory experiments might lead us to expect. It is not a powerful bactericide, but it inhibits the growth of bacteria, and is largely used in surgery. Its heavy, disagreeable odour is against its use in the mouth, but it is a favourite and efficient root-dressing. It parts with iodine rather readily, and some attribute its action to the setting free of iodine. It is nearly insoluble in water, but dissolves freely in alcohol and in essential oils.

Iodol.—A similar body, free from odour, which also readily parts with iodine. As a root-dressing we have found it less efficient than iodoform.

Naphthol (naphthyl alcohol), a solid body, sparingly soluble in water, freely soluble in alcohol, occurs in two modifications, α and β naphthol. It is non-irritant and non-poisonous, but is a powerful antiseptic. It has been largely used as an antiseptic in roots, and with very good success; as a germicide it is claimed that it is even more efficient than mercuric chloride or carbolic acid. Miller places naphthalene, an associated body, high amongst the list of antiseptics.

There are a vast number of bodies more or less derivatives of this naphthyl series, which have been employed—*e.g.*, hydronaphthol, resorcin, pyrocatechin, hydroquinone, etc., almost all the bodies of this series having antiseptic properties.

Essential Oils.—These are almost all mixtures of bodies having different boiling-points. Almost all of them have antiseptic properties, and many of them contain a more solid constituent known as a "camphor." Thus thymol is the camphor of oil of thyme, etc.; and these essential oils come into line with salicylic acid, benzoic acid, hydroquinone, and a number of other bodies used as antiseptics, through their relationship to the great aromatic series.

The oils of eucalyptus, cloves, thyme, cinnamon, and cassia are amongst those most frequently made use of, but their relative antiseptic powers are not fully determined, whilst some of the most efficacious, *e.g.*, oil of cassia, are very irritant.

Listerine is a useful and pleasant antiseptic, benzoic acid, oil of wintergreen, thymol, and boric acid being its chief ingredients.

Tables of the relative efficiencies of various antiseptics will be found in Miller's "Micro-organisms of the Mouth"; but, as he justly points out, too much reliance must not for practical purposes be placed on those tables, as some of the bodies in question we can use as strong as we like, whilst others, from their poisonous or escharotic properties, we can only use in dilute solutions.

Nearly every operator has his own favourite antiseptic, and practical experience has proved, in dental as well as in general surgery, that surgical cleanliness and a strict carrying out of operations upon the lines of aseptic surgery are even more important than the choice of the particular antiseptic.

But whatever antiseptic be chosen in the early treatment of root canals, it is advisable to use one which does not strongly coagulate proteids, lest the canals become blocked by shreds.

It will often happen that, in order to obtain access to the pulp-chamber, it is necessary to drill through or to remove a filling, an operation rendered painful by the tooth being exceedingly tender on pressure. The patient's comfort may be much increased by study of the direction in which the tooth bears pressure best, and still more by fixing the tooth. This may be expeditiously done by the use of a piece of ordinary modelling composition, such as Stent's or Godiva; this is warmed, pressed up round the tooth, then cooled in water, and, when cold and rigid, held in position by the fingers of the left hand. Plaster of Paris, confined to its place by spreading it on one side of a slip of stout paper, may be similarly used.

The treatment of inflammation of the alveolus may conveniently be considered under two heads: that in which there is already a fistulous opening on the gum, either spontaneous or obtainable by lancing; and that in which no such vent exists.

In the first state of things a cure is comparatively quick and easy, for potent agents can be employed from the first without any fear of lighting up a violent fresh access of inflammation. As soon as the roots have been well cleansed they may be filled with creosote; this may be done by means of introducing the tube of a hypodermic syringe a little way up them, or by passing up a wick of cotton copiously steeped in the fluid.

Then the endeavour to pump this creosote out through the end of the root should be made. There is, so far as we know, no better way of doing this than by placing in the general cavity of decay a piece of ordinary rubber sold for vulcanising, large enough to fill it; pressure is made upon this with a large-ended instrument, a tight pledget of paper held in plugging forceps answering the purpose very well, and the pressure being made in a succession of jerks, the piston thus formed will generally succeed in pumping some of the creosote into the abscess and out upon the gum by way of the fistulous opening. If several drops have been successfully forced through, the root can be firmly closed with a creosote dressing on wool, and at the next visit the abscess will be found often to be practically well. Some practitioners even fearlessly fill the root at once at the first sitting, if the creosote stream has passed pretty freely.

Failure is rare when the whole track of suppuration is thus pervious, and when no marked improvement follows the treatment it may be suspected that there is considerable roughening or other alteration of the end of the root, and that success is not likely in the long run. A recent abscess almost always yields at once to treatment, but an old one generally is complicated by alteration of the root or of the superjacent bone.

Hydrogen peroxide may be used in the same way, in which case fresh fluid should be pumped in till frothing, from the setting free of oxygen, no longer takes place.

Unless the root-canals are large, it is always advantageous, in case of old abscesses, to drill them out freely whenever their direction can be ascertained to be such as to render this safe. It seems as though the dentine, long soaked with decomposing material, was not easy to disinfect, and that by drilling away the immediate walls of the canal, we rendered it more easy to cleanse the rest, that which had been most sodden having been got rid of.

Some dentists hold that in all cases of long-standing suppuration the enlargement of the root should be carried to the point of enlarging the apical foramen, and drawing blood in so doing. This commends itself as sensible, though most abscesses can be cured without so doing, and the enlarged apical foramen may sometimes introduce a difficulty in the actual filling of the root afterwards. Unless, therefore, the case prove obstinate, it will suffice to freely enlarge the root down to within a short distance of the end, and to allow plenty of time between the dressings after the active tendency to discharge has passed by.

When the tooth has become quite comfortable, and the root-dressing comes away clean after remaining in the tooth for some days, the root may be closed with cotton moistened with eucalyptus oil, and charged with as much iodoform or naphthol as it will pick up; the cavity then having been thoroughly sealed, it should be left for ten days or more, and then the root-dressings again examined.

If they be found clean, and the tooth has remained quite comfortable, a permanent filling may be introduced, as there is little risk of after-trouble where there has been a fistulous opening; nevertheless, some operators prefer that wool root-fillings, with creosote, or iodoform, should be retained for some months. This latter plan should be adopted if the operator, for any reason, has misgivings as to the tooth keeping well.

But where there is no fistula the conditions are much less favourable. The two essentials of antiseptic surgery, drainage and the destruction of all septic agents, are no longer attainable with certainty; for we cannot be certain that our antiseptic will travel freely throughout the interior of the abscess, nor can we easily secure the speedy draining off of pus or exudations; consequently, we must go to work very much more cautiously, bearing in mind that every time that the little abscess sac at the end of the root gets distended it is retrogressing.

Pumping operations would be dangerous, and we must at first be content with root-dressings not too tightly packed in. Camphorated spirit is useful; and if there be some little weeping of discharge into the tooth, dry root-dressings are to be preferred, as the wool is then capable of sopping some of it up. For such an application iodoform or hydronaphthol on a wisp of dry wool, or a few crystals of thymol, do very well, or the wisp of wool may be dipped in camphorated spirit, and the spirit allowed to evaporate from it, or again it may be dipped in sublimate solution and dried.

Local bleeding frequently fails to afford relief in inflammation of the pulp; but when the dental periosteum becomes the seat of disease, the abstraction of blood is a powerful remedy. One or two leeches may be applied by the help of a leech tube to the gum, opposite the end of the root of the affected tooth, and in connection with the local bleeding an aperient may be given.

The gum over the affected tooth should be strongly and repeatedly painted with tincture of iodine, and Fleming's tincture of aconite may be advantageously applied, though caution is required in using so potent a drug in the mouth. If the inflammatory action has gone on for a day or two, it is probable that suppuration cannot be avoided, especially if the affection has spread to the gum.

If great tenderness exists, or arises during the treatment, the tooth should be left almost or quite open, no gum resins being used on the wool, which should be moistened with camphorated spirit only. In some cases the patient may advantageously dress the tooth for himself, for a time, with wool dipped in compound tincture of benzoin, which has antiseptic properties, but does not make the wool dressing very firm; in such a case the roots are, of course, left without dressings.

We have found it a good plan in the treatment of very tender discharging teeth, which fail to respond quickly to treatment, irrespective of the question of ultimately filling the roots or not, to leave a perforation in the side of the tooth, the pulp-chamber having been filled loosely with crystals of thymol, whilst the main cavity is closed with a slight sandarach dressing or with gutta-percha; drainage is then possible at the same time that the interior of the tooth is prevented from ever becoming foul, as long as the thymol lasts; from its sparing solubility, it remains a long time.

We believe that in a tooth so dealt with the abscess sac shrinks down upon the apex of the root, and its subsequent treatment for root filling, after the lapse of a month or more, becomes comparatively short and easy.

It is quite possible that the coats of an abscess situated in the dilated alveolus may embrace the necrosed but aseptic extremity of the root, and cease to secrete; in which case the gum would heal perfectly, leaving the end of the tooth in a similar position to that of an encysted foreign body. It does not seem likely, *à priori*, that organic union would again take place between the periosteum and the cementum when they had been long separated by pus.

The operation termed intermediate root-filling has been strongly advocated by some writers. In this mode of treatment the tooth is freely opened up, its root canals freely enlarged, cleansed, and disinfected, and a permanent and, in most cases, an irremovable root-filling inserted at the same sitting, even though there be no fistulous vent on the gum.

For this it is claimed that the tooth once cleansed can no longer be a source of irritation, and that if any socket trouble supervenes it can be treated from without.

No doubt this treatment is often quite successful, and ill-consequences are of less frequent occurrence than might have been expected, seeing that in any case the disinfection cannot reach beyond the apical foramen with any degree of certainty.

On the other hand, it needs to be practised with caution, and the writer has chanced to witness the loss of teeth from intractable and violent inflammation, which could presumbly have been saved by a more slow and cautious treatment. On splitting up the teeth, the root-filling was found to have been perfect and absolutely free from any taint—two of the cases came from the hands of a very strong advocate of the method and a very thorough operator. In these cases no doubt infection had already passed beyond the apical foramen, hence the untoward results.

Another point which weakens the advocacy of some who advocate immediate root-filling is that they, on statistical grounds, give by way of comparison such a phenomenally large proportion of failures in teeth which have been dressed in the usual way.

If in treating a tooth which has no fistula over its root we fail to avert suppuration, or to reduce the inflammation, we must then do what we can to relieve the pain and to reduce the disease to a state of passive gumboil. When there is reason to believe that pus has not been formed, a leech may be applied to the gum, and aperients given; but should we find a circumscribed swelling over the tooth, it is pretty certain that pus is making its way outwards, and its progress will be hastened by the use of the gum lancet. The best instrument for this purpose is a short and strong double-edged scalpel, which should be thrust forcibly down to, and, if possible, through, the spongy bone overlying the abscess sac. By thus anticipating the drilling through of the alveolus by the abscess, the patient is saved much suffering, which in the majority of cases ceases with the perforation of bone, whether this be effected by nature or by art. Wherever there is general swelling and tenderness, great relief may be given by a free incision, and by drilling through the bone with a large and sharp drill over the apex of the root, cocaine having been previously applied, or the gum frozen. It is easy to distinguish by touch when the instrument reaches the root, and the operation gives far less pain than might have been anticipated.

This operation would be more generally available were it possible to always hit the right spot; it is of little use in the case of upper molars on this account. The writer has been consulted about such a case in which a drill had been broken off and left in the bone; no ill-results ensued whilst the patient remained under observation.

We think it may be said that as a general rule all acute and recent abscess is amenable to treatment, but that more uncertainty pertains to old and recurrent inflammation, leaving probably a condition short of health in the interval of the attacks.

When the tooth has ceased to be painful there comes the question of the choice of material for filling the roots, and this will partly be determined by the degree of confidence which can be felt in the completeness of the cure; thus a front tooth suffering from its first abscess and cured so completely that a wool dressing left in it for a week is absolutely clean when withdrawn, may be closed up with but little fear that the root-filling will have to be withdrawn again, and fragments of wool and fluid zinc oxychloride, gold, tin, slow-setting zinc oxyphosphate, or any permanent root-filling that the particular operator may select may be employed.

But the case is different with many-rooted teeth, the canals of which it may be impossible to completely fill; so also if the tooth has had several abscesses before, or if it remain a little tender after all discharge has ceased; in such cases the introduction of anything which cannot be got out again will expose the patient to the risk of much pain, and may even involve the loss of the tooth. It will then be safer to fill the roots with wool moistened with creosote, with eucalyptus oil and iodoform, or naphthol, or with paraffin wax, and the rest of the cavity with gutta-percha, till such time as reasonable security for its quiet behaviour has been attained.

The roots should in any case be very thoroughly dried before filling them; absolute alcohol should be used, dried out, and the hot-air syringe employed. A very hot wire passed up the roots is useful for this purpose, as well as assisting the sterilisation of the roots. Recently it has been proposed to sterilise roots by means of electrolysis, one pole being passed as far as possible (in the form of a platinum wire) up the roots, but experience is as yet wanting as to the value of this method.

Very small canals which, owing to their being tortuous, cannot be reamed out, must be left unfilled after such disinfection as is practicable; it is advantageous to leave a wire in them, so as to minimise the vacant space left, if it can be introduced. If their capacity is very small, they rarely give trouble.

A large percentage of success can be obtained by care in the treatment of dead teeth, but some failures, from causes out of the operator's control, will of course occur. And it will sometimes happen that it is not feasible to close the roots tightly during the time at disposal for treatment, or even after protracted treatment, and it becomes necessary either to sacrifice the tooth or to have recourse to the confessedly unsatisfactory course of leaving a perforation through which a minute quantity of discharge can make its escape.

If such teeth were pouring out a material bulk of discharge, so as to taint the breath, they would be better out, but that is by no means necessarily the case, and with the observance of proper precautions they may often do service for years and be apparently perfectly unobjectionable.

But there should at all events never be any large reservoir in the interior of the tooth left in which matter can accumulate, and a two-rooted tooth, such as a lower molar, is best dealt with by filling the body of the pulp-cavity and making separate oblique perforations into each root canal just below the edge of the gum. The difficulties which pertain to the management of the particular cavity must be left to the ingenuity of the operator, always bearing in mind that the minimum of space should be left in the interior of the tooth: this operation is termed **Rhizodontrophy.**

As much of some somewhat insoluble antiseptic should be left in the canals as is practicable without closing them up tightly. Thymol crushed into the orifices of the canals serves this purpose as well as anything, and its taste is unobjectionable, which cannot be said of iodoform.

Other methods of treatment applicable to teeth the roots of which, for some reason, cannot be satisfactorily filled, have been proposed. Thus, the late Mr. Coleman proposed to treat teeth, the roots of which could not safely be filled, by placing a little distance up the root a small pledget of dry wool, carrying a trace of arsenious acid; it was his belief that, owing to the very powerful antiseptic action of this body, any weeping into the root would be converted into an innocuous aseptic mass, and that the tooth, though tightly sealed, would remain comfortable; his own experience was in favour of this method of treatment in a certain class of cases. We have not a sufficient experience of his plan to enable us to say whether the distrust with which one would naturally regard the leaving of so potent a drug for an indefinite time within a tooth is or is not well founded. Mr. McAdam has also made use of arsenic as a medicament for treating roots, but in a somewhat different manner; he employed a dilute solution on cotton-wool, but has abandoned it.

mercuric chloride

And Dr. Miller, having found by experiment out of the mouth (on the pulp of calves' teeth) that mercuric chloride would travel through and sterilise the whole length of the pulp, has proposed to lay over the orifices of the pulp canal, without removing the pulp from them, a little of this salt in the solid state. About one-eighth of a grain would be a sufficient amount for the whole pulp, and Dr. Baker (British Dental Association Journal, 1894) has met with considerable success in its use.

There is much difference in the degree of toleration which is accorded to dead teeth in different individuals, there being a good many persons in whom dead teeth are never quite comfortable for long at a time, no matter how successfully the roots have been filled. And there are others in whose mouths dead teeth seem to be as serviceable as living ones, or nearly so.

And after the long continuance of an abscess it will sometimes happen that there remains an opening through the gum of some size, through which the roughened end of the root can be seen and felt, acting as an irritant and keeping up discharge. It is a good plan to cut off the end of the root in this case, and this can easily be done by running a small drill three or four times through it, and then breaking or cutting it off with fine cutting pliers. The end should be smoothed with a burr, and the discharge will often cease and the gum shrink down upon it again.

It has already been mentioned that there are some conditions of the root which preclude the possibility of satisfactory results by the ordinary modes of treatment, and that these conditions cannot always be recognised beforehand, amongst them being alterations of the end of the root by absorption, or what often goes hand in hand with absorption, irregular depositions upon it of lowly organised cementum. When treatment faithfully carried out for an adequate length of time has failed, there is nothing left save extraction of the tooth, when it will usually be found that in place of the exceedingly thin healthy alveolo-dental periosteum there is a thick spongy membrane, here and there breaking down into pus, but it will very frequently be the case that this unhealthy membrane is almost confined to the neighbourhood of the apex, and to meet this the operation of **replantation** has been proposed.

It is well known that a healthy tooth knocked out and immediately replaced will, in a large majority of cases, reunite, and this even when it has been some time out of the mouth; but such teeth are liable to subsequent abscesses, owing to the decomposition of their dead nerves. Mr. Coleman[1] and Dr. Magitot met with some considerable success by removing abscessed teeth, scraping off the thickening periosteum from their ends, and sometimes cutting off a little of the apex also, and then replacing them without taking any notice of the pulp-cavities; drainage was in some instances secured by making an opening through the alveolus opposite to the end of the root.

But it is obvious that to give the tooth the best possible chance it is necessary to fill the root, and this can generally be done with great ease through the enlarged apical foramen, care being taken to hold the tooth in a napkin moistened with weak carbolised water, so as to avoid, in so far as it is possible, injury to the adherent portions of the membrane.

The operation is only to be regarded at present as a last resort, which may be tried with a valuable tooth near the front of the mouth when the alternative is its entire loss; we have, in a few instances, succeeded in thus saving front teeth and bicuspids, the abscesses upon which could not be got to heal otherwise; but it is seldom that milder treatment does fail with such teeth, and in each instance failure appeared to be due to the rugged state of the apices, which were cut off before the replantation.

There are a good many pitfalls in the way of success in replantation, one being that a tooth which has been an apparent complete success will after a few months or a year be found to become loose, and when it is removed its root will be found to have been in great part absorbed.

It is often a matter of difficulty to get the tooth back into ts socket, and on this account it is sometimes necessary to

[1] Trans. Odont. Soc., 1869; and Trans. International Medical Congress, 1881.

shorten the root; its replacement will occasionally require a good deal of force, and will give a good deal of pain, so that sometimes an anæsthetic will be as much required for its replacement as for its original extraction.

A refinement of the process was proposed and to some extent practised by Mr. Finlay Thompson, which consisted in the insertion of a minute gold tube passing up through one or more of the roots to the surface of the filling to serve for drainage, this tube being ultimately closed by a gold wire, as soon as it seemed to be safe to do so. To meet the tendency to

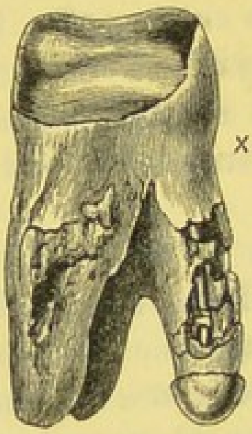


FIG. 204.—Tooth which had been capped, a tube inserted, and the cavity filled with gold prior to replantation. We are indebted to Mr. N. Stevenson for the loan of this specimen.

absorption of the end of the root, this was covered by a cap of thin gold closely burnished down upon it.

All this involved lengthy manipulations out of the mouth, and the results of the operation were not good enough to make it take a place amongst recognised methods of practice. Appended is a figure of a tooth so treated, which was never comfortable, and after a year and a few months was tolerated no longer by the patient. It will be seen that a very considerable amount of absorption had gone on in many places, this being an index of the chronic irritation which had never been long absent after the completion of the operation; thus the capping of the ends of the tooth with gold proved a complete failure so far as preventing absorption went.

All things considered, then, replantation occupies no very useful place amongst the resources of the dentist, but there are just a few teeth which may be saved by its means for a time beyond that at which they would otherwise have been lost. And *à fortiori* it is not to be recommended as a frequent line of treatment, as some have proposed, it having even been practised in lieu of devitalising the pulp by ordinary means. A good many teeth were thus treated in London some years ago by an American practitioner, who may have remained under the impression that his success was greater than it really was, as he had left London before these teeth began to loosen again in considerable numbers, which they did within a year or two. A replanted tooth seldom needs any support beyond that which can be obtained by ligaturing it to its neighbours, and often even this is not necessary.

Mitscherlich transplanted a tooth in a dog, and after six weeks examined it; of the periosteum a good deal was gone, but the tooth had been absorbed in places, and calcification of the osteoclasts had taken place, holding the tooth very firmly, as they were continuous with the bone of the alveolus. The tooth was thus held in largely by bone, with little or no intervening soft tissue, and an ivory peg might be held in in the same way.

It occasionally happens that nature sets up a very energetic process by way of getting rid of a tooth which has become a source of irritation, and its roots are eaten away like those of a temporary tooth. Thus Fig. 205 represents a tooth the pulp of which had been destroyed with arsenic, and a gold filling inserted without the pulp-cavity having been cleared of its contents; the drawing was made from the specimen which was shown to the writer by Dr. Hawes, of Boston, Mass.

But occasionally the same sort of thing will happen without any obvious provocation, as is exemplified by the specimen here figured, from the Museum of the Odontological Society, with no history attached to it. The crown of the tooth is quite intact, but the root is deeply excavated, and the pulp-cavity contains a large mass of secondary dentine which is continuous with the normal dentine where it touches it; it is impossible to say at what period this mass was formed, whether before or after the root had been attacked by absorption from without, though it would seem probable that it was an attempt on the part of the pulp to defend itself, as it exactly corresponds to a deep excavation on the outside of the tooth.

The exterior of the root presents an excellent example of that alternation of absorption and deposition which is so common where irritation has long existed.

A somewhat similar result may follow on the exposure of the pulp by the wearing down of the dentine until the pulp has been quite or nearly exposed. In the human subject relief will have been sought before things have gone on to their ultimate sequel; but in the lower animals instances are now and then met with in which a long time has elapsed without the tooth being shed, as is exemplified in the teeth of a grampus in the Oxford Museum, in which, owing apparently to a twist

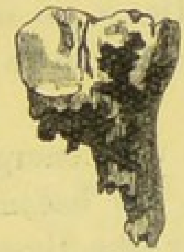


FIG. 205. — Dr. Hawes' specimen.

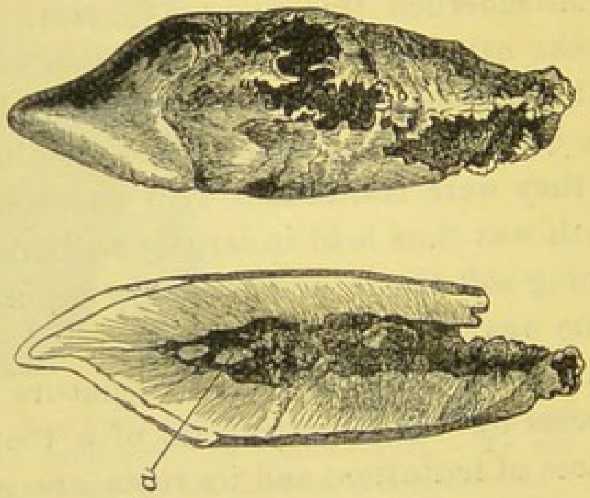


FIG. 206.—Specimen from Museum of Odontological Society: *a*, secondary dentine.

in the jaws, all the teeth of one side in place of interdigitating came to be exposed to destructive attrition, with the result that their implanted portions were enlarged and absorbed in an extraordinary way.[1]

An account of replantation which did not mention **transplantation** would be incomplete, although this latter has not as yet very much practical utility. The Odontological Society is fortunate in possessing a caricature executed in 1787 by Rowlandson, which is reproduced in black and white in the Transactions for 1874. It represents a fine lady of fashion seated by the side of a street arab, whose tooth she is to have transplanted into her own mouth; she regards him with disgust,

[1] For figure see Trans. Odont. Soc., 1872–3.

whilst in the background is a gentleman for whom the operation has been completed, and who is looking at his mouth in a glass with much satisfaction; a child is going out of the door with her hand to her face, and a piece of coin in her hand, whilst on the door is the inscription, "Most money for living teeth."

The caricature tells the whole tale, whilst more detailed accounts are to be found in the pages of John Hunter. A fierce attack was made upon Hunter after his death, and perhaps before, on this ground, it being said that he had communicated syphilis to several persons by means of transplanting teeth, though it is doubtful whether he actually performed the operations himself.

The fact that it fell under the satire of a popular caricaturist would seem to indicate that for a time at least it was practised with some frequency; but a study of contemporary literature shows that in 1783 it was on the wane, and in 1810 it is spoken of as consigned to oblivion, because, when it succeeded at all, the transplanted tooth remained in only for a few years, and there appeared to be good grounds for the belief that syphilis really was transmitted in some cases. Those who are interested in the matter will find some details in the Trans. Odont. Soc. referred to above.

The teeth so replanted, however, are apt to become loose after a time, sometimes from absorption of the root, sometimes without absorption. Dr. Younger had some cases of replantation which remain successful after nine years, and Dr. Louis Jack has recently published (Cosmos, 1896) four cases: one successful for four years, then lost by loosening; a second good for one year; a third good for one year (splint worn for four months); a fourth failed in eleven months. Dr. Jack's transplantations give the following record: one successful (done four years ago), in which the alveolus was deepened, two successful after one year (splint worn eight months), and two immediate failures. His three replantations gave one failure and two successful at end of a year (splint worn six months). Dr. Amædo (Intern. Med. Congress, 1894) recommends a slight decalcification of the apex of the inserted tooth.

The transplantation of teeth has also been to a small extent successfully practised in cases of irregularity where canines and incisors were transposed.

A further development of the same idea has been practised, probably first by Dr. Younger, of San Francisco; teeth have been implanted not in the sockets vacated by damaged teeth extracted at the same time, but in sockets made by drills and burs in the solid bone of the alveolus, so that there was no periosteum in the sockets. Some measure of success has attended this treatment; in quite a considerable proportion of cases union takes place, but exactly how it is effected is not certainly known, possibly by the excavation of absorption spaces in the roots, which subsequently fill by the calcification of the osteoclasts. Of course the tooth requires protection from movement and dislodgment for a time. The foregoing data are given because there may be a future for these operations, which, of course, must be conducted with every aseptic precaution, but at present they remain rather as curiosities of practice than as a part of the every-day resources of the dentist.

Under certain circumstances the abscess sac may become a serous cyst, as is mentioned by Mr. Salter; this, which may occur in all parts of the body, is sometimes attended with peculiar consequences in the jaw, for the cyst may enlarge between the plates of the alveolus, and thus give origin to cystic disease of the jaw.

The fluid in an abscess which has become cystic almost always contains small glittering plates of cholesterine.

The extraction of the tooth is necessary in almost all cases where a cyst has formed. Treatment and filling of the root and free opening of the cyst and cauterising or curetting its interior often bring about a temporary cure, but until the root is removed the cyst is exceedingly prone to refill, and we have almost always had ultimately to extract the tooth.

So far only passing mention has been made of any extension of the morbid action beyond the tooth and its enveloping tissues, but more remote and sometimes very serious affections may arise.

The existence of inflammation about the roots of teeth of course at times leads to the enlargement of the **lymphatic glands** in the neighbourhood of the jaws, though this does not take place with the frequency with which it might be expected. The dentist will often be consulted as to the share taken by diseased teeth in the enlargement of the glands in a particular case, and it will often be impossible to arrive at a conclusion of a definite kind, although it is a good general rule that in all cases in which glands are enlarged all teeth which do not admit of being got into a perfectly healthy condition should be extracted, and that doubtful teeth should not have any attempt at preservation made, or at least no prolonged attempt. As helps to diagnosis, it may be noted that lymphatic glands somewhat deeply seated in the region of the mastoid process are often enlarged, in consequence of diseases of the external meatus; and in the submaxillary region enlarged lymphatic glands are movable, whereas the submaxillary gland when inflamed is fixed, being bound down under the fascia.

The affection of the lymphatic glands may run on to suppuration, though it comparatively rarely does so. Now that surgeons give so much more attention to enlarged glands than was formerly the case, it should be the invariable rule to extract all dead temporary teeth, and probably any *dead* permanent tooth wherever in a child the glands are enlarged.

At the same time there are many other causes for enlargement of the glands, and these are perhaps more often in fault than the teeth; nevertheless the teeth, as possible causes, should be removed in every case of doubt.

The superficial cervical glands, which lie above the sterno-mastoid and beneath the platysma, have been held to have nothing to do with the teeth.

The glands which may become enlarged as a consequence of absorption of poisonous products from the teeth belong mainly to the deep cervical lymphatic system: a useful diagnostic sign is the mobility of the enlarged gland when the head is rotated; if it moves, it is pretty safe to say that teeth have had nothing to do with its enlargement. But some surgeons consider that the communication between the superficial and deep cervical glands is too close to render this a wholly certain indication.

Indeed, according to recent researches the superficial cervical glands lying along the course of the external jugular vein do receive some lymph from the posterior region of the gums. The suprahyoid glands lying between the bellies of the digastric muscle receive lymph from the anterior parts, and pass it on to the submaxillary group which lie in the digastric triangle along the lower edge of the jaw. From these glands it passes on to the deep cervical glands about the internal jugular vein. As the lymph from the upper gums and teeth is said to be received by the deep facial glands at the side of the pharynx near the tonsil, it is very possible that some suppurations regarded as quinsy may in reality be infective suppurations from the upper teeth.

Considering the frequency of alveolar abscess and its situation within the bone, it is somewhat remarkable that general **systemic infection** is so rare as it is. Still, a very considerable number of cases could be collected, and a few are recited here as examples of what may happen.

A somewhat chronic pyæmia has been observed to follow upon an alveolar abscess (Mr., now Sir G., Howse, Medical Times and Gazette, 1876). Suppuration occurred in the inferior dental canal, and acute periostitis in the posterior half of the lower jaw, which was denuded of its periosteum ; the inflammation extended thence through the pterygoid fossa into the orbit, and thence backwards. Ostitis of the vault of the skull followed, and general pyæmia, resulting in the patient's death on the ninth day after the supervention of the acute stage.

The chronic stage had lasted five weeks, and no special history of pain or swelling of the jaws prior to this could be obtained, though the patient's age (four and a half) rendered the history necessarily imperfect; the post-mortem left, however, no doubt as to the sequence of events in the case.

A disastrous case is related by Dr. Harrison Allen (Dental Cosmos, Nov., 1874). The roots of a lower wisdom tooth were filled, this operation being followed by ostitis and periostitis in its vicinity. An abscess formed between the mylo-hyoid and the jaw, which gravitated down as far as the hyoid bone, and crept up along the course of the facial artery; the floor of the mouth was pushed up by pus, and severe unilateral glossitis ensued. Death ensued from mechanical suffocation four days after the occurrence of extra-maxillary complications.

Another case resulted from an unsuccessful attempt to extract an upper molar tooth ; suppurative periostitis around the tooth ensued, and rapidly spread to the body of the jaw; after a fortnight the necrosed bone was readily removed, but severe rigors ensued, and the patient died, at the end of a month, of pyæmia, the immediate cause of death being pleuro-pneumonia.[1]

M. Robert[2] also relates a case in which necrosis supervened on an abscess connected with a lower wisdom tooth; what is described as "purulent infiltration" of the side of the neck followed, and the patient rapidly sank.

In a case which was known to the author a chronic abscess of some size had existed over an upper molar; this was opened and treated, and a small piece of drainage tube tied in. The patient had some slight swelling of the soft tissues of the face, but was well and pursued his ordinary avocations. He, however, lost the drainage tube, and an erysipelatous condition of the face ensued, and one or two small abscesses in the soft tissues of the cheek were opened, and the antrum is said to have been explored. The patient became rapidly worse, and died with symptoms of general septicæmia.

Mr. Eve recalls a fatal case of pyæmia following upon osteomyelitis and periostitis of the lower jaw (Trans. Odont. Soc., 1888), and a case in which a fatal ostitis ensued after the extraction of a tooth by an unqualified operator was the subject of an inquest. There seemed some reason for supposing that a dirty pair of forceps had been employed.

Mr. Pollock (Trans. Odont. Soc., 1876) records a case of brawny swelling extending from the jaw to the clavicle and displacing the larynx; incisions having failed to give relief, it was necessary to perform tracheotomy in order to save life. Another interesting case, related by the same writer, is one in which extensive scrofulous-looking ulceration on the neck, running right down into the clavicle, was also traced to stumps; it healed shortly after the removal of most of them, but recurred a year afterwards, two or three having been left; the extraction of these at once brought about a cure. Exophthalmos and amaurosis have on many occasions appeared to have arisen from diseased teeth, sometimes with obvious antral mischief to account for it, and sometimes apparently without this cavity having been involved.

Another fatal case is reported by M. Poncet (Brit. Med. Journal, March 6, 1886) which was admitted to the wards of

[1] Deutsche Vierteljahrschrift, 1872.
[2] Conférences de Clinique Chirurgicale, Paris, 1860.

Val-de-Grâce ten days after general symptoms of septicæmia manifested themselves. There was much swelling at the angle of the jaw, and both fauces were œdematous, and upon one there were serous vesicles. At the necropsy the right masseter muscle was found to contain small abscesses, as did also the sterno-mastoid.

There were no metastatic abscesses in the arm, but the œdema was purulent, and contained quantities of microbes.

In the blood-clots found in the right heart there were also colonies, so that M. Poncet concluded that the patient died of microbe pyæmia, resulting from dental caries.

A remarkable case occurred at St. Bartholomew's in 1897 : a child had a tooth extracted under an anæsthetic (nitrous oxide) and died within a day or two of meningitis, having previously been, so far as is known, quite well.

Whether this was septic did not clearly appear from the post-mortem ; it was at all events not traced to the teeth.

Mr. Makins reported a case in a child aged four with the following sequence of events: toothache, drowsiness, swollen face and high temperature, hard swelling over lower jaw, and breath very offensive. Many carious teeth were found covered with pus and a cheesy deposit; these were removed, and the sockets cleansed. The face and eyelids became œdematous, and the external jugular was felt as a hard cord, while jaundice and rhonchus in the chest appeared. The external jugular was exposed and found to be full of pus; it was ligatured at its junction with the subclavian and excised up to the angle of the jaw, the internal jugular being as far as could be seen quite healthy. Death ensued on the sixth day from pyæmia, with metastastic abscesses in both lungs. At the post-mortem the glands were found matted together, and the lingual, ranine, facial, common facial, and part of the temperomaxillary veins were full of pus, whilst a clot extended down into the internal jugular vein.

Mr. Arbuthnot Lane met with a case in a child of four in whom it was found that clots formed in the facial and external jugular veins (Lancet, 1897). There were jaundice, enlargement of the liver, and profuse rigors. The plugged veins were excised, but death ensued.

Mr. Roughton (Trans. Odont. Soc., 1897) records a remarkable case. Swelling first appeared round the first lower molar, which was quite loose, but apparently sound. Rigors and a temperature of 105 followed, and swelling extended down to the clavicle. The tooth, which by this time had pus round it, was extracted, but does not appear to have been examined with a view to ascertaining if the pulp were dead. Death ensued on the eighth day, but no post-mortem was obtained. It appears to have been a case of ostitis originating about the tooth followed by phlebitis and pyæmia, but where the organisms obtained entrance remained obscure.

Gangrene may result from inflammations originating about the teeth; thus Mr. Stanley Boyd relates a case in which an amateur extraction of three roots was effected by means of a sharpened piece of wood in a youth aged 18. After four days swelling ensued, and a black patch on the plate, easily detachable, appeared under which was some necrosed bone. This was scraped with a Volkmann's spoon, and strong carbolic applied, some loose teeth in the neighbourhood being at the same time removed. After sixteen days the teeth were all loose as far as the lateral incisor, sloughing extended, laryngotomy became necessary, hæmaturia followed, and purpuric patches appeared, and death followed on the twenty-second day. Cultures yielded an abundant crop of staphylococcus pyogenes aureus, and the blood was found much altered, the red corpuscles being crenated and crescentic, and large white cells very numerous.

Mr. Goadby has also reported a case in which sloughing ensued after the use of ethyl chloride to freeze the gum; death from sapræmia ensued.

Infective suppurative processes may extend to the cranium. Thus Heydenreich met with a case supposed to be mumps. The patient, aged 33, had stiffness of the jaws, swelling over the right parotid and neck, delirium, and rigors. On the third day pus was found in the mouth, the swelling had become limited to the angle of the jaw, and the temperature had fallen from 105 to 102; a doubtful diagnosis of suppurative ostitis in the mouth was then arrived at. The temperature rose, right hemiplegia came on, and on the fifth day the patient was moribund. No pus was found on an incision being made with the thermo-cautery. A post-mortem showed the presence of pus both outside and inside the meninges.

Mr. Pearce Gould (British Dental Assoc. Journal, March, 1886) has recorded a case of death from alveolar abscess, resulting in thrombosis of the cavernous sinus. On admittance the patient, ætat 57, presented a sloughy opening in the centre of the right cheek. An incision was made from the outside, and six molar teeth were extracted. The trismus was relieved, but œdema of the right temple appeared, and subsequently an abscess above the external angular processes of the orbit, and another in the posterior triangle of the neck, but the internal jugular was not thrombosed. The respiration became stertorous, pulse 126, small, temperature 103·8, and crops of herpes appeared about the lips. Great œdema of the orbit and chemosis, with some proptosis, ensued, and some rigors occurred. Death in a state of coma ensued.

At the post-mortem the outer part of the right side of the lower jaw was sound; some lymph was detected along the basilar process of the occipital bone, and sella turcica; the right cavernous sinus was distended and contained yellowish pus; the right ophthalmic vein was similarly affected. The left cavernous sinus contained a clot. Probably thrombosis had spread through the pterygoid vein on the right side, and thence by the circular sinus to the left side.

Cases of this kind, though fortunately rare, might easily be multiplied, but enough has been given to show that a fatal pyæmia or septicæmia is by no means an unknown sequence to alveolar abscess. And it is indeed rather remarkable that serious results are as uncommon as they are, for suppurations connected with bones elsewhere are notoriously dangerous to life.

In Wedl's "Pathologie der Zähne" (p. 173), a case is quoted from M. Leynseele in which a portion of the lower jaw was splintered in the removal of a tooth; pus burrowed along the side of the jaw, ascending by the ramus to the base of the skull, and gaining access to the cranial cavity by the foramen ovale, rotundum and spinosum, caused the patient's death from meningitis.

DISEASES OF THE MAXILLARY BONES.

Apart from those diseases which will be considered under the head of Tumours, the alveolar and other portions of the jaw are subject to much the same diseases as bones elsewhere. The commonest of these is necrosis.

The death and ultimate separation of portions of the alveolar margins is, in a slight degree, of very common occurrence; the thin edge of the alveoli may exfoliate after an extraction, however skilfully performed, and no ill results attend its doing so, save a prolongation of the healing process. But, in place of this very limited death of the bone, the necrosis may be far more extensive, involving the complete destruction of the alveolar portion, and even the whole depth of the jaw. The causes which bring about necrosis of the jaw are various, and cannot in every instance be traced.

Thus, in a case formerly under observation, the upper canine of the left side was found to be painful and slightly loose; the pain increased, some little swelling appeared, and pus was found to exude around the tooth. As there seemed to be no hope of saving the tooth, it was extracted, when attached to the apex of the root was found a fragment of necrosed bone, on the upper part of which, as is shown in the figure, was a hollow, smooth surface. This was found to be a part of the floor of the nose, into which air passed freely, and fluids poured through the nose in drinking.

Since the removal of the tooth some years have elapsed, the aperture being covered by a process from the artificial teeth which are worn by the patient. This remedies the inconveniences of a communication existing between the nose and the mouth; but, although the aperture has greatly contracted, it shows no disposition to entirely close up.

The most remarkable feature of this case is the entire absence of any assignable cause for the mischief. The patient was a healthy man of middle age, with no history of syphilis; the tooth had been only in very slight degree decayed, and had been successfully filled with gold years previously. No blow had been received; in short, nothing whatever could be discovered to account for the lesion.

Another case came under personal observation at the Dental Hospital, of necrosis occurring without any assignable cause. In this case the sequestrum was much larger, extending from the second lower molar of the right side to the lateral incisor of

FIG. 207.—Left upper canine, to the apex of the root of which is attached a fragment of necrosed bone. The hollowed surface on the upper and right-hand surface of the bone formed a portion of the floor of the nose. On the side of the root is a smooth, slightly depressed surface, more conspicuous in the figure than in the specimen, which may perhaps have been due to absorption consequent on the pressure of a neighbouring tooth, and there is a slight eroded groove at the front of the neck, but otherwise there is no visible diseased condition to account for the necrosis.

the same side, and including the mental foramen and a portion of the inferior dental canal. The teeth involved in the dead bone were all sound, and the patient, whose statements appeared perfectly reliable, could not throw any light on the origin of the disease. No history of syphilis could be elicited.

A case of bilateral partial necrosis of the mandible occurring in a previously healthy man aged 60, and due to traumatic inflammation intensified by septic infection, was recorded by the writer in the Trans. Odont. Soc., Nov., 1903. On each side the necrosed bone comprised the whole of the alveolar process from the first bicuspid backwards, and a portion of the internal plate of the body of the mandible. On the right side a solitary molar and on the left a bicuspid and two molar teeth came away with the diseased bone.

The immediate cause of necrosis is periostitis; but the inflammatory action always involves the bone itself as well as the periosteum, creeping in along the vessels which pass from it into the bone; purulent effusion follows between the bone and the periosteum, thus cutting off this part of the blood supply of the bone, though the periosteum itself but rarely sloughs, owing to the richness of its vascular supply. In a large majority of cases the more remote cause of the disease can be traced out.

Thus, in children of strumous diathesis, large portions often necrose, and the disease may be, and we think very commonly is, set up by a decayed tooth. The tooth-pulp inflames, the inflammation extends to the periosteal lining of the socket, and from thence spreads to the body of the jaw.

A very frequent cause of necrosis is constitutional syphilis, which may lead to the destruction of any part of the jaw, though its chosen site seems to be the palatine plate of the maxilla. A node forms on the hard palate, rapidly degenerates and liquefies, and, by separating the periosteum from the bone, leads to necrosis, and consequent perforation into the nares. Not uncommonly the morbid action commences on the floor of the nares, and thence penetrates the hard palate.

I have myself met with a case in which extensive necrosis of the lower jaw was the only manifestation of syphilis which had occurred for twenty years, but the diagnosis was put beyond a doubt by the after-occurrence of pains in the head, and finally of swelling of the testicle, and by the marks of congenital syphilis in the children. In this case I at successive times removed all the lower teeth, and the extension of the necrosis only ceased with the loss of the last of them, which were the incisors; so that I was driven to the conclusion that it would have been far better for the patient had I adopted a less conservative line of treatment at first.

As has already been stated, necrosis of the alveolar portion, sometimes extending further into the body of the bone, may be set up by a diseased tooth, though this will happen but rarely in a healthy individual. Ulcerative stomatitis not very rarely leads to the exfoliation of small scales of bone; and, in fact, any form of ulceration of the gums may cause this more serious mischief, the ulcerations due to salivation, to scurvy, or cancrum oris being especially prone to lead to necrosis. Very extensive destruction of the bone often follows exanthematous fevers, and exposure to the vapours of phosphorus sets up a severe form of the disease, which presents several special characteristics.

Mechanical violence will often cause the death of portions of the maxillæ; thus, large sequestra often come away after gunshot wounds, or after fractures; and the unskilful extraction of teeth is capable of causing extensive mischief. Thus, a patient presented himself at the Dental Hospital in whom the alveolar portion of the lower jaw was fractured from the position of the first molar to that of the lateral incisor of the opposite side. The fracture, which was caused by an ineffectual attempt to extract the first molar, had run horizontally round the jaw, completely separating the alveolar portion from the base of the jaw. There was no evidence to show whether the forceps or a key instrument had been used; the treatment adopted was fixation of the fragment by a gutta-percha cap adapted over the crowns of the teeth. The detached piece, however, did not reunite; abscesses formed under the chin, and finally it was removed, in consequence of its becoming necrosed.

Necrosis of a portion of the bone may follow upon the extraction of a tooth, however skilfully this has been performed, and it must not be supposed that the operator is always, or even commonly, to blame for the advent of necrosis after the extraction of a tooth. The conditions leading to necrosis are, in the great majority of cases, developed previously to the removal of the tooth, and are quite independent of its removal; the necrosis would generally have been quite as sure, and perhaps even more extensive, had the tooth been left in. There is not the smallest reason for believing that the removal of a tooth should be deferred because the tissues around it are in a state of acute inflammation or suppuration; if the tooth be the exciting cause of the mischief, there is no excuse for delaying its extraction for a single moment; and the opinion to the contrary, held though it be by a number of medical men, is in no degree shared by dentists, and, being based on no evidence whatever, must take rank in the category of popular errors.

Fatal consequences have in several instances been known to follow upon necrosis after tooth-extraction, some of which cases have been already alluded to.

It must be remembered that the bone constituting the alveolus is apparently very intolerant of injury, and seems to have little recuperative power; moreover, things have often gone far towards a necrosis before the operation is performed, and necrosis is not rare without any violence being done to the inflamed tissues.

On the other hand, excessive violence is capable of fracturing portions which subsequently necrose, as was frequently exemplified in the old days of the key instrument, and the writer was once consulted with reference to a necrosis which had destroyed the whole ascending ramus and a portion of the body of the lower jaw, and which had been attributed not only by the patient, but also by the surgeon who had removed the dead bone, to violence done in the extraction of the wisdom-tooth. But upon a careful consideration of the history of the case, and an examination of the separated sequestra, it seemed quite as probable that the patient was, so to speak, in for the necrosis before the removal of the tooth.

The disease may arise at any period of life, but it occurs more frequently in children than in adults; and in the former it is, we think, more commonly seen in the lower than in the upper jaw.

In children the sequestrum is generally limited to the sockets of one or two temporary, and the crypts containing the succeeding permanent, teeth; and the situation in which the disease most frequently establishes itself is that occupied by the temporary molars. To this rule many exceptions will be found. The dead bone may be cast off, and leave the forming permanent tooth or teeth behind, injured, perhaps, but not destroyed.

Necrosis, when it occurs in adults, may fall upon any part of the alveolar arch, and may arise at any period of life. We have seen cases in young, middle-aged, and in quite old people.

The indications which attend necrosis are at the outset undistinguishable from inflammation of the alveolar periosteum, but they differ as the disease advances. Instead of the formation of a local and circumscribed swelling, the gum over the diseased bone becomes generally thickened, tumid, and of a deep red colour, and there may be great swelling of surrounding parts; pus oozes up from the edge of the gum. After a time the gum separates from the alveolus, the margin of which becomes exposed. The involved tooth or teeth loosen and fall out. In the course of a few weeks the dead alveoli are detached from the subjacent living bone, and lie loose in the substance of the thickened gum, bathed in pus.

Pain is complained of early in the disease, and is commonly supposed to be toothache; later in the course of the necrosis the face becomes swollen, especially in cases of phosphorus necrosis, which disease, being in some respects peculiar, requires a short special description.

If the pus, which is very profusely poured out around the sequestrum, does not find a ready exit into the mouth, it will often point below the chin, or even pass down the neck beneath the fascia, thus sometimes reaching as low as the clavicle. In the case of the upper jaw the pus usually makes its way into the mouth.

Phosphorus Necrosis.—A peculiar form of necrosis affecting the jaws has been repeatedly observed in persons whose duties expose them to the vapours of phosphorus. So numerous are the cases, and so clearly is their history traceable, that no doubt can be entertained that the phosphorus is the actual cause of the disease. There is a prevalent idea that the lower more frequently suffers from the disease than the upper jaw, but this is not borne out by statistics, as out of fifty-one cases collected by Von Bibra both jaws were affected in five instances, the upper alone in twenty-one, and the lower alone in twenty-five.

One fact connected with the origin of this disease gives it a special interest in the eyes of the dental surgeon: there is some evidence in favour of the view that the poison acts locally, but that in the first instance it cannot attack an unbroken surface. Hence it was formerly believed to gain access to the bone through the socket of an extracted tooth, or through the cavity of a carious tooth, exposure of the pulp being, according to Mr. Salter,[1] the only manner in which it gains access.

It is stated that the disease has never been known to occur in a person whose teeth were sound; whilst many who have worked for years with impunity have only been attacked after teeth had become carious. The experiment of Von Bibra confirmed this opinion; he exposed rabbits to phosphorus fumes, and found that they experienced no injury so long as the teeth and jaws were intact, but that if teeth were extracted, or the jaw otherwise exposed, necrosis speedily followed.

On the other hand, it must not be forgotten that other bones than those of the jaws are liable to become affected by phosphorus necrosis, and anæmia and other forms of general ill-health are common amongst those exposed. A good deal of evidence has accumulated, much of which will be found in a Blue Book containing the evidence and report of an arbitration heard between the Home Office and the match manufacturers in regard to new rules to be enforced, which points to a constitutional affection in the course of which any unhealthy or damaged bone is liable to necrose. The frequent occurrence of inflammation about dead teeth renders the jaws far more frequently unhealthy than any other bones in the body, and hence the manifestation of this disposition to necrosis occurs in them with far greater frequency than elsewhere. If this comes to be established, a carious tooth the pulp of which is exposed is only a potential source of danger; till it is dead it would have no effect, and *à fortiori* a carious tooth, the pulp of which is not exposed, has not yet reached a dangerous condition. As mechanical injury, apart from prior inflammation, has been experimentally found to determine necrosis in a bone when an animal has been exposed to phosphorus poisoning, it is very necessary to keep workers in a match factory away from their work after the extraction of a tooth until at least such time as the socket is healed. The introduction of safety matches made with amorphous phosphorus has greatly diminished the number of cases which occur, and additional precautions, amongst which may be mentioned periodical inspections of the teeth of the workers, have had

[1] Holmes's Dictionary of Surgery, vol. iv., p. 39.

the same effect even where the more dangerous form of phosphorus is still employed.

The disease very rarely occurs, except in the persons of lucifer-match makers, but Sir James Paget quotes an instance where it was induced by the inhalation of phosphorus fumes as a quack remedy for nervous depression, and a case has lately occurred in which it resulted from a long course of phosphorus pills, taken without medical advice. Mr. Heath quotes Grandidier to the effect that a case has been met with in a child but six weeks old. This case is remarkable inasmuch as the teeth were not yet erupted, so that the poison seems to have obtained access through an unbroken surface so far as teeth are concerned.

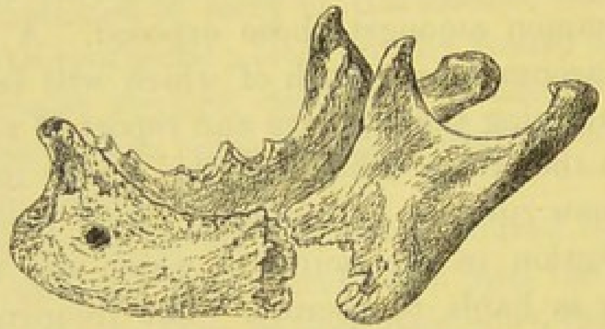


FIG. 208.—Jaw from a lucifer-match maker, aged 35, who died whilst suffering from phosphorus necrosis. The bone is diseased from the base of the left ramus to a point slightly beyond the symphysis.

This form of necrosis is, perhaps, the most severe of any which is met with.

The swelling of the soft parts is very great, and the integument becomes very red and shining; the suppuration, which may give rise to external fistulous openings, though the bulk of the pus is generally discharged into the mouth, is very profuse. The advent of suppuration is marked by rigors and pyrexia, and in severe cases by delirium; after it is fully established the severity of the constitutional symptoms abates, though the patient's health suffers very greatly from inability to take solid food, from swallowing decomposing pus, and from exhaustion. Gangrene of the soft parts or erysipelas may supervene as complications, and terminate the patient's sufferings. Still, the majority of cases recover, though with considerable loss of bone. In the case of the lower jaw a very large amount of callus is thrown out around the sequestrum; while in the case of the upper jaw little or none is found.

The bony deposit which is thrown out in phosphorus necrosis is peculiar in appearance, and has been compared to pumice-stone; although usually present in great quantity, it is not invariably to be found, and in the example here figured it was apparently absent. It is also exceptional for a portion of the jaw to be affected in phosphorus necrosis, the destruction more commonly involving the whole body of the jaw, the ascending rami alone remaining intact. It is, of course, impossible to say how far the disease might have extended had the patient lived; but the necrosis in the specimen does not reach far beyond the middle line, though no attempt at separation has as yet been made.

The new bone thrown out seldom surrounds the sequestrum, but generally forms a trough in which the dead bone lies.

The separation of the sequestrum usually takes a very long time, often a year or more; but the surgeon must on no account be tempted to remove it before it is detached. All that can be done is to support the patient's strength by a generous diet, and by tonics; though the duration of the disease renders the avoidance of drugs, as far as possible, desirable. The mouth should be frequently syringed out with lotions of Condy's fluid, sanitas, or phénol sodique.

Dr. Garretson advises the insertion of pledgets of cotton wool into the sinuses, with a view of hastening the separation of the periosteum, which is already inevitable.

Large quantities of pus will be swallowed, but it is desirable to avoid the formation of any external sinuses, and to induce the discharge of pus into the mouth, as the sinuses may afterwards prove very troublesome.

In the upper jaw there is a greater tendency to recurrence, but the course of the disease is not so violent, and the necrosed portions may be removed much sooner.

It has been stated that in this form of necrosis there is no great tendency to extension of the disease; the whole region affected is attacked at once, from the very first, that is to say, at the period of the first attack of acute inflammation.

Exanthematous Necrosis.—During convalescence of children from the eruptive fevers, and particularly after scarlatina, it is sometimes found that portions of the alveolar border of the jaw, very commonly including the developing permanent teeth, are exfoliating.

The course of the disease is not usually violent, and all that will be required is to remove the fragments as they become loose. Otto Weber,[1] however, mentions the occurrence of far more severe cases, which threatened gangrene from the excessive infiltration of the soft parts; in such cases free and deep incisions would be required. The disease is remarkably symmetrical, affecting the two sides of the mouth alike; it is most frequent about the age of five or six years, though it has been met with at a later age. Several examples of jaw necrosis occurring after continued fever are to be found in the different hospital museums.

Dr. Austen, however, who has had great opportunities of observation at the Fever Hospital, states that the necrosis always commences during the acute stage, and he has never seen it originate during convalescence. He is inclined to attribute it to wounding of the mouth, by the displacement of loose teeth or otherwise, whilst in a very foul condition, a thing almost impossible to avoid in making applications to the throat in young children.

Treatment is much the same for every form of necrosis. Whilst the disease is in the stage of periostitis, threatening to run on to necrosis, free incisions should be made through the inflamed gums, and poppy fomentations assiduously used. And every means should be taken to cleanse the mouth and render it as far as possible aseptic. Any teeth or stumps which may be causing irritation should be *at once* removed, no matter how violent the inflammation around them may be; and the practitioner who is deterred from so doing by the popular idea that teeth should not be removed until the inflammation has subsided is likely enough to be waiting for a time that will never come, and is assuredly grievously prejudicing his patient's chances of escape from the more serious ailment.

The propriety of at once extracting sound teeth which have become implicated by the extension of the disease may be questioned.

1 "Lehrbuch der allgemeinen und specialen Chirurgie."

Instances have been recorded of teeth loosened and apparently in a hopeless condition having, after the removal of the sequestrum, become firmly fixed, either in the remaining portion of the bone or in alveoli subsequently developed.

The sequestrum here figured contains (*a*) the sockets of the canines and bicuspids, and the history of the case, related by Mr. Sharp at the Medico-Chirurgical Society,[1] is briefly as follows :—

The disease had commenced with toothache, six months previously, followed by alveolar abscess, and a fistulous opening under the chin. Extensive ulceration of the integuments under the chin had ensued, and after the lapse of two months

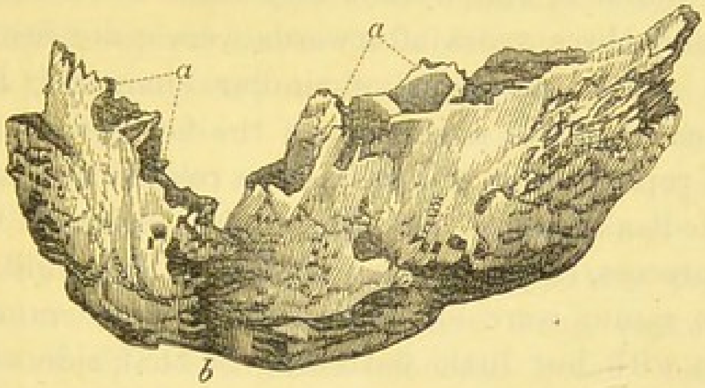


FIG. 209.—Sequestrum containing the symphysis (*b*) and the sockets of the bicuspid and canine teeth (*a*). From a drawing by Mr. de Morgan. "Lectures on Dental Physiology and Surgery," by J. Tomes, F.R.S.

it was thought that the sequestrum was detached. The existing sinuses under the chin were thrown into one, and the dead bone, amounting to about two-thirds of the lower jaw, easily removed with forceps. The teeth, with the exception of a bicuspid which had been extracted, remained in their places, and became tolerably firm, notwithstanding the entire destruction of their original alveoli.

Mr. Heath has collected several other cases in which the teeth remained firm after the removal of sequestra which contained their sockets, and were in a measure useful to the patient ; though in other cases they were inconveniently loose and were subsequently removed. Mr. Heath also relates a case

[1] Medico-Chirurgical Transactions, vol. xxvii., p. 432.

in which the teeth remained firm after very extensive necrosis of the outer plate of the alveolus, the inner having remained to serve as a support.

In the Museum of Bellevue Hospital, New York, there are several very remarkable specimens of reproduction of bone after necrosis, met with in the practice of the late Dr. J. R. Wood.

In one, the entire lower jaw had been subperiosteally resected for phosphorus necrosis, and a complete lower jaw was reproduced, lacking only the condyles, which were represented by thin laminæ of bone laid against the glenoid cavities. A figure of this case is given in Erichsen's "Surgery." Another specimen consists of the symphysis and two-thirds of the ramus; the lower incisors were left *in situ*, being held by the gum alone, and it is stated that they came to be embraced by new bone, and three years afterwards were quite firm. There are several other specimens of similar character, Dr. Wood having given no little attention to the subject.

A case of reproduction of lost tissue is related by Dr. Marshall (Chicago Medical Journal, January, 1884), in which the entire condyloid process, the posterior part of the body, and the lower part of the ramus were lost, and a fully-formed ramus and an articulation with but little flattening of that side of the face were found less than two years afterwards. There was perfect mobility of the joint. The case was peculiar in that the necrosis of the condyloid region was induced by a large dentigerous cyst, which had cut off this portion from the coronoid process; there was at no time any noteworthy amount of suppuration, and the cyst wall was evacuated and crushed, so that the periosteum was everywhere intact.

The dentigerous cyst was induced by the presence of a wisdom-tooth in the sigmoid notch, with its roots imbedded in the condyloid process.

It has been usually supposed that restoration of bone after necrosis was effected by the periosteum, and in most instances this is certainly the case; Sir Thomas Smith[1] has, however, met with an example of new formation of bone, which he considers could not have been derived from periosteum.

Mr. Salter[2] points out that the newly-formed lower jaw is

1 St. Bartholomew's Hospital Reports, vol. i.
2 Holmes's Dictionary of Surgery, vol. iv.

apt to be absorbed, and to dwindle down to a mere bar; and adds, "How far this loss by absorption of supplemental bone may be prevented by supplying it with a function through the means of artificial teeth is a question of theoretical interest and of practical importance."

It is a curious fact that there is rarely or never any repair by bone after necrosis of the upper jaw, though in children, and more particularly after exanthematous necrosis, the gap is often filled up by fibrous tissue.

Disease in a temporary tooth will sometimes set up inflammation, which in a strumous or enfeebled subject may spread, and ultimately involve a large portion of the jaw, and result in necrosis. The teeth, whether permanent or temporary, implanted in the sequestrum, are usually lost. Mr. Oliver Chalk relates several cases in which portions of the jaw, including the temporary and the crypts of the permanent teeth, were lost. New bone eventually took the place of that which had been removed, and the jaw again became perfect. In several of these cases, permanent teeth most unexpectedly made their appearance, suggesting the idea that the teeth, as well as the bone, had been reproduced. In each instance in which this unusual result occurred, the sequestrum was allowed to become perfectly separated and quite loose before its withdrawal through the opening which already existed was attempted. The phenomena, as respects the teeth, admit of explanation on other grounds than that of supposing a second series of permanent teeth to have been developed.

Dead is in all cases detached from living bone by absorption of the layer of the living tissue which connects the two, in addition to which we commonly find marks of absorption scattered over the whole of that surface of the sequestrum which has been connected with the soft parts. Again, the apertures of the crypts are by the same process greatly enlarged. The connection between the walls of the crypt and the sac of the developing tooth-pulp is in the normal state but a slight one; and this, in the character of cases referred to, may be rendered still more slight by disease of the bone and periosteum. Now, with the foregoing conditions, it is not improbable that the pulps of the permanent teeth remained attached to the soft parts, while the crypts included in the sequestrum were removed; and if such were the case, the developing teeth might again be surrounded by newly-formed bone. The truth of this explanation of the manner in which the peculiar results were brought about is rendered probable by the absence of any well-authenticated cases of the occurrence of a second set of permanent teeth.

But whatever explanation be adopted, we think all will agree that it is desirable, in those cases where necrosis of the jaw occurs during the presence of the temporary teeth, that the sequestrum should be allowed to remain until it is perfectly detached both from the contiguous bone and soft parts before its withdrawal is attempted; and that its removal should be effected with the least possible injury to the latter, so that the permanent teeth, if not destroyed by the disease, may be placed under the most favourable circumstances for their future growth and evolution.

As Wedemeyer observes, the limits of the necrosis are known to nature alone, and the surgeon will fall short of or pass beyond them.

Before the dead is separated from the living bone a layer of the latter must be absorbed, a process which has already been described in connection with the shedding of the temporary teeth. The separation of the sequestrum must be left to nature. We can render no direct assistance; but it must be the business of the practitioner to see that nature has a fair chance, by attending to the general health of the patient, removing any obvious source of local irritation, and keeping the diseased part in a cleanly state. In effecting the latter purpose, a wash composed of five grains of chloride of zinc to an ounce of distilled water may be used. It will excite healthy action, and greatly diminish, if not entirely overcome, the fœtid smell which attends suppuration associated with dead bone; or dilute solutions of permanganate of potash may be used for the same purpose; the point of a syringe may be inserted into the sinuses, so as to effectually wash them out.

If, after the sequestrum has been separated from the body of the jaw, it is entangled in the soft parts, the scalpel must be used to effect its liberation. With the removal of the dead bone the treatment of the case may be said to terminate. The inflammatory action in the gums and contiguous structures, in the absence of a source of irritation, rapidly subsides, and the mouth is speedily restored to a state of health.

It is important, however, that the sequestrum should be picked out as soon as it has become loose : if this be neglected, burrowing abscesses may be formed. Thus Mr. Cattlin relates a case in which a piece of dead bone from the jaw passed down in abscess cavities, and was finally removed below the clavicle ; and Mr. Wood has forcibly pointed out that it is quite possible to wait too long before removing the dead bone. It has already been mentioned that developing permanent teeth are often lost in the sequestrum thrown off in the so-called "exanthematous necrosis."

Not only, however, may the permanent teeth be exfoliated, but the whole lower jaw has been known to be cast off. Mr. Pollock figured and described such a case[1]; there was not a vestige of a lower jaw, which, according to the statement of the patient's friends, had been thrown off when she was two years of age. The deformity was less than would have been expected.

Tubercle is not very common in the mouth, and tubercular affection of the bone of the jaw is quite a rare affection. It is capable of setting up a rarefying osteitis (tubercular caries) in which the spaces become filled up with caseating material. The alveolar borders appear to be more frequently attacked than the body of the bone, probably because they are more exposed to direct infection, which may perhaps be derived from a bucco-pharyngeal tuberculosis, this being the commonest form of tubercle in the oral tract.

In acromegaly the lower jaw is often greatly enlarged, and osteitis deformans may affect the jaws in common with other bones; and actinomycosis, which is treated of under another head, may invade the bone of the jaw.

The jaws are also subject to **hypertrophies,** general or localised. A form of abnormal development of bone in the alveolar region, which is productive of great inconvenience to

[1] Art. Diseases of the Mouth, Holmes's Dictionary of Surgery, 2nd edition.

the patient, consists in a gradual filling up of the sockets of the teeth by bone.

After the luxation of a tooth, the socket in young and middle-aged subjects is to a certain extent filled up from the bottom by the development of bone. This process, which after the loss of a tooth is reparative, becomes destructive when the action is set up in the socket of a sound tooth. The tooth by slow degrees becomes longer than its neighbours, and, after the lapse of a considerable length of time, loosens and falls out, or is removed in consequence of its inconvenient length.

In other cases, again, the teeth, without being extruded by the development of bone within their sockets, are separated

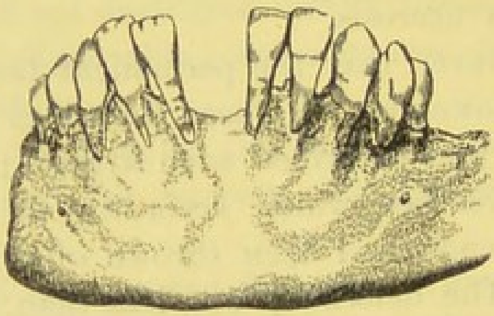


FIG. 210.—Shows the front teeth in the lower jaw separated from each other in the median line by the thickening of the intervening bone, independent of the presence of disease. From Sir E. Saunder's collection.

from each other by the thickening of the intervening bone. In some cases the shifting of position may be due to derangement of the normal antagonism of the upper and lower teeth; but there are others in which this cause will fail to explain the gradual separation of teeth which are apparently sound and healthy. This deposition of bone may also have the effect of displacing the teeth forward, thus, in the case of the upper incisors, producing a very unsightly appearance. The gum is usually pale, hard, and closely adherent to the necks of the teeth.

Hypertrophy of the alveolar portion of the jaw, when limited in extent, is far from uncommon. The writer remembers one case in which a stout bony ridge ran out to the extent of more than half an inch, and then turned upwards. The patient stated that the lodgment of food on the shelf, as he termed it, was the only annoyance to which the exostosis subjected him.[1]

Otto Weber[2] mentions the occurrence of limited exostoses and thickenings of the bone near the alveolar border, and refers them to the irritation caused by diseased teeth; he observes that over such exostoses there is marked tenderness on firm pressure.

Small exostoses, which seemed to be due to the irritation caused by carious teeth, have in some few cases been known to disappear after the extraction of the teeth,—a course which

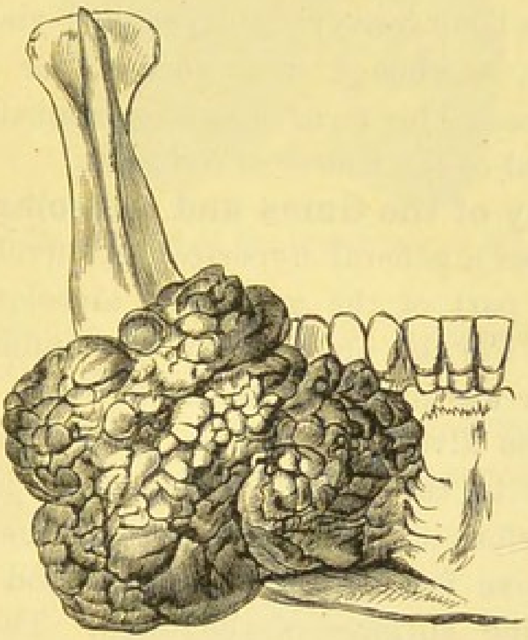


FIG. 211.—Large exostosis on outer plate of lower jaw. From a specimen in the Boston Medical Museum.

should therefore always be tried when there appears to be any such cause in operation.

But symmetrical exostoses upon the lingual aspect of the lower jaw are very common in mouths where the teeth are all perfectly sound; there are often as many as three or four upon each side, and they usually are not productive of any inconvenience, though they are troublesome to the dentist when it is desired to insert artificial teeth.

Sometimes exostoses occur upon the outer surface of the bone, as in the specimen here figured; and when they attain

[1] An excellent example of numerous exostoses, studded over the alveolar border of the jaw, is given in "Atlas zur Pathologie der Zähne," von Heider and Wedl, Plate xv., Fig. 138.

[2] Otto Weber, "Lehrbuch der allgemeinen und specialen Chirurgie."

to such size as to be productive of serious inconvenience, which they rarely do, no treatment but excision of the morbid growth will be of any service. Owing to the excessive hardness of some of these exostoses, their removal is often attended with more difficulty than was at all anticipated. A Hey's saw or a surgical engine will generally be found suitable for their removal; they are often too hard for a gouge or bone-forceps to be of much service.

In other instances the enlargement of the bone is of a soft, spongy character. Teeth removed in such cases come away very readily, the bone conveying a peculiar yielding sensation to the operator, as though it crushed under the application of moderate force. This form of enlargement slowly disappears after the removal of the source of irritation.

Hypertrophy of the Gums and Alveolar Processes.—In some few cases a general hypertrophy, involving the whole or the greater part of the gums and alveolar processes, has been observed. For the opportunity of examining one of these cases the author was indebted to the late Mr. Alfred Canton. The whole of the alveolar bone was greatly enlarged; it projected upwards in the lower, and downwards in the upper jaw, carrying before it a red and thickened gum, and concealing within the groove formed by its lingual and labial portions the corresponding surfaces of the teeth. The thickening in the front part of the mouth was so great that the lips could not be closed. At the back part of the alveolar arch the thickened and elevated gums of the respective jaws, though flattened by mutual pressure, did not allow the molar teeth to come in contact.

The patient was a half-witted, strumous child, aged about thirteen years, whose appearance led to the presumption that the disease was a manifestation of the strumous diathesis. No treatment was attempted in this case, the patient returning to her native village.

Several cases of the affection have been put on record.[1]

[1] Other cases may be found in—"System of Surgery," by S. D. Gross, M.D., Philadelphia, 2nd edition, vol. ii., p. 535; Boston Medical and Surgical Journal, April, 1869, two cases; "Injuries and Diseases of the Jaws," by C. Heath, 3rd edition, 1884, p. 227; Faro, British Dental Association Journal, 1898. In this case there was abnormal growth of hair, extending down nearly to the eyebrows and the front of the ears.

A fairly characteristic case, which occurred in the practice of Mr. Syme, and was seen more than once by Sir John Tomes, was met with in an adult, and affected both jaws alike. The increase was slow, and no operation was resorted to; the

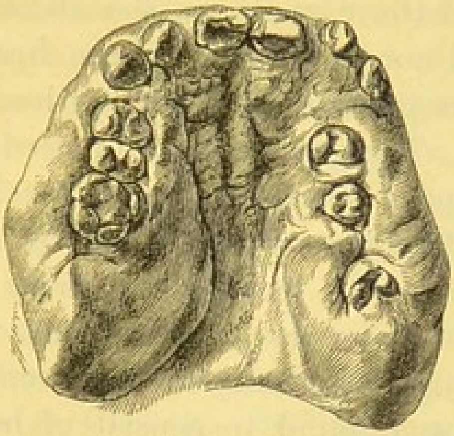


FIG. 212.—From a model of the upper jaw of Mr. Syme's case.

accompanying figure is taken from a model now in the Museum of the Odontological Society.

Another case, in which the growth was much larger, and caused more distortion of the features, was successfully operated upon by Mr. Pollock.

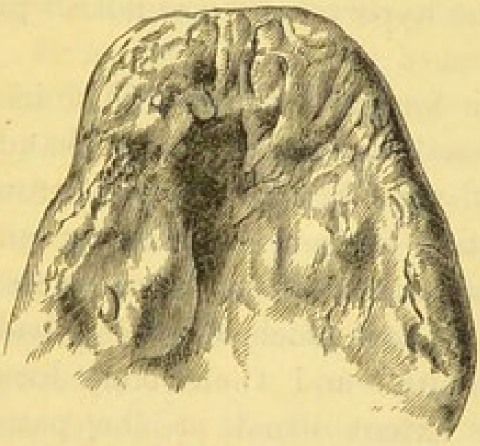


FIG. 213.—From a plaster model of the upper jaw of Mr. Pollock's case.

The following notes of Mr. Pollock's case are abridged from Mr. Salter's [1] article. At the fifth week after birth, six teeth had appeared, and it was noticed that the gums were thick and

[1] "A System of Surgery," by Timothy Holmes, M.A., 2nd edition, 1870, art. "Diseases of the Teeth," vol. iv., p. 342.

puffy. At the age of two years all the temporary teeth were extracted, and the gums cauterised.

At the time of admission into St. George's Hospital the child was eight years old; it was remarkable for an abnormal development of hair, which grew low on the forehead, and reached in front of the ears on to the cheeks. A large pink mass, which could not be covered by the lips, protruded from the mouth; it was indistinctly lobed, with a dense, insensitive skin-like surface. The greater bulk proceeded from the upper jaw, which overlapped the lower, the latter being, as it were, imbedded in it. The mass was removed by operation, portions of it being cut away with scalpels and bone nippers, and the removal completed at successive operations.

There was a slight tendency to recurrence of the growth. In structure it was found to consist of hypertrophy of the alveolar border, together with immense thickening of the fibrous portion of the gum, which bore an exuberant growth of papillæ. In the upper jaw it extended three quarters of an inch forwards beyond the alveolar border.

Those of the temporary teeth which had not been extracted were deeply imbedded in the mass, though the first permanent molars had appeared, and the second lower temporary molars were visible, as the hypertrophy was not so great at the back of the mouth.

The roots were found to be imbedded in sockets, but the crowns were enclosed in smooth walled chambers in the dense fibrous tissue, and were free from bony surroundings. One of the superior central incisors was nearly an inch from the surface. The permanent teeth were excessively large—the incisors larger than any which Mr. Salter had ever before seen in a female's mouth—and their bony loculi had not been absorbed to the extent usual at the patient's age. The epithelium had become converted into a thick and hard epidermis, beneath which were enormously long papillæ, attaining to one-sixth or one-fourth of an inch in length; this papillary growth being in unity with the great teeth, excess of coarse hair, thick skin, and other indications of a tendency to tegumentary hypertrophy.

Mr. Erichsen operated upon a child two and a half years old by simply paring the mass off, extracting some of the teeth, and freely cauterising the cut surfaces; it proved to be a simple hypertrophy, no abnormal structures being found in the mass, but five years afterwards it had all been reproduced, and was described as almost completely covering the teeth, and forming numerous papillomatous growths. The patient presented peculiarities of the skin, subcutaneous connective tissue, periosteum, and ends of the fingers and toes; the patient's brother, aged four, and a sister, aged two, presented a similar condition of the mouth. A fuller description of these children will be found in the Medico-Chirurgical Transactions, vol. lvi., "On the Three Cases of Molluscum Fibrosum," by the late Dr. John Murray. The hairy woman, Julia Pastrana, formerly exhibited in London, was also an example of this affection, and the Odontological Society is fortunate in possessing models of her mouth. She was called the pig-faced woman, and was supposed to have had an excessive number of teeth, and in this connection is mentioned by Darwin in several of his works; this, however, was not the case, though the teeth, such of them as can be seen not completely buried in the hypertrophied gums, are excessively large.

But by far the most remarkable example of this hypertrophy is related by Mr. MacGillivray,[1] from whose paper (for the use of which we are indebted to Mr. Heath) this account and figure are taken. It is noted that the gums were unusually large at birth; of the deciduous teeth two only made their appearance, and by the time that the girl had reached the age of four the growth attained to such a size that her medical man attempted its repression by caustics, with little or no success. At the age of ten an operation was performed in which nine completely hidden teeth were extracted, and the redundant gums pared down.

When first seen by Mr. MacGillivray, the patient was twenty-nine years of age; the mouth was kept widely open by great lobulated masses springing from both upper and lower jaws. These huge lobular excrescences were found to spring mainly from the palatal surface of the alveolar portion of the jaws, the labial surfaces being comparatively healthy. Inside the mouth they reach backwards along the hard palate,

[1] Australian Medical Journal, August, 1871.

and project below the soft palate. The surface of the growth was everywhere lobulated, in some parts smooth, in others rough from the presence of enormous papillæ; it was nowhere ulcerated, and no pain was felt in the masses.

Its removal was effected in three separate operations, performed at intervals; the lobular masses of gum being pared off with a scalpel, and the hypertrophied alveolus excised with bone-forceps; profuse hæmorrhage occurred, but was arrested by the use of the actual cautery.

The patient made a good recovery, and the operation seems to have been perfectly successful, both as regards the patient's

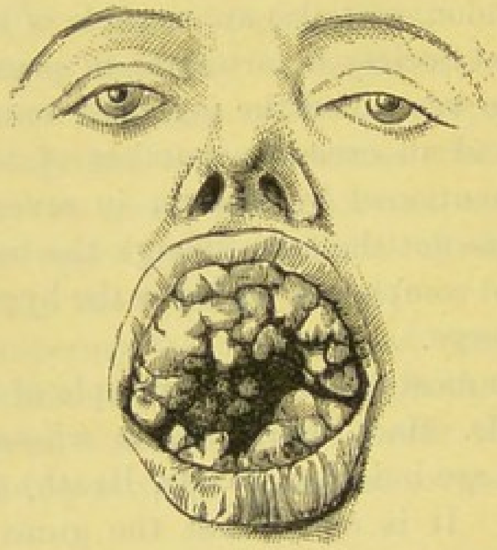


FIG. 214.—From a photograph of Mr. MacGillivray's case.

appearance—she being able to close the mouth—and as regards the recurrence of the disease.

In this case, as in Mr. Erichsen's, which was examined by Mr. Bruce, no abnormal structures were found; it was a case of true hypertrophy, in which some of the papillæ attained the enormous length of half an inch.

Mr. Heath gives a report of another case in a child aged four and a half. "She is one of five children; the other four are healthy. Two years ago the swelling of the gums began by the side of the temporary molars, which were just coming through, and from them the swelling has spread right round the jaw. At this time she had fits about once a week; the fits have continued up to the present time, but with longer intervals. They appear to be epileptic. The patient is a very tractable child; her general health is good. The gums are enormously hypertrophied, the teeth being entirely covered with the exception of the tips of the crowns, which appear depressed in the gums. The hypertrophy of the gums is so great that the cheeks are bulged out on each side, and the cavity of the mouth is almost filled with them. The teeth are irregular and slightly carious. The child is always biting and putting cold things in her mouth. She can bite nothing hard, and has been fed entirely on liquid and pulpy food. Her breath is very offensive. Under chloroform I removed the hypertrophied gums and the alveolar margin of the lower jaw in two pieces. On one side the first permanent molar came away; on the other it was left, not being quite erupted. Hæmorrhage, which was free, was stopped with the actual cautery. A fortnight afterwards I detached the hypertrophied gums and alveolar border of the upper jaw in one semi-circular piece. Roots of the permanent teeth left. On June 3rd the patient was discharged well.

"A microscopic examination by Mr. Charles Tomes showed that the structure of the growth closely resembled that of the small polypi which are sometimes found occupying the cavity of carious teeth; it was a true hypertrophy of the gums, and chiefly of the fibrous portion. It sprang from the periosteum round the neck of the teeth, just within the margin of the alveoli. From this point a dense stroma of interlacing fibres, covered by a thin mucous and epithelial layer, grew up round the tooth, the growths from opposite sides meeting over it and coalescing so as almost to cover it. The attachment within the socket was important, for this explained how it was that a successful result could not be obtained without removing some of the alveolus. Unless this was done, part of the growth remained behind, and recurrence soon took place."

It would be interesting to see what would be the result of simply removing the teeth, so as to set up the process of absorption of the alveolus which follows upon their loss. As these cases are not very urgent, the loss of time involved would not be serious, even if it afterwards became necessary to resort to a more extensive operation, whilst it seems quite within the bounds of possibility that such a measure might result in the shrinkage of the whole mass.

A saccharomyces has been found abundantly in the growth in one case, and it is suggested that it may have been the cause (Dental Cosmos, 1901).

Amongst the specimens presented by Mr. Bland Sutton to the Odontological Society is one of the jaws of a rickety lion, which presented in all respects the characters of this disease.

In the condition just described the gums and actual alveolar borders alone are affected, but the maxillary bones are sometimes the starting-point of a remarkable form of general hypertrophy of the bone, which in severe cases affects the

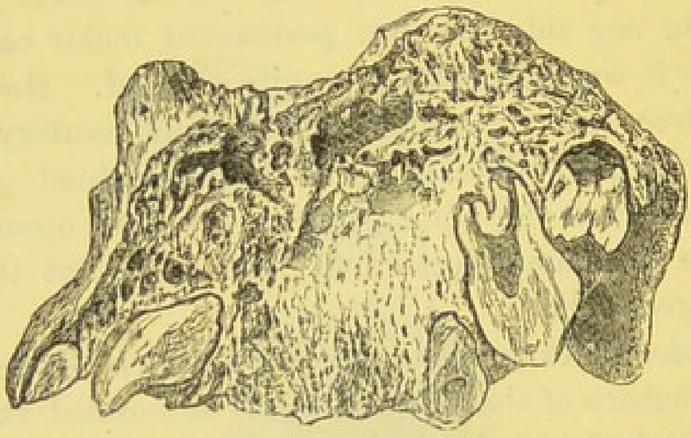


FIG. 215.—Half of the left upper maxilla (Mr. Heath's case); the section has been carried through the permanent teeth, which had not as yet been erupted; some of the teeth are in the other half of the bone, so that they are not shown in this figure.

other bones of the face and cranium, and, more rarely, bones elsewhere in the body.

Although it is a rare disease, and one which falls into the hands of the surgeon for treatment, it is very necessary for the dental surgeon to be acquainted with its nature and characters, as it is likely to be brought before him in its early stages for his opinion.

The disease consists in an interstitial growth and alteration affecting the whole substance of the bone, and not merely its surface: in its progress the whole bone becomes enlarged, the antrum, and eventually also the nasal cavities, obliterated; it goes on to encroach on the orbit till the eye is destroyed by its pressure, and the most hideous deformity produced. In Mr. Heath's work[1] several figures are given showing the extreme deformity which is caused by the disease.

[1] "Diseases and Injuries of the Jaws," 2nd edition, 1872, p. 132.

The coarse, rough, porous appearance of the surface of the bone is well shown in the plate of Mr. Bickersteth's case,[1] and this same porous cancellated structure, extending through the whole substance of the bone, is seen in the appended figure, from a specimen for the use of which we are indebted to the kindness of Mr. Christopher Heath. In this case the disease was first noticed at the age of three months, when the left side of the face was found to be enlarging. The left eye became closed at the age of six, and the enlargement steadily increased till the boy reached the age of twelve, when the left upper maxilla was removed by Mr. Heath; the integument having,

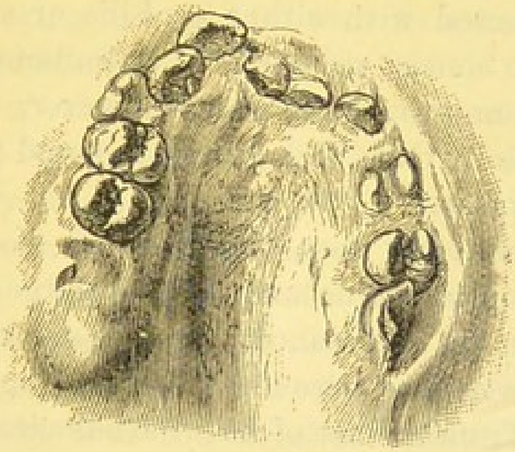


FIG. 216.

however, shared in the hypertrophy, great deformity still remains.

A model of the mouth (Fig. 216), taken before the operation, shows that on the right or healthy side the permanent incisors, canine and bicuspids, are in place; while on the left side the temporary incisors and canine (?) are retained, and the bicuspids not fully erupted.

As seen in the sections made through the bone after its removal, the incisors, canine, bicuspids, and first permanent molar (carious) are found to be well-developed, full-sized teeth.

Behind the first permanent molar the antero-posterior development of the jaw has been checked, and the second permanent molar is a somewhat stunted tooth, whilst the crown of the wisdom-tooth is extremely small.

In this case, then, the development of those members of

[1] Transactions of the Pathological Society, 1866, p. 245.

the permanent set which are the last to take their place was stunted, and the whole process of dentition retarded, so that the temporary incisors and canines were retained for several years beyond the period at which they should have been shed. It is stated that the temporary teeth were erupted at their normal periods.

In all the cases the enlargement of the bone is slow, and at first painless, so that commonly many years elapse before the patient suffers the removal of the maxilla, which is the only available treatment; it seems usually to commence before the age of puberty, though this is not a universal rule.

Little or nothing is known as to its origin: it is apparently in no way connected with either syphilis or struma, and has been supposed to consist primarily of an inflammatory affection of the periosteum—to which view, however, there are some objections; while by Otto Weber it is supposed to be sometimes a result of erysipelas.

In Mr. Bickersteth's case the diseased bone presented a curious microscopical structure, having large branching vascular canals in its substance, totally unlike the ordinary Haversian canals: these were described and figured by Mr. De Morgan in the Transactions of the Pathological Society[1]; but in Mr. Heath's case, which was examined by the writer, these canals did not exist, the only noteworthy peculiarity being the absence of well-developed Haversian systems.

Probably these diseases of the bones, though obscure, are inflammatory in their nature.

Diseases of Temporo-maxillary Articulation.—An occasional cause of material discomfort is found in the loss of the back teeth having allowed the jaws to close to an unnatural extent; this result has usually come about so gradually that the parts have become accustomed to it, but if it has arisen more quickly there is apt to be a sort of straining of the joint which may become very painful; the remedy is obvious in the insertion of artificial teeth.

Slight degrees of rheumatic affections of this joint are not uncommon, and are but little amenable to treatment.

Patients will sometimes complain of stiffness and grating

1 Transactions of the Pathological Society, 1866, vol. xvii., Plate xii.

sensation in moving the jaws, and it is very unusual for this to proceed beyond the extent of more or less inconvenience; but it is probable that such sensations are often due to a slight degree of inflammatory change in the articulation, which, were it to proceed far, would be described as chronic arthritis.

In this disease (which as affecting this joint is rarely met with in such development as to be unmistakable) the articular cartilage wholly disappears, and the surfaces become greatly deformed, the condyle sometimes becoming distorted but atrophied, and sometimes enormously hypertrophied. Mr. Heath ("Injuries and Diseases of the Jaws," 3rd edition, p. 420) met with a case in which one condyle alone was affected, with the result of throwing the chin far over to one side, and utterly deranging the articulation of the teeth.

The excision of the condyle and its neck, an operation rendered difficult by the size of the head of the bone, gave a result satisfactory in all respects. The thrusting of the chin over to one side was so great as to have suggested to an eminent surgeon that a dislocation existed, but there was nothing else to support such a view at the time when Mr. Heath was kind enough to show the patient to the writer. Mr. Heath suggests that the so-called subluxation, occurring generally in delicate women, and thought to depend upon a relaxation of the ligaments allowing of too free movement and slipping of the inter-articular cartilage, is in many cases due to rheumatic or gouty changes in the joint, the varying degree of inconvenience, its aggravation by damp and cold, and its amelioration by counter-irritation and anti-rheumatic remedies seeming to indicate something other than a constant mechanical cause.

And in a case recorded in the Lancet (1860) such copious effusion in this joint was found that it was described as hydrarthrosis.

Disease restricted to the temporo-maxillary articulation is rare, but the possibility of the occurrence of various forms of mischief should be borne in mind. In the Philadelphia Dental College Museum is an example of what had apparently begun as caries, which had gone on to the destruction of a good deal of bone, and then had been succeeded by deposition of bone in an irregular form.

Acute inflammation and suppuration may involve this just like other joints, and such conditions may very easily be confounded with disease of the ear; perhaps, also, suppurations of the middle ear may extend to the joint; fibrous or bony anchylosis is the probable outcome of these destructive inflammations.

Thus Greig (Brit. Dent. Assoc. Journal, 1897) points out that a septic arthritis may extend to the joint from the middle ear viâ the glasserian fissure, or from the parotid gland, or an arthritis may arise from mechanical injury. In some cases dissection has shown that the joint was wholly gone, and the neck and condyle had come to form one mass with the temporal bone, or, again, a more limited anchylosis of the coronoid process with the maxilla has been met with.

As a secondary result of the absence of action of the masseters and the pterygoid muscles, the angle of the jaw usually wastes in chronic cases.

Immobility of the Jaws.—Besides those just alluded to, there are various other causes which may lead to loss of freedom in the movements of the jaws, some of which are of very grave import, so that any complaint of this kind on the part of the patient should lead to careful examination, though the diagnosis at best is often very obscure.

The commonest and the most remediable is the result of muscular spasm, which may be so constant and so prolonged, lasting even for months, that the idea of its being of spasmodic nature is apt to be lost sight of. A wisdom-tooth, which from faulty direction, or from want of space, encounters difficulty in its eruption, is usually the source of the trouble, inducing tonic spasm of the muscles which close the jaws; but the writer has seen one case in which clonic spasm of the muscles opening the jaws was induced every time that the closure of the teeth brought about pressure on the inflamed parts, and this caused the patient extreme distress. The effect of difficult eruption of the teeth has been treated of at another page, so that it is merely necessary here to allude to the existence of this state of things, and we may pass at once to the consideration of the other causes which have to be kept in mind in forming a diagnosis.

In the majority of cases the irritation is due to difficult eruption of the wisdom-teeth, though it may be due to exposure of the nerve in these or the first and second molars. We do not know of its having been produced by teeth situated farther forward in the mouth, though there is no reason why it should not be so caused. The trismus may be of sudden occurrence, or it may come on quite gradually; and the condition of tonic spasm of the muscles may last for months or even years.

The closure of the jaws may, however, be due to actual organic changes. The late Dr. Gross, of Philadelphia, enumerated the following as the most frequent causes of immobility of the lower jaw:—

The fixation of the jaw by cicatricial tissue in the cheek, gums, etc., which may result from cancrum oris, or from gangrene supervening on profuse ptyalism. Anchylosis of the temporo-maxillary articulation, which may be osseous, or the result of fibrous adhesions in and around the joint. Or, thirdly, it may be occasioned by a bony bar extending from the lower to the upper jaw, a condition usually resulting from so-called chronic rheumatic arthritis. Or, lastly, it may be due to the pressure of a tumour, especially one occupying the parotid region.

Gangrene of the cheeks, etc., may occur in children worn out by the effect of the exanthemata, as well as in cancrum oris; and these are amongst the most difficult cases to relieve.

Mr. Heath,[1] quoting Professor Esmarch, points out that the inability to open the mouth in such cases is due not so much to the presence of actual adhesions, binding together the jaws, as to the destruction of the exceedingly elastic and dilatable mucous membrane of the cheek, and its replacement by a dense unyielding cicatrix which contracts strongly.

Hence in all operative procedures it is the aim of the surgeon not merely to divide cicatrices, but to restore the extensile mucous membrane; and if there be no available portions of mucous membrane left, the formation of a false joint in front of the cicatricial band affords the best prospect of speedy relief. This operation, which bears the name of Professor Esmarch, consists in removing with a saw a wedge-shaped fragment of the horizontal ramus of the lower jaw. For

[1] "Injuries and Diseases of the Jaws," 3rd edition, p. 398.

a fuller account of the operation the reader is referred to Mr. Heath's work above cited.

In favourable cases another form of operation yields a thoroughly good result, and that is the division of all constricting bands, and the maintenance of the mobility by the use of properly constructed shields during cicatrisation. It has already been mentioned that one of the causes of immobility, where the soft pliant mucous membrane has been lost, is the substitution for it of dense inelastic cicatricial tissue, which after division would soon re-form, contract, and bring about a state of things no better than it was before. To meet this difficulty metal shields are constructed, capping the teeth or the alveolar border, and extending down between these and the cheek; the adjustment and the subsequent wearing of these is, as might be expected, painful, and needs no little resolution on the part of the patient and the surgeon as well, and thus, though good results are attainable, Mr. Heath gives the preference to Esmarch's operation for most cases.

But, contrary to what might be expected, there appears to be occasionally a re-formation of mucous membrane in the sulcus, and it is upon this that permanent success hinges.

Whenever immobility of the jaws is threatened the mouth should be regularly stretched, but despite all such endeavours it is seldom that the contraction can be stayed, and the case ultimately calls for surgical interference. The speculum used for opening the mouth during anæsthesia, answers admirably for stretching the jaws in these cases.

In a case which the writer saw through the kindness of Sir James Paget, there was an increasing immobility, which was due to an exostosed condition of the zygomatic arch, interfering with the play of the coronoid process inside it.

In one case almost complete anchylosis slowly supervened after a fall upon the chin; the mobility of the jaw had slowly decreased for two or three years. And some years since there was a case in the wards of the Massachusetts General Hospital, under the care of Dr. Bigelow, in which, for no apparent cause, mobility steadily diminished for eight years, till at last the teeth could not be separated at all, and the lower jaw had considerably wasted, so that the chin had almost disappeared. Under ether the jaws were forcibly separated, with but little difficulty, but the patient, a healthy woman, aged 30, had very slight power over the movements of the jaw.

Attention may be directed to the fact that immobility of the jaws is sometimes the first symptom of a deep-seated growth, of which no other sign may be present; thus, in a case under the writer's care, this symptom was complained of some months before anything else could be detected, although an anæsthetic was administered, the mouth thoroughly opened by means of a powerful speculum, and the whole region of the joint explored by the finger both by Sir James Paget and the writer.

Ultimately neuralgic pains became severe, vision was interfered with, some proptosis occurred, and ophthalmoscopic examination revealed signs of pressure; after about eighteen months the patient succumbed to a deep-seated sarcoma, apparently originating from the base of the skull.

Mr. Coleman has also recorded a case in which stiffness of the jaws was the first sign of a malignant growth.

DISEASES OF THE ANTRUM.

THE maxillary sinus is liable to become the site of various new growths, the consideration of which does not fall within the province of this volume; but, the malady with which it is most frequently affected being generally traceable to the influence of diseased teeth, it is indispensable that the dental surgeon should be well acquainted with at least this affection of the cavity. It is quite possible that the development of fibrous, enchondromatous, or malignant tumours of the antrum may have been in some way influenced by the irritation produced in the antral cavity by diseased teeth; nevertheless, the dental surgeon is not called upon to deal with such affections, so that any description of their characters would be superfluous in this place.

Suppuration in the antrum—sometimes termed abscess, and sometimes empyema of the antrum—is very often traceable to the influence of diseased teeth, which is not to be wondered at, seeing that the roots of the second and first molars often pierce its bony wall, and are therefore covered only by the periosteum. The teeth which most commonly come into close relation with the antrum are the canines, bicuspids, and first and second molars, the roots of which may pass through its floor; or alveolar abscesses attached to their roots may perforate and burst into the antral cavity, as is exemplified by two specimens, one of which was in Sir John Tomes' collection, and is here figured.

This alveolar abscess was connected with the stump of the first molar, and has opened the antrum above the socket of the palatine root. The manner of perforation is very peculiar, there being, as is seen in the figure, a regular bony tube standing up into the antrum from its floor. It is noteworthy that the abscess has found exit through the bone elsewhere, as there are large openings through both labial and palatine walls of the alveolar process.

The nature of the discharge varies according as the disease is acute or chronic; it is also modified by the cause and by complications, such as the presence of necrosed bone and the condition of the pus-forming membrane inside the antrum. In the early stages of a catarrh the discharge is white, viscid, glairy, and mucoid; later it becomes blood-stained, more tenacious, opaque and greenish or yellowish in colour, and consists of muco-pus (Mr. J. G. A. Fairbank, Dental Record,

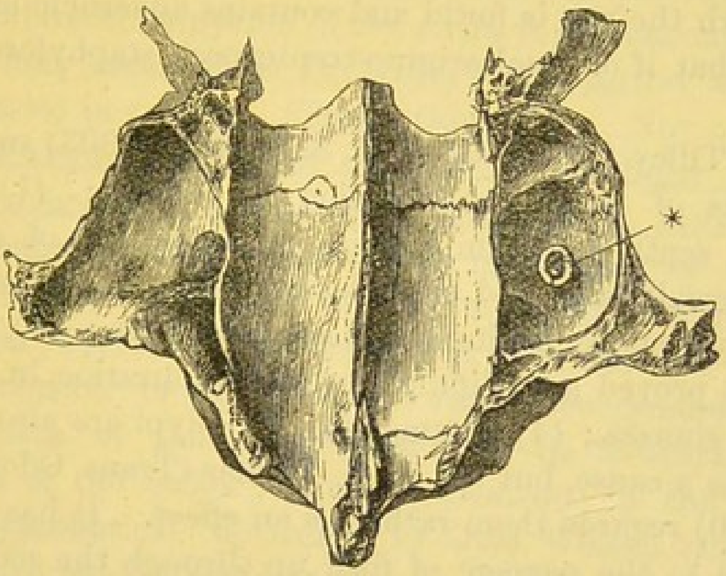


FIG. 217.—Superior maxillary bones viewed from above. A horizontal section has been carried across the antral cavities, which are seen to be partially divided by septa rising up from the floor. On the left side is seen the perforation (*) caused by an alveolar abscess. The specimen is now in the Museum of the Odontological Society, among a series of antra which have been lent by Mr. Cattlin.

1904). In acute cases it is generally copious, in chronic cases inspissated and scanty. Where dead bone is present it is usually copious, greenish yellow, and foul; in any case it may be blood-stained.

By the burrowing of an alveolar abscess through the substance of the bone, teeth which do not ordinarily come into very close relation with its floor may cause abscess in the antrum; thus, amongst the out-patients of the Middlesex Hospital some years ago a case occurred where extraction of a loose and painful central incisor gave exit to a quantity of exceedingly offensive pus; a probe passed through the vacant socket entered the antrum through a canal as large as a goose-quill; and Dr. Latimer, in the Dental Cosmos for January, 1870, records a case where abscess of both antra had followed on filling the two lateral incisors over exposed pulps.

It must therefore be borne in mind that although diseased second premolars and molars are the teeth usually at fault, yet any tooth is capable of causing abscess of the antrum; diseased teeth are the cause of the greater majority of cases, yet some few have arisen from other influences.

Some Continental observers throw doubt on the teeth being so common a cause. It has been stated that if suppuration be due to teeth the pus is fœtid and contains anaerobic organisms, etc., but that if of nasal origin streptococci, staphylococci, etc., abound.

uses antral suppuration

Dr. H. Tilley (Trans. Odontol. Soc., Nov., 1903) summarises the causes of antral suppuration as follows: (1) diseased teeth, *i.e.*, septic infection ~~starting from the root of a diseased~~ tooth, especially ~~a second premolar or molar;~~ (2) infection from the nose, especially ~~during acute specific fevers;~~ (3) influenza, which has proved a ~~prolific parent of suppuration in the nasal accessory sinuses;~~ (4) traumatisms. Polypi are also regarded by some as a cause, but Mr. J. G. Turner (Trans. Odontol. Soc., Feb., 1900) regards them rather as an effect. It has also been attributed to the passage of food up through the socket of an extracted tooth. Otto Weber states that it sometimes arises after chronic nasal catarrh, or obstruction of the nares by nasal polypus. Dr. G. A. Rees records a case occurring in a new-born infant (Medical Gazette, vol. iv., new series) which seems to have resulted from pressure of the face on the arch of the pubis during parturition.

We have met with several cases of antral suppuration which could not be attributed to diseased teeth, and one in particular was so striking as to deserve more than passing notice. The patient, a gentleman, aged about 45, presented himself with all the usual symptoms of pus in the antrum of the right side, which discharged pretty freely into the pharynx; several teeth had been previously lost, and those which remained presented no sign of alveolar inflammation, nor had any of them dead pulps.

The patient had suffered from primary syphilis some years previously, and was at this time much troubled by headache, and slight iritis, for which he was undergoing mercurial fumigation. A bicuspid was extracted, its alveolus enlarged, and the antrum, after a prolonged period of treatment, brought into a healthy state again.

However, after a few months the patient returned, saying that he recognised all the old symptoms, and was convinced that the other antrum was full of pus. Here again there was no tooth capable of setting up irritation, so a practically sound bicuspid was extracted, and the patient's diagnosis found to be quite correct. In each instance the pus was horribly fœtid. Bilateral empyema of the antra is not uncommon. Out of sixty-four cases under Dr. Tilley's care antral suppuration was bilateral in twelve. (Trans. Odont. Soc., Nov., 1903.)

In the normal condition the antrum is lined by a thin mucous membrane, continuous through an orifice in the middle meatus, with the mucous membrane of the nose; this delicate mucous membrane is attached to a thick, dense periosteum covering the bone. It was formerly supposed that distension of the antrum was often produced by an accumulation of mucus secreted from its membrane, owing to closure of the orifice; but the existence of the mucus is purely hypothetical, according to Otto Weber, none having been seen in the dead body on opening the antrum. According to Otto Weber suppuration in the antrum may take place in two situations; the entire lining of the cavity may be inflamed, as, for example, by the spread of catarrhal inflammation from the nasal cavities, in which case the discharge of pus will flow out through the natural opening into the middle meatus of the nose. But what very much more commonly happens is that the suppuration, when excited by the root of a tooth, takes place beneath the periosteum, which is then lifted from the bone, and separates the accumulated pus from the true cavity of the antrum. Hence, perhaps, it is that pus so frequently fails to escape by the natural orifice into the nose. When the antrum becomes distended by suppuration, the bone is often sensitive to the touch, and the teeth appear lengthened; as the accumulation of fluid progresses, a swelling may appear in the sulcus between the teeth and the cheek from the canine backwards as far as the third molar. Occasionally the concavity of the palate becomes obliterated on that side, and in extreme cases the floor of the orbit becomes pushed up, displacing the eyeball.

In most cases of antral abscess some little tenderness and swelling of the cheek and fulness about the zygoma are noticed; but the lachrymal ducts are not closed, as would often be the case with the growth of solid tumours.

The symptoms attendant upon inflammation of the lining of the antrum are, in addition to those already mentioned, dull, deep-seated pain, occasionally of a lancinating character, œdema and tenderness of the cheek, and a varying amount of pyrexia. The formation of matter is sometimes, but by no means invariably, indicated by the occurrence of slight rigors. In a more advanced stage an offensive discharge may flow from the corresponding nostril, or drip into the throat at night, so as to be expectorated in lumps in the morning. As far as our own somewhat limited experience goes, the discharge from the nostril which occurs in the earlier stages of malignant disease is not usually so offensive or so thick as that which proceeds from simple inflammatory affections of the maxillary sinus. There is also another point by which simple inflammation may be distinguished from certain of the more formidable diseases causing enlargement in that region. The teeth, though somewhat lengthened, are seldom or never disturbed in position by the former malady, but where a morbid growth, originating in the antrum, has progressed to a considerable extent, the teeth often become separated from one another, and diverted from their natural directions. In one case which terminated fatally, the discharge which flowed from the nostril was for some months thin and watery, and destitute of offensive odour; but, as it is more common for the matter to find no exit in cases of empyema of the antrum, the discharge is often not present to afford any guide to a correct diagnosis.

Pain may be local, or neuralgic and referred. Local pain is due to inflammation, and does not always occur, but when it does it is usually deep-seated, dull, and aching in character, with a tendency to throb after stooping or exertion. Pain is only very severe when pressure occurs within the antrum; and supraorbital neuralgia is not uncommon.

Symptoms of very closely similar character may be associated with the earlier stages of malignant disease, though malignant growths seldom remain long confined within the antrum, but pass out and invade surrounding parts; and it is very necessary that the practitioner should be aware of this, for should he, under the impression that the case is a simple one, remove a carious tooth, he may get the credit in the mind of the patient of having induced a fatal disease by his injudicious interference.

A case of this kind was seen by the author in consultation. A perfectly loose sound tooth had been extracted, and its socket had never healed up; to some want of skill in the extraction the patient attributed all his troubles. The open socket was found to communicate with the antrum, and was perseveringly syringed for about two months by his medical attendant. The orifice of the opening was tumid, but not otherwise of suspicious aspect; it was not possible, however, to get any evidence that there was, or ever had been, any distinctly purulent discharge, and there was slight enlargement of the zygoma, and even of the temporal region; no glands could be felt. The indications, however, were slight, and an eminent surgeon called in, whilst not excluding absolutely the diagnosis of malignant disease, on the whole regarded it as improbable. A few weeks, however, left the matter in no doubt, and the patient's age (seventy-five) and the extent of the disease rendered operative interference out of the question.

This case is related as an example—not the only one which we have seen — of malignant disease simulating antral empyema, and very insidious in its early progress.

The other affections which are most likely to be confounded with empyema of the antrum are mucous polypi and dentigerous or other cysts in its cavity. Careful inquiry into the history of the case will often very materially aid a correct diagnosis, but in a certain number of cases it is impossible to be perfectly certain of the true nature of the enlargement, and it has more than once happened that surgeons have commenced an operation for the extirpation of a jaw that proved to be enlarged by nothing more formidable than an antral empyema.

With care, acute inflammation of the antrum may generally be correctly diagnosed, but chronic suppuration, especially when leading to considerable thickening of the bone, may very closely simulate the solid growths.

This thickening of the bone around a chronic abscess may be so considerable as to produce marked deformity after the cure of the empyema, and may even necessitate an operation for its removal.

An antrum filled with pus or with a solid growth is dull on percussion. Also if a tuning fork is struck and placed on the cheek over the antrum, first on one side and then on the other, the sound will be heard better on the healthy side.

Transillumination by an electric lamp placed in the mouth will sometimes very distinctly show an opacity when the antrum is filled up from any cause ; this is known as Heyring's sign, and is useful for diagnostic purposes when forming part of a systematic examination, but the result is merely suggestive or confirmatory and is of little value by itself.

A useful method of diagnosis is thus described by Sir Felix Semon (Trans. Odont. Soc., 1889). The nose is thoroughly cleansed and inspected with a speculum ; the patient is then made to lie down across a chair, with the head down and hands on the floor, the suspected side of the head being held uppermost. After ten or fifteen seconds only in that position, the nose is again inspected without blowing or breathing through it. If pus is then seen in the middle meatus, it can only have come from the ostium of the antrum.

Sir Felix Semon is not much in favour of the nasal puncture, trouble and hæmorrhage from which sometimes occurs, but prefers the alveolar one.

However, as Dr. Tilley remarks (Trans. Odont. Soc., Nov., 1903), an exploratory puncture is the only absolutely certain means of proving the presence of pus, and he strongly advocates that this puncture should be made within the nose. He describes his method as follows : "A small dossil of wool is moistened with a 10 per cent. solution of cocaine and applied by means of a probe to the inner wall of the antrum underneath the anterior end of the inferior turbinal bone. In a few moments a fine trochar and cannula are passed outwards, backwards, and slightly upwards, through the inner antral wall. The trochar is withdrawn, leaving the cannula in position, and to its proximal end is fitted a rubber tube through which some warm boracic or normal saline solution can be injected. If there be any pus in the sinus it is at once demonstrated by this simple, bloodless, and absolutely reliable method."

The floors of the nose and antrum are upon the same level, a fact which is of practical importance in any operation in which it is desired to secure free drainage from the antrum into the nose, so we see that when there is any doubt an exploratory puncture should be made; it is not in the least likely to lead to any bad results, and may prevent the surgeon from falling into a very important blunder. A small perforation may with perfect safety be made with a spear-headed drill in the engine, and will at once close if it is not needed; if this is insufficient a trocar or a scalpel should be used, as the indications afforded by the insertion of a grooved needle are uncertain. In some instances patients have been conscious of a sensation of fluid washing about in the cavity when the head is suddenly moved, but of course this can only happen when the cavity is incompletely filled with fluid.

If left to itself the pus is sometimes evacuated into the nose by the natural orifice, or finds an outlet through a vacant alveolus. But this fortunate result is rare, and the neglect of antral abscess not uncommonly leads to serious consequences, the pus sometimes finding an exit through the cheek and leaving considerable deformity, but more commonly finding its way into the orbit, causing great protrusion of the eyeball, temporary or permanent blindness, and finally making its exit at the inner or outer canthus. In a case recorded by Dr. Latimer, the discharge was so profuse as to necessitate a cloth being constantly kept upon the patient's face, and the skin in the neighbourhood of the eye had become excoriated by the discharge to such an extent that it had all the aspect of malignant disease.

A most remarkable case of death from intra-cranial suppuration, consequent on neglected antral abscess, is recorded by Dr. Mair, and quoted in full by Mr. Heath in one of the appendices to his work.

Necrosis of a portion of the walls of the cavity, or even caries of the bone, occasionally ensue, and sometimes, when the disease is acute, it is accompanied by erysipelatous inflammation of the face, with very great constitutional disturbance.

Mr. Salter has pointed out that permanent amaurosis may result from the displacement of the eye ; indeed, he also gives an example of amaurosis following inflammation without abscess. Dr. Latimer also alludes to cases of impaired vision, the result of antral abscess.

In the first case, the history of the disease was briefly this : violent toothache around the first upper molar, enormous swelling of side of face, infiltration of the lower eyelid so as to close the eye, protrusion of the malar bone, and frightful pain in the eye, which became protruded later and became blind. Pus escaped near to the outer and inner canthus of the eye, and in this condition the patient remained for two or three weeks, with occasional discharges of matter by the nose.

The hard palate was convex within the mouth. Mr. Salter removed the roots of the first molar, and a wisdom-tooth ; the pressure of the instrument caused pus to pour from the openings below the eye, and there was a sensation of bagginess and yielding about the whole bone. After the extraction blood also poured out from the fistulous openings. The eye was sightless, the globe prominent, the pupil fixed ; there was general inflammation of the fibrous textures of the eye, and extreme conjunctivitis. Eventually a large sequestrum came away, and the inflammatory condition passed off, but the sight of the eye never returned. On ophthalmoscopic examination, the only abnormal appearance observed was extreme anæmia of the optic nerve, a condition constantly associated with suspension of the function of vision when dependent upon causes external to the globe.

The result is not always so disastrous as in the last case ; thus Stellwag quotes a very interesting case reported by Galezowski, in which, after blindness of one eye for thirteen months, complete recovery ensued. The first thing noticed was the sudden advent of exceedingly severe neuralgia, recurring from time to time ; the eye became painful, protruded, and sight was lost.

After six months, great swelling came on, and several drachms of pus were discharged from the lower eyelid ; the pain then subsided, but the sight did not improve. Eventually the pain recurred with increased intensity, but although the eye remained blind and the pupil dilated, no structural change could be discerned. The first upper molar was carious, and on its removal a splinter of wood was found at the end of the root, which was probably the end of a toothpick. The antrum was opened by the extraction, and on the same evening the eye was sensible of light; by the next day it had completely recovered. It is remarked that the toothache, seldom present, was not coincident in point of time with the neuralgic pains and pains in the eye.

In a case of Mr. Pollock's there was no actual empyema of the antrum, but there was deep-seated active inflammation of the superior maxillary region, and the eye was much congested. On the removal of the first bicuspid and first molar, about which there was much irritation, the inflammatory symptoms rapidly subsided; but the eye remained blind, although the pupil subsequently contracted in sympathy with that of the sound eye. In the blind eye no structural change could be detected.

It is pointed out by Mr. Salter that in most of the cases recorded no permanent mischief could be detected in the structures of the eye, even when sight was never recovered, save anæmia of the optic disk, thus suggesting the idea that some irreparable damage had been inflicted on the optic nerve external to the eyeball.

The case of a girl of sixteen has recently come under the observation of several ophthalmic and dental surgeons, in which there was orbital cellulitis with but slight constitutional disturbance, great protrusion of the eyeball, and loss of sight. The teeth were remarkable for their very imperfect development and tardy eruption; several carious teeth were removed, but the antrum was not explored, so that it is not possible to say whether the removal of the teeth did or did not aid in curing the cellulitis, which entirely subsided, and has left the sight of the eye fairly good. The patient did not come under our personal observation till after the subsidence of the ophthalmic trouble.

Brophy (Dental Cosmos, Dec., 1896) relates a case of antral disease in which cure was protracted, and on freely opening up it was found that pus came down from the frontal sinus. He thinks that, the membrane of the antrum being continuous with that of the infundibulum, frontal sinus, and ethmoid cells, these may all become involved.

Fillebrown in the same number records that Merke and Dr. Cryer long ago showed that the infundibulum continued to and terminated close by the foramen of the antrum, where there is a sort of pocket, which might easily direct discharge from the frontal sinus into the antrum. The occasional communications between the two cavities had been regarded as anomalies, but Fillebrown regards the relations referred to as normal. He found the infundibulum continued to the antral foramen in each of fifteen heads examined.

In nineteen out of eighty-two cases of antral suppuration Dr. H. Tilley found the frontal and ethmoidal cells also in a state of chronic suppuration, and in four patients the sphenoidal sinuses as well as the afore-mentioned accessory nasal cavities were also discharging pus.

Dr. Tilley (Trans. Odont. Soc., Nov., 1903) records the following case :—"Mr. F., aged 54, had for five years suffered from a purulent nasal discharge, associated with nasal obstruction due to large polypi within the nasal cavities. On several occasions the polypi were removed, but the discharge continued as freely as before, and it was ascertained that it proceeded from the frontal, ethmoidal, sphenoidal, and antral sinuses. Both maxillary antra were drained by the alveolar method, and for two years were irrigated twice daily with antiseptic lotions. The purulent discharge, although lessened in amount and robbed of its fœtor, continued to flow, and the patient used on an average fifty handkerchiefs a week. He finally decided to submit to radical operations upon the different sinuses with a view to the discharge being entirely cured.

"Last June I operated upon both frontal sinuses, and to my astonishment found that it was not necessary to further treat the antra, for from the day on which the operation on the higher sinuses was performed not a single drop of pus could be washed from the antra. Surely it is a remarkable thing that these sinuses (antra) could have merely acted as reservoirs of pus for so long a time without themselves becoming actual generators of the same."

The treatment of empyema of the antrum consists in giving free exit to the pent-up matter, and this may be effected in several ways; the most usual and the best course is to extract any dead teeth on that side of the mouth, when it will probably be found that matter makes its escape through one of the alveoli. Should this be the case, the orifice should always be enlarged by using a *large* trocar—which would also be the proper course if the matter did not appear—the socket of the first molar being usually selected as the most suitable point for puncture. In forcing the trocar into the antrum the thumb should be supported against the jaw, so as to obviate the risk of the instrument suddenly entering and wounding the floor of the orbit from below.

Briefly stated, the treatment of acute empyema of the antrum consists in extracting dead teeth and roots on the affected side, making an opening into the cavity of sufficient size to admit of free drainage, and daily irrigation with mild antiseptic lotions for two or three weeks, after which the opening may be allowed to close.

In chronic cases it is even more important to remove all diseased teeth and roots. The opening must be large, drainage must be free, and irrigation frequent. The general health of the patient must receive due attention, and if necessary a radical operation must be performed with the object of quickly effecting a cure, accompanied by a more or less complete obliteration of the diseased cavity.

The alveolar treatment is adapted to all cases of short duration; the radical operation may be expected to cure all cases when the simpler methods have failed.

Most surgeons use either a gouge or a trocar for opening the antrum. An opening commenced with a trocar may be enlarged with a gouge; but the operation may be done with far less disturbance, and consequently with far less after-discomfort to the patient, by a large spear-head in the dental engine. But if the case be an obstinate one the gouge is best suited for the making of a very large opening.

In this connection it may be mentioned that a moderate opening is sufficient if the antrum can be thoroughly washed out through it; and it is not generally known that, if the opening into the nose be patent, this can be very efficiently done without any syringe. If the patient holds that side of the mouth full of water, after a very little practice he will be able by the pressure of the cheeks to send it in a full stream through the nose, and in this way a large bulk of water can be forced through, though, of course, no very strong medicament can be thus used.

In case there are no diseased teeth, a sound first molar may be extracted, or the puncture made near the malar process, or backwards from the canine fossa; one of these situations must be selected in the rare case of empyema of the antrum occurring in an aged and edentulous person. O. Weber recommends that the hole should be made large enough for the little finger to enter the cavity; this is rather unnecessarily large, except for an obstinate chronic case, but there is no doubt that, in all cases where we have to open up a cavity, the safer course is to make a large opening. It is a great and important error, though one often committed, to be content with a small opening into the antrum; and many cases are greatly and needlessly prolonged by the accumulation of morbid secretions in consequence of such treatment. It has been pointed out by Mr. Cattlin (*loc. cit.*) that the floor of the antrum is often divided by a transverse septum of bone, which conformation would render it quite impracticable to thoroughly and efficiently wash out the cavity through any small opening.

Having made a free opening, the cavity should be thoroughly washed with weak boracic solution or normal saline solution thrown in with a large syringe; a piece of gum-elastic catheter, placed on the nozzle of the syringe, will often aid in doing this effectually.

After the cavity has been thoroughly cleared out, astringent and disinfectant lotions should be used daily. A weak solution of permanganate of potash answers the purpose excellently; but should the mucous membrane take long to recover a healthy condition, a stimulating injection composed of a weak solution of chloride or sulphate of zinc or nitrate of silver may be used, weak boracic acid lotions also being useful, and in obstinate cases tincture of iodine has been advantageously applied.

Plain water ought not to be used, and all lotions should be employed at about the body temperature.

Insufflations with dry powder, such as boracic acid, have been employed with success in certain stages of the disease.

Mr. Shield swabs out antra with strong carbolic acid, makes a counter-opening into the nose, and packs with iodoform gauze; curetting being occasionally needed. And Mr. Smale has found packing the cavity with strips of lint dipped in a 1 in 40 solution of carbolic acid successful after the failure of other remedies.

The opening should be kept closed lest the accidental access of food excite fresh irritation. It has been recommended that a gold tube with a stopper be fitted to the opening, and secured to the neighbouring teeth, or to a plate, which is generally better.

A solid vulcanite plug, continuous with a small vulcanite plate, is in the majority of cases quite as effective as a metal tube, and is easier to accurately fit and adjust. The plate with its plug is removed to admit of syringing and replaced directly after the cavity has been washed out. The plug should only penetrate the antral cavity a short distance.

Dentigerous and other cysts of the antrum will be noticed in another chapter, and need not be referred to here.

Occasionally the root of a tooth passes into the antrum during an attempt to extract it, and this accident may occur in the hands of the most careful and skilled operators.

As has already been noticed, the root of an upper molar not uncommonly passes through the floor of the antrum, and may even become enlarged within that cavity. When an attempt to remove such a root is made, one of two things happens: either a portion of the antrum is brought away with the tooth (Mr. Cattlin, *loc. cit.*), or the root slips up into the cavity. Such an event occurred in the practice of Mr. Cattlin; and as the patient's father had died from malignant disease of the jaw, it was deemed prudent, not only by Mr. Cattlin, but by Mr. Stanley and other surgeons of eminence, to remove the stump, lest it should become the source of local irritation. A trephine was applied to the labial plate of the alveolus, and the cavity of the antrum laid open. For some time the missing root could not be found, and it was only by employing a cup formed of gutta-percha, mounted on a piece of bent wire, that it was ultimately removed. In most cases the employment of a strong current of water will suffice for the dislodgment of a stump, but in this instance the floor was divided into two compartments by a transverse septum of bone.

In one instance a canine tooth was driven into the antrum by a fall, and its presence only discovered after some time, when empyema of the cavity had resulted. In such a case its removal should be at once effected.

It is an easy matter to get an antral empyema nearly well, but a difficult thing to get it quite well.

When the ordinary measure of a moderate opening with a tube inserted into it, and thorough syringing, have failed to effect a cure, a larger opening must be made.

This may best be done in the canine fossa either with a gouge or chisel and mallet, and if possible the bone should be chipped away down to the level of the floor of the antrum, and a hole large enough to admit the finger made. The interior of the antrum may be curetted, or treated with stronger applications than would be advisable as injections. Some operators even go so far as to make a fresh opening from the inferior meatus of the nose with a Krause's trocar and cannula, but this can hardly be often necessary or desirable.

After free irrigation with boracic lotion, the cavity is packed with lint dipped in an antiseptic, or with iodoform or creolin gauze, which is left for a day.

The subsequent treatment is just the same as that advised for ordinary cases in which a smaller opening has sufficed.

In performing the radical operation, Yonge (Jour. Brit. Dent. Assoc., Aug., 1902) reflects the gum and periosteum in the canine fossa, cuts a window with chisel or drill large enough to admit the little finger; after curetting the cavity he makes a large counter-opening into the nose, carefully avoiding injuring the end of the nasal duct. The antrum is then packed with iodoform gauze, the end of which is drawn into the nose, and the mucous membrane reunited over the canine fossa with fine catgut.

In the pus from an antral abscess Mr. Roughton has found a diplococcus, probably that of sputum septicæmia, *Micrococcus tetragenus,* torula, and staphylococci, *Bacillus buccalis septicus,* as well as several others.

DENTAL EXOSTOSIS.

The implanted portions of the teeth, like other parts of the skeleton, are liable to local hypertrophy. In exostosis this layer of cementum becomes thickened either locally or generally, the dentine in no case participating in the enlargement, but, on the contrary, having often been diminished in amount by absorption. The disease may be defined as an addition of tissue, more or less normal in character, but abnormal in amount, to a pre-existing tissue of the same structural character. If, for example, we make a section from a tooth the root of which has been increased in size beyond the natural dimensions, an unnaturally thick layer of cementum will be found, but it will in many instances be difficult to point out a sharp line of demarcation dividing the pre-existing from the recently-added tissue.

Fig. 218. — An upper bicuspid tooth, with exostosis of the cementum of the root.

Of recent years, Mr. Douglas Caush has most fully investigated dental exostosis (British Dental Association Journal, 1894, Dental Record, July and August, 1896), and amongst the earlier papers may be mentioned those of Mr. Shelley (Trans. Odont. Soc., 1856-7) and Dr. Bödecker (Dental Cosmos, 1878 and 1880, and "Anatomy and Pathology of the Teeth," 1894). The last-mentioned writer holds the opinion that diffuse exostosis is a fœtal malformation, and that it never takes place in teeth which have lost their pulps.

To neither of these propositions does Mr. Caush give his support, but expresses himself decidedly to the contrary, and indeed, after careful perusal of Dr. Bödecker's chapter, we do not think that he has at all established his position. The chapter in his book, however, is taken bodily from an article by Dr. Frank Abbott (Dental Cosmos, 1886); but as it is quoted without comment, we suppose that Dr. Bödecker fully endorses all that it contains. The term exostosis has gained such wide acceptance that it seems undesirable to displace it, though it is pointed out by Weil that "hyperplasia" would better include both general and localised hypertrophies of cementum; other terms such as osteoma and hyperostosis have got into use to a certain extent. But in the absence of any established difference in the pathological process involved it seems undesirable to multiply terms.

Drs. Abbott and Bödecker and Mr. Caush in most respects agree in their descriptions of histological features; they differ in their interpretation, inasmuch as the former writers believe that what they have seen and described must always from the first have existed, whilst the latter holds, and we agree with him, that they are the results of subsequent absorptions and redepositions, in fact, pathological processes arising late in the life of the tooth; Wedl also holds this view.

The structural characters depend to a great extent on the thickness of tissue present, just as in a normal cementum we have at the neck of a tooth a thin layer with no lacunæ, and lower down abundant lacunæ and canaliculi. So do the tissues vary in an exostosis.

The occurrence of vascular or medullary canals (Haversian canals) is to a certain extent exceptional, being dependent upon the presence of a larger amount of cementum than is usually found in perfectly healthy teeth. Their presence is not, however, necessarily an indication of disease; for when two contiguous roots are united by the intervention of cementum, a vascular canal will not uncommonly be found to traverse the medium of union.

Exostosis is generally distinctly laminated, and the laminæ do not always correspond closely in texture; sometimes laminæ very perfectly calcified, with few or no lacunæ, occur, and these, Mr. Caush suggests, are deposited from an alveolar-dental periosteum which has become for the time being healthy. Sometimes, however, the deposition has been continuous, and no laminæ are traceable; sometimes, too, laminæ already formed become encroached upon by absorption and partly removed.

Indeed, these alternations of absorption and deposition are a marked feature of exostosis.

The more rapid the development of an exostosis, the larger its lacunæ, and the more free the anastomosis of its canaliculi with those of neighbouring lacunæ; there is, however, generally a considerable mass of apparently structureless material between them.

The conditions under which exostosis arises are but little known; it appears, however, to be a product of a very chronic inflammatory condition.

Mr. Caush thus describes it:—"The layer of cells in that portion of the membrane attached to the cementum becomes more and more active, breaking up into new cells, these new cells dividing and sub-dividing until there is a much larger number of cells at this point than is to be found in the membrane in a normal condition, and, as a consequence, these cells press upon the cementum. As the pressure increases with the development of the new cells, they change their character from that of an ordinary nucleated cell to that of an osteoclast, or giant cell, having the power of absorbing the cementum at the point of contact. If the blood supply becomes normal at this stage no further change takes place, and but slight or no discomfort will have been felt by the patient, but should the irritation be kept up, the cells will continue their activity; or if the slight inflammation becomes chronic, the result will be the same. The giant cells thus formed will continue to absorb the cementum, until the whole of it is absorbed away, after which the giant cells pass into the granular layer of the dentine and there continue their work until a portion, or the whole, of the granular layer is absorbed. This absorption takes place in an irregular manner owing to the difference in the density of the tissue it is absorbing, this difference of density being caused by the more or less perfect calcification of the dentine; the osteoclasts having arrived at the more dense portion of the dentine, the absorption ceases, and another change takes place in the giant cells developed in the alveolar dental membrane; the osteoclasts in this membrane are changed into cementoblasts, and begin their function of depositing cementum into the spaces produced by the absorption previously carried on.

"It is not at all an unusual thing to find (especially in the layer next the dentine) a number of these cells retaining their soft structure, surrounded by cementum, as if some of the osteoclasts had been slow to change their character, thus leaving portions of soft tissue in the newly deposited cementum. The new tissue is usually deposited in layers differing from the original cemental tissue in that it contains a large number of lacunæ and canaliculi, these frequently occupying the position previously occupied by the original layer of cementum; the new layer of cementum continues to be deposited as long as the blood brings to the cells material in the form of food for the development of new tissue. The amount deposited varies much: it may be but a very thin layer, not much thicker than the thickness of the original cemental layer, or it may be continuously deposited until it is many times as thick as the original layer."

The alternation of absorption and deposition of cementum has already been alluded to; it is especially apt to be found where a stump has for a long time been a source of slight irritation.

The absorption which later takes place may go as far as to eat into the dentine, after removing the whole thickness of the cement; examples of absorption and subsequent deposition of osseous material in the cavities so formed have been described by Mr. Henry[1] under the name of Inostosis. The absorption is effected by the agency of polynucleated cells, which are derived from the osteoblasts or formative bone cells. Whether they themselves become calcified, or in turn give place to fresh osteoblasts, has not, so far as we know, been determined by actual observation; but, seeing that calcified cartilage matrix is drilled with the utmost rapidity by the advance through it of the osteogenous tissue, it seems most probable that the same osteoblast cells are capable of effecting the absorption and subsequently becoming calcified.

FIG. 219.—Lower molar, the root of which has been affected by exostosis, and also by absorption.

[1] Transactions of the Odontological Society, December, 1871, and April, 1872.

The abnormal growth is, as compared to the exostosis of bones, confined within very narrow limits. The size of the root of a tooth may be doubled, and two contiguous teeth may become united by the development of cementum about their roots, but we never see a great mass of new tissue produced.

We are indebted to the late Mr. Spence Bate for the following illustration, and for the loan of the specimen from which it was

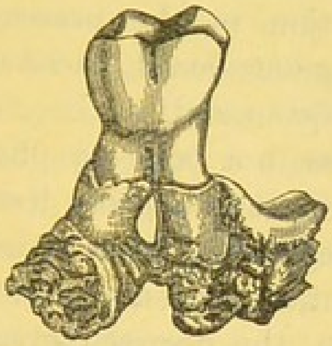


FIG. 220.—Showing exostosis in a lower molar tooth, uniting the two roots and the stump of a contiguous tooth. From a specimen in the collection of Mr. Spence Bate.

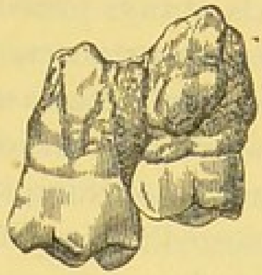


FIG. 221.—Showing the second and third molar teeth of the upper jaw united by the abnormal development of cementum. We are indebted to the late Mr. Martin for the use of this rare specimen.

taken. The amount of hypertrophy is here very considerable, and has not only connected the two roots of the tooth, but also the remaining stump of a contiguous tooth, the crown of which had been previously lost.

Through the kindness of the late Mr. Martin, of Portsmouth, we are enabled to add an example in which the second and third upper molars are united by the abnormal development of cementum.

Although numerous instances may be found where two teeth have become united by cementum developed under circumstances which constitute its formation a disease, yet in no well-authenticated instance has the cementum become continuous with the bone of the socket. In reptiles the anchylosis of the teeth to the jaw is a normal character, but in the human subject an undoubted case is yet wanting to show that anchylosis between the teeth and the jaw is under any circumstances possible.

The late Mr. Storer Bennett, however, met with a case where an upper wisdom tooth appeared on microscopical examination to be anchylosed to the portion of bone that came away with the tooth on extraction; and Mr. John Murray (Trans. Odont. Soc., May, 1905) recorded a case in which two lower molars were continuous with a growth of bony nature, this latter being itself firmly attached to the bone of the mandible (it was probably a cementoma).

In two tissues so similar to each other in structure that their distinction is often attended with difficulty, we should be able to point out why their separation in the presence of disease is always preserved when contiguous bones, placed under similar circumstances, become so readily united.

If we examine a case of local disease in a bone—a phalanx, for example, in which the vitality is at one point lost—we shall find an opening through the integuments from which pus is discharged; extending from this point, the skin and periosteum will be inflamed to a certain distance, the diseased gradually merging into the healthy tissues. If an opportunity of a careful examination be afforded, it will be found that where the dead joins the living bone, the latter is undergoing absorption, and that beyond this point new osseous tissue is becoming developed upon the surface of the pre-existing bone, the latter part corresponding to the junction of the healthy and the diseased soft tissues, and the former to the part where the sinus exhibits all the indication of chronic suppuration. In a tooth the periosteal investment of which has become inflamed, conditions in many respects similar to those which take place in bone may be observed. Thus the end of the tooth will be denuded of periosteum, and in some cases diminished in bulk by absorption. Higher up the membrane will be adherent and thickened, and beneath this the cementum also will be increased by recent additions of new tissue. In order to allow of the increased bulk, the alveolus is necessarily enlarged. Still the interval which separates the wall of the socket from the contained root is small, and might readily become the seat of bone uniting the tooth to the jaw but for the existence of some cause which prevents the union of the tooth to the jaw while it allows two bones, when similarly placed, to become connected by ossification.

It may be remembered that bone or cementum is not developed by a direct metamorphosis of the periosteum, but by the calcification of osteoblasts. Now, the various stages of this new development are to be seen on the inner or tooth surface of the periosteum of the socket, and never on its outer or bone surface; and this may in a measure serve to explain why bony union apparently does not take place.

When a disease consists in the mere increase of a tissue the presence and position of which are normal, the transition from health to disease is imperceptible, and is usually destitute of symptoms. It is only when the amount of new tissue has attained a considerable thickness that distinct symptoms are developed, and even then they are in many cases absent. In dental exostosis, a distinction must be drawn between those cases in which the disease is consequent upon pre-existing disease in the tooth, followed by marked irritation of the alveolar membrane, and those in which it is developed independently of any other disease.

When the disease arises in connection with caries, it is attended by a thickening of the gums, which assume a deep dull colour, and a disposition to bleed when subject to friction either from the tooth-brush or food. But when the crown of a tooth is free from disease, exostosis of the root may be unattended with any recognisable change in the condition of the contiguous gum. The occurrence of sympathetic pains in the head, face, or neck may be, and often is, the only indication of disease. In the presence of such pains it is often extremely difficult to determine whether the teeth are in fault, and if so which tooth or teeth have occasioned the suffering. Sooner or later local symptoms may arise by which the offender can be recognised. The tooth will become tender on pressure, or sensitive to the effect of hot or cold fluids, or the gum may become absorbed, and leave exposed the neck of the tooth, which eventually becomes loose. Such obvious symptoms, however, commonly appear only after the patient has undergone great suffering from assumed idiopathic tic-douloureux,

FIG. 222.—A molar tooth of the upper jaw, the roots of which are thickened by the addition of cementum, the crown being free from disease.

a complaint for the relief of which patients have often submitted to have tooth after tooth extracted, although the relief afforded after each operation was but questionable.

There are cases, however, in which the presence of exostosis, even of slight amount, produces great misery; a certain tooth is pointed to by the patient as the cause. Its removal brings relief. The complaint returns; another tooth is fixed upon, and removed with a similar result. Another and another follow; and it is only after all the teeth in the upper or lower jaw have been removed that the patient gains permanent immunity from pain, as is exemplified in the following case, which came under the writer's treatment some years ago. The crowns of the teeth were sound, but the roots had become slightly enlarged by exostosis. The patient, when first seen, stated that she had suffered from tic-douloureux for several years, and had submitted to the usual treatment without advantage. Two teeth had been extracted, and the operation was followed by a remission of the symptoms. The pain, however, soon returned with full severity, and at this time two upper bicuspid teeth were regarded as being connected with the production of the disease. She stated that the pain came on gradually at irregular intervals, lasting sometimes for twelve or fourteen hours, or until, exhausted by suffering or narcotised by opium, she fell asleep. The suspected teeth appeared quite healthy, but the patient stated, that, though they did not ache, yet they were seldom free from an uneasy sensation. She always felt that they were there, and prior to an attack of facial pain they became hot and felt full. Leeches were applied to the gums, and internal remedies administered, but without producing any mitigation of the symptoms. After a time the teeth became sensitive to the effects of changes of temperature, and a current of cold water or air not only produced pain in the two teeth, but also brought on an attack of pain in the face. The teeth were extracted, and for several months the patient was comparatively free from pain. Other teeth became similarly affected, and were removed with similar results; but it was only after the whole of the teeth of the upper jaw had been extracted that the patient became perfectly free from the recurrence of the pain. In another case the patient had suffered for several years from intermittent pain in the head and face. For a long time the cause of the disease appeared to have a constitutional rather than a local cause, but the usual remedies failed to afford relief. After a time a feeling of uneasiness attracted attention to the only remaining molar tooth, the second molar of the upper jaw, situated on the side in which the pain was felt. On removal the crown was found to be sound, but the roots of the tooth were enlarged. In this, as in the preceding case, the liability to pain in the face ceased after the operation.

In the two cases cited the relief was complete, although by no means instantaneous ; the pain became gradually less severe, and the attacks less frequent, and shortly ceased to recur.

It may be stated generally, that the removal of a tooth which has been the cause of sympathetic pain usually produces a severe attack, the paroxysm bearing some relation in its duration and in intensity to the previous attacks, and to the length of time during which the disease has existed.

The sympathetic affection may, however, in a few rare examples, extend to a derangement of the whole nervous system. Two cases have occurred under the writer's observation in which epilepsy appeared to be possibly consequent upon diseased teeth, the most prominent feature being exostosis of the roots.

The diagnosis of exostosis is attended with the greatest difficulty, pain or uneasiness not to be otherwise accounted for being often the only symptom present. And it must not be forgotten that there are many persons whose teeth are materially exostosed, who suffer not the smallest inconvenience from them, so that the existence of disease is only recognised when teeth are, for other reasons, extracted.

It will sometimes happen that an exostosed tooth will convey a peculiar sensation to the finger : when moved in its socket it moves very freely up to a certain point, at which it is abruptly and suddenly brought up ; exostosed teeth are also apt to be intolerant of a jar, such as is produced by a blow from the handle of an instrument.

So far the X-rays have not been found of much use in diagnosing dental exostosis of moderate amount, owing to the difficulty of obtaining a skiagram showing the margins of the tooth roots with sufficient accuracy. Nevertheless there can be no doubt that a skiagram may be of considerable value in confirming the suspected presence of this condition; nor is there any objection to the application of the X-rays once or twice for such a purpose. A caution should, however, be given that it is possible to excite a severe dermatitis by their repeated employment.

ABSORPTION AND NECROSIS OF THE ROOTS OF PERMANENT TEETH.

THE removal by absorption of more or less of the root in teeth the crowns of which have been injured by disease has been already mentioned; but cases from time to time arise in which, while the crown of a tooth is perfectly sound, the root is attacked by absorption. It is to absorption, when it occurs under the latter circumstances, that attention will be directed.

Although the processes of absorption will be the same under whatever circumstances they may be set in action, yet we may arrange the cases under two divisions, in accordance with the character of the exciting cause. In the first may be placed those examples in which the whole or part of the root of a sound permanent tooth is absorbed without reference to the growth of an adjoining tooth; and in the second, those cases where a portion of a permanent tooth is absorbed to make way for the eruption of a neighbouring tooth.

We have seen many cases of absorption in permanent teeth where the waste has so far reduced the roots that they became loose and painful; but we are indebted to Mr. Canton and to Mr. Brookhouse for specimens showing complete absorption of the root. In the one case the incisors, one after another, became loose, and fell out, the patient being on the younger side of forty, just as though they were temporary teeth making way for their successors. In the other a permanent lateral incisor was lost under similar circumstances. In neither patient was there any indication of the presence of disease,

FIG. 223.—Sound permanent central incisor, the root of which has been absorbed. From a specimen placed at our disposal by Mr. Alfred Canton.

either in the gum or in the alveolar process. The attention was attracted by no other symptom than the gradually increasing looseness of the tooth. In a patient of the writer's, aged 50, an upper central became rather suddenly loose and painful. It was subsequently found that the one side of the root had been removed by absorption, the process having been arrested when the walls of the pulp-cavity were reached, leaving the pulp perfectly encased in a thin tube of dentine. But for the supervention of inflammation, followed by the secretion of pus, it is probable that in this, as in the preceding cases, the whole of the root would have been removed.

The fact that the walls of the pulp-cavity resisted the absorbent action with greater success than any other part of

FIG. 224.—A permanent incisor, one side of the root being removed by absorption. A thin case of dentine enclosing the pulp has been preserved.

FIG. 225.—A pivoted tooth, with the root reduced in size by absorption, and gold pin exposed at one point by a perforation, also produced by absorption.

the dentine accords with what we may observe taking place in a limited degree in temporary teeth. It is probable that the presence of the pulp gives this power of resistance; for in pivoted teeth the root is sometimes reduced by absorption, and perforations are sometimes made, by which the metal pin is exposed. In a specimen in the museum of the Odontological Society, the root of a tooth has been in great part absorbed in consequence of the irritation produced in its socket by a bristle which had made its way up the empty pulp-canal.

The six upper front teeth of a young person were shown some years ago to the writer subsequently to their removal on account of looseness. There was no assignable cause for their destruction, and the patient's general health was quite good; yet the roots of all these teeth had been shortened with singular uniformity until not more than half the root remained.

The cases which fall under the second heading are usually dependent upon the malposition, and consequent retarded eruption, of a permanent tooth. The extent to which the absorption of tissue is carried is usually limited to the production of a slight depression in the neck or root of the tooth, but in a few cases the process is continued until the pulp-cavity is laid open and the pulp exposed.

The canines of the upper jaw being more frequently malplaced than any other teeth, except the wisdom teeth, we should expect to find instances of absorption in the lateral incisors and first bicuspid teeth. But in these we seldom see more than a simple depression, towards which the advancing crown of the coming tooth has been directed, though instances of the exposure of the pulps of lateral incisors have been placed on record. It is upon the second molars that the greatest extent of injury is inflicted. When the crown of a wisdom-tooth is directed forwards, it leads to absorption at the neck of the obstructing tooth; and the process, though generally arrested before the second molar is permanently injured, will, in some cases, lay open its pulp-cavity. We have seen several cases in which the injury has been followed by inflammation of the pulp, necessitating the immediate removal of the tooth. In one case which occurred, the patient complained of severe pain in a second molar of the upper jaw. The tooth appeared in every respect sound; directions were therefore given that a leech should be applied to the gum. On the following day the patient returned, complaining that the abstraction of blood had failed to produce relief, and strongly urged that the tooth should be removed. The tooth had become slightly movable, and the crown had lost a little of its natural brilliancy of colour. After removal, the cause of the suffering was manifest. The pulp-cavity had been laid open; the pulp became inflamed, lost its vitality, and at the time of the operation was in a state of decomposition. In this instance there was not the slightest evidence of caries; but in others which have come under observation the cavity produced by absorption subsequently became the seat of caries.

The exact mechanism of the absorption which takes place when one tooth impinges upon another below the level of the gum is not fully understood. When the contact takes place above the edge of the gum, no harm is done, unless the crowding induces caries at that point; but when it is at a lower level, absorption is set up, whether by the periosteum being irritated by being squeezed between the crown of the advancing tooth and the cementum of the other, or by some other process. But as a practical matter it must be remembered that there may be absolutely nothing to show for it, save pain and tenderness, for the spot at which absorption is taking place may be far beyond the reach of a probe; this has been observed both with lateral incisors and with second molars.

In a case recently under observation, pain was complained of in a second molar, which was found to be eaten into at the gum-level, where a short wisdom tooth impinged upon it. It was grasped with forceps, and, though previously apparently fairly firm, the crown came away instantly. On examination it was found to have entirely lost its roots, save the shortened remains of the anterior labial roots, and yet its pulp had remained, in part at least, alive.

Necrosis of the Teeth.—After the death of the tooth-pulp, the tooth may long retain an organic connection with the part outside it by means of the cementum, and usage has led us to speak of such a tooth as a dead tooth, though in fact it is not really wholly dead. But usage has likewise limited the term "necrosed," which really means just the same thing, to that more complete death in which the cementum and periosteum likewise are involved.

A perfectly dead tooth is soon thrown off by Nature as an extraneous body, its expulsion being attended with more or less local inflammation of the surrounding soft parts. The amount will to a considerable extent depend upon the relations of the several parts involved at the time the death of the tooth takes place, and upon the cause which produced it.

If, for instance, the alveolus and the gums have receded, the inflammation excited by the dead tooth will not be great, unless the death of the tooth has been consequent upon recent inflammation of the pulp and of the dental periosteum. Even then the symptoms will be less severe than they would have been had the alveolus and gum risen to the usual level. But we see many discoloured teeth which have remained for years firmly implanted in the jaw, and their presence has been unattended with serious inconvenience, yet they may be described correctly as necrosed teeth. In such cases the disease has not, however, involved the whole of the tooth; some part has retained its vitality, through which the connection with the soft tissue has been maintained, and consequently the tooth has been enabled to hold its place. The circumstance that a tooth, the crown of which presents all the external characters peculiar to a dead tooth, retains its position, and in certain cases fails to produce considerable local disturbance in the jaw, while in other instances great irritation is set up, indicates that the disease is subject to important modifications, which at first sight are not very apparent. On investigating a series of cases it will, however, be found that the modifications which they present are consequent upon the extent to which the tooth has become involved, rather than upon any special difference in the disease. Thus the dentine may lose its vitality in consequence of the pulp having been destroyed, and the tooth assume the peculiar brownish-red colour which arises from the decomposition and diffusion of the blood contained in the pulp through the dentine, and yet the cementum may retain its connection with the periosteum. This connection affords the means by which the tooth may retain its place for an indefinite period. Examples are often seen in which the pulp has been suddenly destroyed by a blow received many years previously, and the injury has been followed by discoloration of the crown of the tooth. The patient will state that the tooth is dead, but this is not strictly correct. The death has been limited to the pulp and dentine; the cementum has retained its vitality, although its normal state may not be perfectly preserved.

Again, in pivoting or crowning a tooth we reduce the root to a similar condition. The vitality of the dentine is sacrificed when the pulp is destroyed, but if the operation is attended with success, the life of the cementum will be maintained.

The time during which a tooth so circumstanced will retain its position without undergoing further change is not unlimited, for the cementum is apt to become the seat of an increased, if not a morbid action, so soon as the vitality of the dentine is lost. In some cases great additions are made to its surface, and through the new tissue the connection with the periosteum is preserved. In others, again, absorption is set up, and the root becomes reduced in bulk, is gradually detached from the periosteum, loosens, and falls out. In the former case the living portion of the tooth appears to be very limited in amount, its extent being often confined to the newly-added tissue; for the appearance presented by some specimens would justify the conclusion that the cementum which existed at the time the dentine lost its connection with the soft parts, though not deprived of life concurrently with the dentine, yet subsequently lost its vitality, but not, however, before new cementum had been added upon the surface of the older tissue in parts.

If we remove a tooth which has been the subject of the foregoing changes and allow it to become dry, those portions of cementum which are of comparatively recent formation will present the opaque white aspect of healthy bone; while the other parts of the tooth, including the older cementum, exhibit more or less discoloration. Now, it is possible that the whole of the tooth became necrosed at the same time, but it is more probable that the death of the cementum was subsequent to the death of the dentine, and also to the development of a new layer of cementum. Otherwise it must be admitted that the living tissue was developed upon, and united to, and continuous with, the dead structure, which is not likely.

Necrosis may, however, be confined in the first instance to the cementum, the dentine and dentinal pulp retaining their normal relations. In cases which present this character the tooth becomes loose, and the gum usually, although not necessarily, recedes. The surface of the cementum is detached from the periosteum, excepting, perhaps, at and about the extremity of the root, where the nerves and blood-vessels pass into the pulp-cavity.

The patient complains of intermittent pain in the tooth, excitable at any time by the application of hot or cold water; very commonly pus will escape from between the tooth and the gum when the latter is pressed. The crown of the tooth does not assume the dark slate colour which follows after the death of the pulp. In this form of the disease additions are not made to the cementum, unless in small and isolated spots. Sometimes the cementum is greatly reduced by absorption, and even the dentine in many cases suffers also, though necrosed tissue is usually a source of so much irritation that it comes to be bathed in pus, and so is to be removed from the action of osteoclasts.

There is yet another form of partial necrosis. One root of the double-rooted teeth, or one or two of the treble-rooted teeth, may become dead and perfectly detached from the lining membrane of the alveolus, while the remaining root or roots preserve their vitality. Teeth when in this condition are apt to be at times very troublesome. When they are used in mastication, pain is experienced from the dead root being pressed into the socket, the lining membrane of which is injured by the rough surface usually presented by the dead root. The continued irritation arising from this cause is productive of thickening of the alveolar covering, accompanied by the development of a high degree of sensitiveness in the hypertrophied parts, the susceptibility to pain in which is consequently increased. Hot or cold fluids taken into the mouth also excite pain in the tooth itself, or in the irritated alveolus (it is very difficult to say in which). The alveolus and gum of the dead root may or may not become absorbed.

Such teeth may sometimes be restored to usefulness by cutting off the necrosed portion, which is usually not at all difficult of accomplishment with the aid of the engine. An upper molar, one labial root of which has thus been cut off, will preserve a considerable degree of firmness if its other two roots are fairly healthy.

In one case we may see the whole of the root, even to its extreme point, laid bare by the removal of the investing parts, and in another case the gum will nearly maintain its normal height. Of the two, the former condition is preferable, on account of the greater degree of irritation and pain which usually attends the latter.

The thickened periosteum, if adherent at any point to the cementum, may be, and sometimes is, withdrawn from the socket on the tooth being extracted. It is usually light in colour, of considerable thickness, and almost as dense as fibro-cartilage.

It is probable that the success sometimes attendant upon replantation, after all other treatment has failed, depends upon the possibility of thus removing any necrosed cementum or much-thickened periosteum before restoring the tooth to its socket.

EROSION OF THE TEETH.

It occasionally happens that the enamel and the subjacent dentine become eaten away without any of the ordinary appearances of dental caries being manifest. The cavities, if such they may be called, are in general regular in form, and saucer-shaped, the removal of the enamel having taken place more widely than that of the dentine. The surface is perfectly hard and polished, and often absolutely free from discoloration.

Hunter was probably the first to describe this affection under the name of "decay by denudation," and in his "Natural History of Human Teeth" writes:—"From its attacking certain teeth rather than others in the same head, and a particular part of the tooth, I suspect it to be an original disease of the tooth itself, and not to depend upon accident, way in life, constitution, or any particular management of the teeth."

Erosion most commonly attacks the necks of the teeth, forming a smooth horizontal groove close to the edge of the gum; it is more frequently met with in the upper than in the lower jaw, and closely simulates the appearance produced by mechanical abrasion caused by the friction of a tooth-brush.

Now and then, however, teeth are attacked in positions inaccessible to the tooth-brush; thus, in the canine tooth here figured, the groove was not only upon the anterior surface, but extended back on both sides of the neck of the tooth; moreover, it was distinctly undercut.

This erosion may go on till the pulp-cavity is opened and even passed, so that the tooth is fairly cut through by it. An instance of a lower bicuspid, with its crown thus undermined, has recently presented itself which, from its position, was thoroughly protected from the ordinarily recognised sources of friction. Although the labial surfaces of the teeth are usually attacked, the lingual surfaces may in some few instances be eaten away; in the two incisors here figured this has taken place, the gum having at the same time receded. In the right-hand figure an island of enamel has been thus removed from the lingual surface of the crown.

Sometimes the enamel is attacked at several points on the labial surfaces of the crowns of the front teeth. In a patient lately under treatment, the enamel had been removed in irregular-shaped patches from the upper incisors and canines, and to a less extent from the bicuspids. The subjacent dentine, which had been but little eroded, was perfectly hard

FIG. 226. — Well-marked erosion, affecting crown and root.

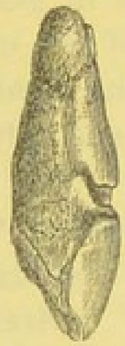


FIG. 227.—Canine, of which the front and sides of the neck are deeply grooved.

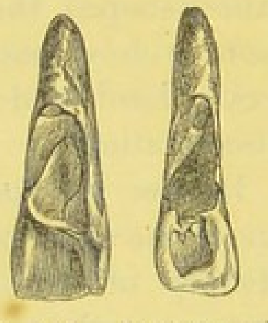


FIG. 228.—Incisors, the backs of which are eroded.

and polished, but the edges of the enamel, which were sharp and angular, were partially disintegrated, chalky-looking, and crumbly. The patient had been confined to her room, and for the greater part of the time to her bed, by a severe attack of rheumatic fever and its sequelæ, for upwards of nine months; and during this time she had taken much medicine, and had been incapable of giving any attention to her teeth.

Occasionally this disappearance of the enamel, etc., may be traced to peculiarities of diet, such as sucking lemons, and in one case the patient, a hysterical girl, subsisted mainly upon grapes, which she sucked in such a manner as to bring them largely in contact with the labial surface of her front teeth.

In other cases the mucous membrane of the lip is found to be thickened and altered in appearance where it lies upon the surface of the teeth, but it has yet to be shown whether this is cause or effect.

A somewhat similar case is figured in Harris's "Dental Surgery" (tenth edition, p. 261); and Dr. Parmly mentions a case in which a natural tooth, set upon an artificial plate, was similarly grooved; this last observation the writer can confirm, and may add that it occurred in a case where the patient rarely or never resorted to the use of a tooth-brush; a similar observation was recorded by Mr. Harrison in the Transactions of the Odontological Society, May, 1870.

But yet a more cogent argument for the existence of this "erosion" of the teeth, as distinct from mere mechanical abrasion, is furnished by an observation of Dr. Murie,[1] who found that the teeth of a sea-lion (*Otaria jubata*) had been thus wasted. The excellent figure given (*loc. cit.*) is too large for reproduction in these pages, but it is at once evident, on inspection of the drawing, that the circumferential grooving of these teeth cannot easily be accounted for by friction, as in most instances, and notably in the great canines, the places most affected are situated on the sides of the teeth most protected from wear, and the crowns are merely worn down in the ordinary way.

This condition, at least in this extreme degree, is not common among the seals, but I have seen an approach to it in the teeth of other specimens of Otaria, and in the proboscis seal.

In the museum of the Royal College of Surgeons there is a skeleton of *Otaria stelleri*, in which this form of wasting of the teeth is well exemplified. In it the teeth are much worn down by mastication, but in addition to this, some of them are deeply grooved in positions not at all exposed to ordinary wear. The third left upper incisor is thus deeply notched on its outer and anterior aspect, close to the edge of the gum, whilst other teeth present a similar condition, though less markedly.

Mr. Coleman (Trans. Internat. Med. Congress, 1881), discussing these teeth of Otaria, points out that some seals are known to take stones into their mouths, and very probably take more or less sand also; moreover, hard fish-scales are very frequently in their mouths, and their long and very flexible tongues are capable of sweeping all round these eroded teeth. Whilst admitting that it is difficult to account for, and that

[1] Transactions of the Odontological Society, June, 1870.

some uncertainty still rests upon the subject, he does not think that we can fairly rule out mechanical attrition as not being amongst the possible causes in these cases.

Mr. Bland Sutton, in one of his most valuable papers on comparative dental pathology (Trans. Odont. Soc., Jan., 1884, and April, 1885), has touched upon this condition of erosion in seals, and draws attention to the reduced dentition of the elephant seal (*Macrorhinus leoninus*), whose peg-shaped molars present a circumferential grooving perhaps due to erosion, and also to a skull of *Otaria jubata*, the property of Mr. C. Bartlett. In the latter the skull and jaws are affected with a sort of porous soft hyperostosis like that seen in the skull of rickety animals about puberty. A racoon-like dog (*Nyctereutes procyonides*) is also quoted as having the characters of mollities ossium, and the teeth as having undergone erosion. Hence he thinks that in face of these instances of erosion occurring with constitutional bone disease, and with comparatively functionless, imperfectly-developed teeth, there would seem to be an association between erosion and defective development.

And beyond this, it is easy to suppose that the secretions of the gum overlying the diseased bone might well be altered, and possibly might be such as to soften the teeth round their necks.

According to Brubaker (Internat. Dent. Journal, 1894) the secretion of the mucous glands of the lips, etc., consists of mucin, inorganic salts, and water, and owes its alkalinity to sodium phosphate. He is of opinion that when these glands become irritated and hyperæmic, their secretion is increased and acid sodium phosphate formed, and that this acid is the decalcifying agent in erosion.

Michaels (Dental Cosmos, 1901, p. 719) believes that these labial salivary glands play an important part in the production of erosion, and succeeded in artificially producing erosions said to be absolutely similar to those found in teeth in the mouth.

Znamensky (Journal Brit. Dent. Assoc., 1898, p. 8) does not believe that the enamel plays any part in the process of erosion, but thinks that there is a sort of mechanical removal of particles of lime salts in the part affected. This, he remarks, is due "to a disappearance of the cement substance and to the swelling of the organic portions of dentine," also to "unequal abstraction of the glue-yielding substances of the dentine."

An appearance similar to erosion has been met with on the functionless tusks of the female Indian elephant: upon one of these a mass of eggs, apparently of a dipterous insect, were found, and it is stated by sportsmen this is no uncommon occurrence, the larvæ or pupæ being often found in the margin of the gum and attached to the tusks. Mr. Sutton, however, disposes of the idea that these parasites play any part in the erosion, if such we are to term it, for the excavation took place for three inches below the exserted portion of a rudimentary tusk which was examined *in situ* in an elephant which died in the Zoological Gardens. This, then, is a true case of absorption, and not of erosion, and Mr. Sutton comments upon it thus: "Pathologists have long been aware that morbid changes are more prone to attack undeveloped, functionless or imperfectly acting organs; hence I imagine that the tusks of female elephants are more prone to inflammation than the fully-developed representatives in the male."

There is yet another form of wasting of the teeth, which is more rare than those already described. In it not isolated spots, but the whole exposed portion of the tooth is attacked; as the morbid action goes on, the enamel is slowly removed from the crown, so that the teeth become shorter and thinner, and assume a peculiar yellowish, translucent appearance, the position of the pulp-cavity being strongly marked by a difference of colour. In one case which has come under personal observation, the wasting of the teeth was established beyond all doubt by taking models from time to time. The patient, an anæmic girl, was reduced to a state of great prostration by acute dyspepsia, and was for a considerable time confined to her bed; she was, however, so hysterical that it was exceedingly difficult to rightly estimate her condition. At one time there was great tenderness of the teeth, and general periostitis in the front of the mouth, which, judging by colour alone, appears to have resulted in the death of one of the upper central incisors. The use of alkaline applications seemed to have no effect whatever; but the patient's condition has now greatly improved, and the disease appears to be no longer progressing. It is remarkable that during her prolonged illness, while the teeth were being rapidly eroded, no caries occurred in the mouth.

A somewhat similar case has been under the writer's observation for some years. The patient, a man of about 40, has long been the subject of acid dyspepsia and dilated stomach. The yellowish brown translucent teeth have become somewhat rapidly washed away, as it were, to knife-like cutting edges. Since a comparatively recent operation for pyloric stricture his health has markedly improved, the acid dyspepsia has almost ceased, and the rapid wasting of the teeth, so

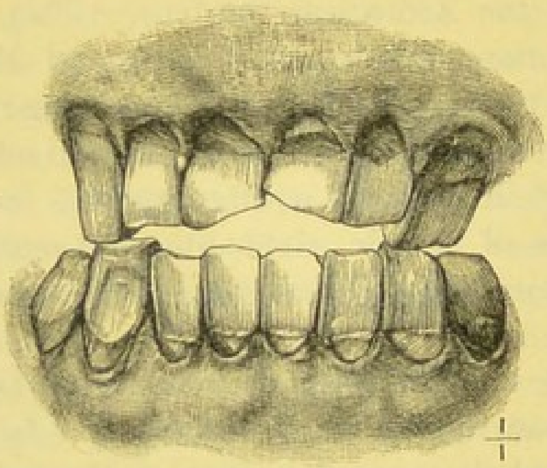


FIG. 229.—Erosion of upper and lower incisors and canines, fully half the substance of each crown has disappeared ; no recession of the gums.

noticeable previously, has apparently been arrested : caries was present to an average extent only.

Quite recently a most interesting example of advanced erosion affecting the teeth of a retired army officer, aged 60, has come under the author's notice. In this instance the labial surfaces of the upper and lower central and lateral incisors are cut away to less than one half of their original thickness; these teeth are non-sensitive and highly polished, with white enamel, pale yellow dentine, and deeply stained calcified pulp tissue shown in perfect section. The canines are less affected, the teeth are very firmly implanted, and there is no recession of the gums (Fig. 229).

A case of wasting of the front teeth, by which a separation of three-eighths of an inch was brought about between the incisors in the course of two years, is related in Harris's "Dental Surgery" (p. 264); and Mr. Bell has given figures of a case in which this wasting, affecting mainly the edges of the teeth, effected a wide separation between the upper and lower central incisors, and attacked also, though in a less degree, the laterals and canines, which could not be brought into contact with one another.

The cause of these various forms of erosion has been, from time to time, the subject of great discussion; though some hypotheses, such for instance as that which attributes it to disease inherent in the dentine, may be at once dismissed.

Mr. Hopewell-Smith writes ("Patho-Histology of the Teeth," p. 340):—"It is exceedingly probable that the condition is predisposed to by the denudation of dentine at the necks of teeth by the thin edges of enamel and cementum which as a rule overlap it," *i.e.* when these two tissues neither overlap nor meet each other.

It has already been shown that mechanical abrasion will with difficulty be made to account for all the cases, though Dr. Bonwill has recently pointed out that the elastic flexible hairs of a tooth-brush could make grooves of forms not at first sight readily explicable.

Absorption cannot always be called in to account for the removal of the tooth substance, for it often takes place at spots remote from any structure capable of developing an absorbent organ, and it seems that we must fall back upon the idea that it is an example of chemical solution. But whence the solvent comes, and why the affected surfaces are not the site of ordinary caries, are questions which remain unsolved, though it seems probable that mucus, by fermenting or affording a nidus for fermentation, may provide the acid solvent.

Dr. Magitot [1] regards the grooving of the necks of the teeth

[1] Recherches sur la Carie des Dents. Paris, 1871, p. 523:—"La cavité offre alors l'aspect singulier qui la fait comparer à un trait de scie transversal à parois lisses, polies, dures et résistantes. Ce sont ces cavités que Duval et divers autres auteurs désignaient sous le nom de 'caries simulant l'usure,' et dont le mode de production n'était pas expliqué. Elles ont, en effet, toutes les apparences de l'usure véritable, mais nos observations sur la succession des diverses périodes de la maladie nous ont démontré que ces sillons nets et polis ne sont autre chose que des caries du collet passés à l'état de guérison spontanée ou caries sèches."

as the result of caries, which has tended to spontaneous cure by the obliteration of the dentinal tubes; but this view does not differ from that which ascribes it to chemical solution, as Dr. Magitot holds that caries itself is the result of a chemical solvent.

In erosion the granularity of the enamel is exaggerated.

Underwood (Trans. Odont. Soc., 1888) says that normal enamel is faintly granular, the granularity being much exaggerated in the brown striæ of Retzius. He also mentions interglobular spaces with accompanying calcospherites in human enamel as a factor in erosion, and says he has only found these spaces in enamel subject to erosion.

Miller suggests (Dental Cosmos, 1890) that it might be well in the future while searching for the cause of erosion to bear in mind that the teeth may be acted upon by agents which attack primarily the organic as well as those which attack only the inorganic constituents.

Our knowledge of erosion is far from satisfactory; in microscopic sections the dentine affected is unaltered, looking exactly as if cut down to the particular point by a sharp instrument. As against the hypothesis of an acid solvent, it has been pointed out that not only is the surface apparently hard and polished, but that in sections it does not take a stain any more deeply than the subjacent dentine, so that the softened tissue, if softened tissue there ever were, has wholly gone.

Treatment.—When the cavities produced are of suitable form, the further progress of the malady may be arrested by filling them with gold, porcelain inlays, or gutta-percha. Gutta-percha is often found exceedingly efficient for a time. But where the surfaces attacked do not admit of protection by a filling, treatment does not yield satisfactory results. The use of softer tooth-brushes should be enjoined, and alkaline dentifrices prescribed, as being the most likely to prevent solvent action on the teeth.

The cavities produced by erosion of the teeth are often excessively sensitive to the touch of an instrument, or to alternations of temperature. This sensitiveness may be cured by applications of nitrate of silver, or, where a black stain would be objectionable, by chloride of zinc.

THE OPERATION OF EXTRACTION.

In extracting a tooth, the following conditions should be fulfilled :—

First, the whole of the offending organ should be removed.

Secondly, it should be removed with as little injury as possible to the structures in which it is implanted.

Thirdly, the patient should be spared all unnecessary pain in the operation.

Fourthly, septic infection of the wounded parts should be as far as possible guarded against.

The present forms of **dental forceps** were invented by Sir John Tomes during the period of his house-surgeoncy at the Middlesex Hospital. The success which attended their use, and the attention devoted to their perfecting, had much to do with his selection of dental surgery as the branch of the profession which he should follow, as prior to that time he had had no thought of doing so.

He laid down certain general principles which remain good to the present time, and which cannot be neglected without prejudicing the general effectiveness of the instrument. The terminal edge of the jaws should fit with accuracy to the neck of the tooth for the removal of which it is designed. The whole of the circumference of the neck cannot be embraced, but a large portion of the lingual and labial surface of that part of the tooth can be reached by the instrument. The greater the surface over which the pressure is diffused, the less will be the risk of breaking the tooth by the force employed to effect its removal. Assuming the tooth to be grasped by the instrument, the jaws should diverge from the terminal edges sufficiently to clear the crown, but the divergence must not be greater than is necessary to effect that object, otherwise the form of a cutting instrument will be approached.

In forming the terminal edge some little care is necessary, as it must be sufficiently thin to pass under the gum and separate it from the neck of the tooth, and, in some cases, even to pass a short distance within the alveolus. At the same time, a sufficient amount of metal must be preserved to ensure the requisite strength. If a section were made of a well-constructed pair of forceps for the incisor teeth, each jaw of the instrument would present the outline of a sharp wedge, which, when applied to the tooth, would be in close apposition to the neck of the tooth, leaving the crown untouched. The length of the jaws should be sufficient to clear the crown; any further increase would diminish the power of the instrument, or necessitate an inconvenient length of handle.

Size and Curve of Handle.—In respect to the length of the handle there is great difference of opinion, the size of the hand of the operator by no means determining his selection of the length of handle most convenient to him. Perhaps there is a tendency to use forceps with handles both longer and larger than is consistent with the utmost attainable delicacy of manipulation, but hardly any two people think alike on the matter. Forceps for extracting the front teeth will necessarily be straight, but those used for the removal of the molars must be more or less curved, and the direction and degree of the curvature are questions of some importance. The straighter the instrument, the more readily will its action be controlled. On this account it is desirable to limit the curve at the joint, and, in the case of forceps for the upper teeth, to antagonise it by an opposite curvature in the handles, so that the line of the blades tends to be parallel with the line of the handles.

Many American dentists, however, seem to prefer forceps for the extraction of lower molars which have a very considerable curve in the handles, and a crook at the end of one handle for the reception of the little finger; but we do not think this form of forceps is at all equal to the usual English patterns. The jaws of the forceps must, however, form some angle with the handles at the joint, in order to enable the latter to clear the other teeth in the mouth, when used for removing the back teeth.

As the teeth are variously shaped, so will it be necessary to have forceps of different forms—in fact, a pair fitted to each kind of tooth. In order to secure perfect adaptation of each instrument to its allotted purpose, average teeth should be selected, and given to the forceps-maker, who should be instructed to make the jaws fit accurately around the neck, whilst they diverge enough, and only enough, to secure the crown of the tooth from pressure.

The roots of all teeth having a general conical form, forceps, when well made and applied, should be but as a lengthening of the cone in the direction of its base. Instruments for extracting stumps should be made altogether lighter, and the jaws should be thin and sharp at their edges, so that they may be made to cut rather than to tear the structures connecting the root with the adjoining tissues.

The Application of Forceps.—When forceps are used for the extraction of teeth, the operation is divided into three stages: first, the seizure of the tooth; second, the destruction of its membranous connection with the socket; third, the removal of the tooth from the socket. It will be of great service to the student, and advantage to those operated on, that he should pay strict attention to these stages, and that each should be well and efficiently executed before he proceeds to its successor; for should the tooth be unskilfully seized, the crown will be broken off in the attempt to detach the tooth from the periosteum of the socket; and until this is effected, the roots cannot be removed from their bony cells. A tooth will resist a great force applied in a line with its axis, or, in other words, if an attempt is made to pull a tooth straight from its socket; and some most disastrous results have been known to follow such attempts made by persons unacquainted with the form of the molar teeth which they attempted to extract: three or four teeth and the alveolus inclosing them have been brought away, and the greater part of the floor of the antrum was actually torn away in one case. It must be remembered that, if single-rooted teeth be excepted, no tooth could be extracted from a rigid, perfectly unyielding bone, and that it hence is important to study in which direction the bone of the socket is most yielding. In applying the forceps the jaws should be closed lightly upon the tooth, inserted under the free edge of the gum, and then *forcibly* driven down to the edge of the alveoli, or even a short distance within them. We say forcibly, because all beginners, and even some practised in the use of forceps, are liable to failure because they do not use sufficient force; they seize the tooth at the edge of the gum, instead of at the edge of the alveolus. The beginner should be strongly impressed with the necessity of laying hold of the tooth as far down towards the roots as the instrument can be passed.

An old and successful operator, when instructing another in the use of forceps, said: "Push the jaws of your forceps into the sockets as though you intended they should come out at the top of the head, or under the chin."

Even in recent American works it is said that the use of the gum-lancet should generally precede the application of the forceps, and its employment is strongly advocated. Nevertheless, we do not think its use either necessary or even advantageous, save in those very few instances where the gum is unusually adherent; and the only position in which this adherence of the gum to the tooth is likely to be productive of trouble or injury is the posterior surface of wisdom-teeth. It will occasionally happen that the gum may be unnecessarily lacerated when firmly adherent to this part of the wisdom-tooth, so that it is, perhaps, safer to ascertain whether it is or is not closely attached to the tooth before attempting its removal. But, with this somewhat rare exception, we are unable to see what is to be gained by lancing the gum, if the edges of the jaws of the forceps be in proper condition.

American forceps, as a rule, appear to have the blades much thicker, and to approach less to a cutting edge, than those of English make, and it is probably on this account that lancing of the gum is still advocated by some transatlantic writers.

When the forceps have been pressed well up, the student must be on his guard lest he crush the tooth by squeezing the handles of the forceps too tightly. To guard against this, some operators pass the little finger between the two handles; but a preferable plan is to regulate the pressure exerted by partly introducing the fleshy part of the thumb between the handles. No more pressure should be put upon the tooth than will suffice to prevent the forceps from slipping.

The manner of effecting the second stage will depend on the shape of the tooth to be removed, as will also the third. But it is quite impossible for any person to extract teeth properly, whatever instrument may be used, and especially if the forceps be chosen, unless he is perfectly acquainted with the form of each tooth, with the relative position and size of the roots, with their direction in the alveoli, with the general form of the alveoli themselves, and with the directions in which they offer the greatest and the least resistance. And the difference between a good and a bad operator lies largely in the quick, almost instinctive recognition by the sense of touch of the direction in which yielding is taking place, and the abandonment of force in directions where rigid resistance is encountered. An educated hand will thus often successfully remove teeth with abnormal roots, which would assuredly be broken by less skilled manipulation.

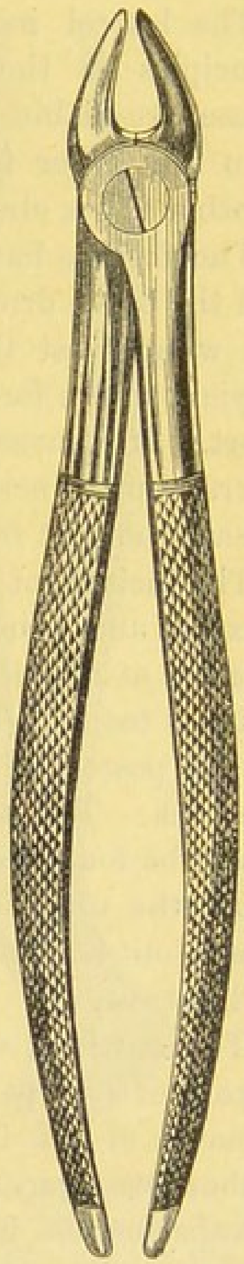


FIG. 230. — Forceps adapted for the removal of the incisor teeth of the upper jaw.

In describing the manner in which the operation of extraction should be performed on the different teeth, the incisors, canines, and bicuspid teeth will be first considered, and afterwards the molars.

A section through the neck of an **incisor** of the upper jaw will show that the anterior is larger, and forms part of a greater circle, than the posterior surface. Now, the end to be attained in the application of forceps, is to apply them over as large a surface as possible, so that the pressure may be diffused, and the chance of fracturing the tooth by the pressure of the instrument avoided. To extract these teeth, therefore, the jaw to be applied to the posterior surface must have a smaller curve than that for the anterior. When the forceps are closed upon the tooth, they should embrace, not only the anterior and posterior surfaces, but a part of the lateral surface also. A cylindrical tube of thin metal, when pressed upon equally in every direction, will resist enormous force; but if the pressure be confined to one or two points, a comparatively trifling power will crush it; so it is with a tooth.

The lateral incisors require forceps made upon the same principles as the central teeth, but somewhat less in size. These are liable to greater variation in external dimensions than any other teeth, sometimes being very small indeed, and at other times almost as large as the central incisors.

The forceps having been well pushed up towards the alveoli, and the tooth firmly grasped, then, by a firm and steady turn of the wrist, twist the tooth in its socket, and so soon as it is felt to yield to the force, it may be drawn from its socket with little effort. If unusual resistance is offered by either a central or lateral upper incisor, an inward pressure will almost invariably release the root from its socket.

The incisors of the lower are smaller than those of the upper maxilla, and much more compressed laterally, so that any attempt at rotation is inadmissible. Forceps for the extraction of these teeth will require to have the jaw which is to be applied to the posterior smaller than that for the anterior surface of the neck. The jaws of the instrument should be straight; but it will be found convenient to have the handles curved, so as to avoid the upper teeth. When the tooth is grasped it must be forced outwards, and, when it is felt to yield, draw it upwards and outwards.

The **canines** of the upper and lower jaws require for each a pair of forceps made upon the same plan as those for the removal of the incisors, except that they must be larger and rather stronger. Those for the lower canines should, like forceps for the incisors, have the handles bent either slightly or at a right angle. Sometimes these teeth are very small, in which case forceps adapted to the adjoining teeth may serve for their removal. The canine teeth, in the upper, may be detached from their membranous connection with the jaw by a rotatory movement, and will then leave the socket readily; in the lower jaw the rotation movement is often impracticable.

The **bicuspids** will be extracted with instruments similar to those already described, except that there will be a little difference in the blades, which must be accurately fitted to the neck of the tooth. These teeth are not very frequently liable to much variety in size, so that an instrument which is well

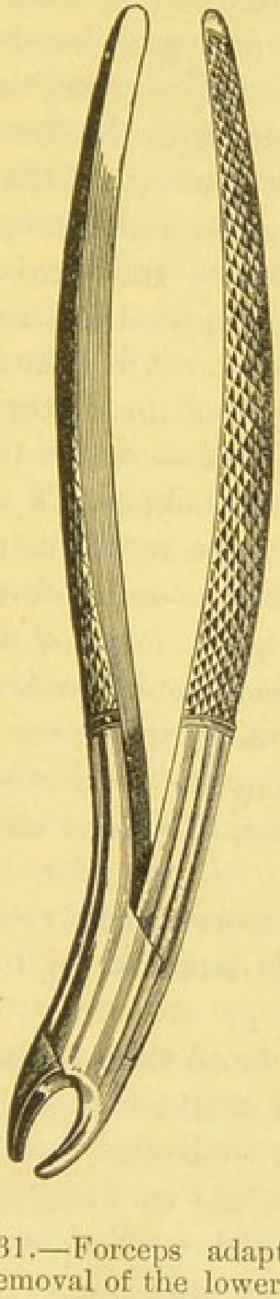


FIG. 231.—Forceps adapted for the removal of the lower incisor teeth, with the handle curved to enable the operator to avoid the teeth of the upper jaw.

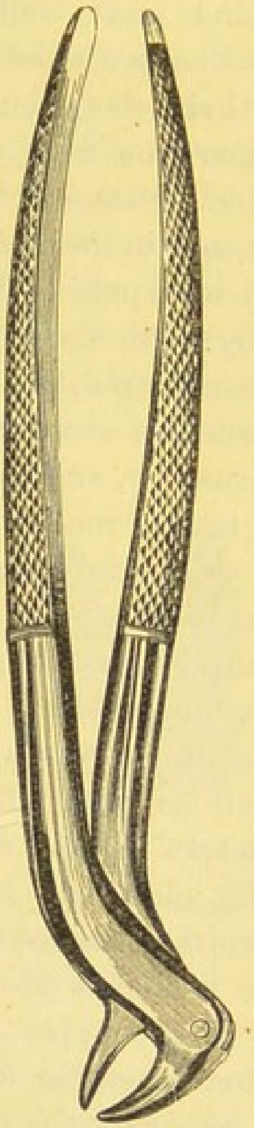


FIG. 232.—Forceps suitable for removing the bicuspids of the lower jaw. The joint is placed in an unusual position, and the handles bent in order to allow the hand of the operator to avoid the teeth of the upper jaw. The merit of inventing this useful instrument is due to Mr. Evrard.

adapted to an ordinary bicuspid tooth will apply itself to almost all. We prefer forceps in which the blades are bent at right angles with the handles, and open laterally, such as those figured on page 565 for the extraction of bicuspids of the inferior maxilla. Some prefer instruments which are nearly straight, or those in which the handles are constructed in the manner shown in Fig. 232, thinking it less convenient to apply the necessary force, and more difficult to regulate its direction, with the former than with the latter forceps. In extracting teeth which have their roots laterally compressed and are placed in an unbroken line with other teeth of like-shaped roots, the only available movement will be at right angles with the line of the alveoli, and in the direction of the greatest diameter of the roots.

The bicuspids of the upper jaw have the necks compressed laterally. In removing them, whatever be the form of the instrument used, the force must be mainly applied in a direction outwards and at an angle to the dental arch. After the forceps are thrust up, and made to grasp the neck of the tooth, a very slight inward motion may be made, but it is outwards that the tooth will mainly yield, as may be seen in looking at a vertical section of the bone and teeth *in situ*, when it will be noticed that there is a far greater thickness of bone on its inner than on its outer side. But it must be borne in mind that in forcing it outwards or inwards we desire only to break its connections with the socket; and that if the force be too completely in this direction in removing the tooth, the outer alveolar plate will be needlessly injured, so that it should be finally drawn somewhat downwards.

The bicuspids of the lower jaw have more conical roots than those of the upper, and hence may be detached by rotation, and then lifted out of the socket.

By rotation, it is not meant that the tooth shall be twisted a half or even a quarter turn, but that it shall be twisted till its attachments are felt to give way. This controlled rotation can be with advantage applied to any tooth, and is of assistance by tending to expand the tooth socket which consists of slightly yielding tissues. If, in order to effect this, more force is required than can be judiciously employed, then the direction may be changed, or the rotatory movement abandoned. There are some teeth whose roots vary so much from the usual form that they cannot be turned in the socket. The degree of force that it is necessary to employ, in this and in all other cases of like operations, can be learned only in practice.

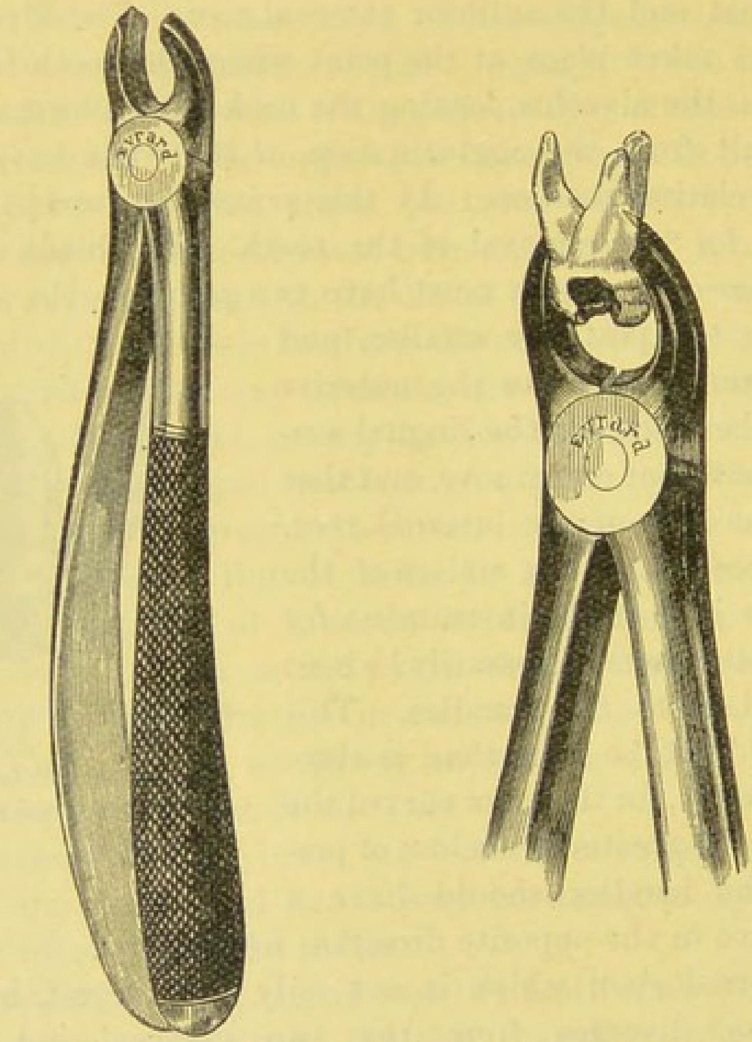
Extraction of the Molars.—Normal molars of the superior maxilla have three roots—two external, one internal. Of the two external roots the anterior is the largest, and is placed in a plane slightly external to the posterior root, which is both shorter and smaller. The third, the internal root, is thicker and of greater length than either of the others, and is situated opposite to the posterior external root, and to the space between that and the anterior external root. The divergence of the roots takes place at the point where the tooth becomes concealed in the alveolus, leaving the neck with a form such as would result from the agglutination of the roots having the described relative position. At this point the forceps should be applied for the removal of the tooth. The blade for the labial surface of the tooth must have two grooves—the anterior the larger; the posterior smaller, and upon a plane internal to the anterior groove. The blade for the lingual surface must have but one groove, and that fitted to the base of the internal root. From the position of the molars of the maxilla, the jaws of the instrument for their extraction must necessarily be bent at an angle with the handles. This angle should not be more than is absolutely necessary, for the more curved the instrument the greater is the loss of precision. The handles should have a general curve in the opposite direction to the jaws.

$\frac{1}{1}$

FIG. 233.—Upper molar with long divergent exostosed roots, offering great resistance to removal.

The internal root, which is not only the largest, but the longest also, diverges from the two external, and passes upwards and inwards towards the internal wall of the antrum, and is enclosed in tolerably dense bone. The external alveoli are composed of thin and porous bone.

In removing these teeth, then, the tooth being firmly grasped at its neck, the first motion should be very slightly inwards, to disengage the roots from the external alveoli, but this movement should be through a very small distance: in fact only just perceptible, for the nature of the parts precludes the possibility of its being carried far, and perseverance in this direction will lead to disaster. The force should then be directed downwards and outwards in the axis of the internal root. If these precautions be observed, no difficulty will be found in removing the superior molars. The first and second molars of the superior maxilla are so nearly alike in size and shape, that an instrument well fitted to one will serve equally well for the removal of the other.



Figs. 234 and 235.—Forceps for removing the superior molar on the right side of the mouth. In the second figure a left side instrument is shown embracing a tooth.

The first molar, however, if isolated by the previous removal of the second molar and the second bicuspid, will, when their vacated alveoli have been filled with solid bone, offer great resistance to extraction, and is sometimes broken off in the attempt. Indeed, a solitary tooth surrounded by firm bone is always more difficult to extract, and requires more care, than one situated in a continuous row of teeth.

In the third molars, or dentes sapientiæ, of the upper jaw, though the roots are often united into one conical mass, yet the shape of the neck of the tooth is so like that of the preceding teeth, that an instrument which is suited for the removal of the anterior molars is often sufficiently well adapted for the removal of the wisdom-teeth. The dentes sapientiæ are, however, sometimes much smaller than the other molars, in which case a smaller instrument might be required; but when of small size, the upper wisdom-teeth are for the most part removed by the application of so slight a force that any instrument by which they can be embraced will serve for their removal. A useful form of forceps for the extraction of upper wisdom-teeth is made with two nearly rectangular curves, like those of the plugging instrument represented on p. 352; the same forceps will answer equally well on both sides of the mouth.

The molars of the mandible have two roots, an anterior and a posterior root, which at their union form the neck of the tooth, and leave upon it a depression or groove on the lingual and labial surfaces. A transverse section through the neck of a lower molar, in outline, roughly resembles the figure of 8, and it is to the surface so formed that the jaws of the forceps must be adapted.

The two roots are not equal in size, neither are they strictly parallel in position. The anterior is both broader and thicker than the posterior root. Their position as regards each other is slightly oblique, giving at the point of confluence at the neck of the tooth a slightly greater breadth to the labial than the lingual surface. The position of the tooth in the jaw is also a little oblique. A line passed from the centre of the labial across to the centre of the lingual surface of the neck would, if continued, proceed over the tongue, with a slightly diagonal direction backwards. Owing to these peculiarities in the form of a lower molar tooth, it becomes desirable to possess forceps destined to effect their removal fitted to the teeth on each side of the mouth—an

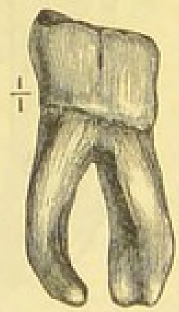


FIG. 236.—Right lower molar tooth with very broad curved and twisted roots, offering great resistance to removal.

instrument for the right, and one for the left teeth. One pair may be made to answer the purpose, perhaps, but the obliquities of position and conformation render it quite impos-

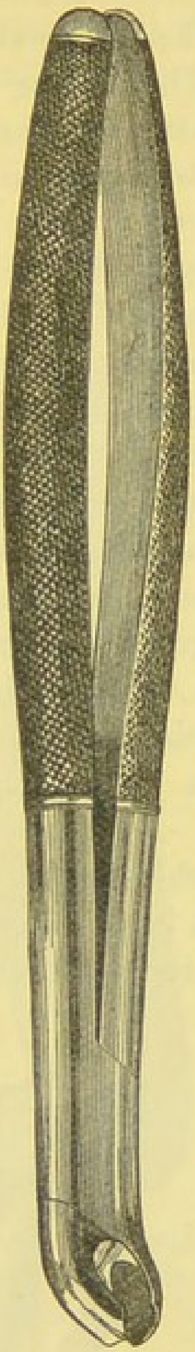


FIG. 237.—Forceps for the removal of molar teeth of the lower jaw.

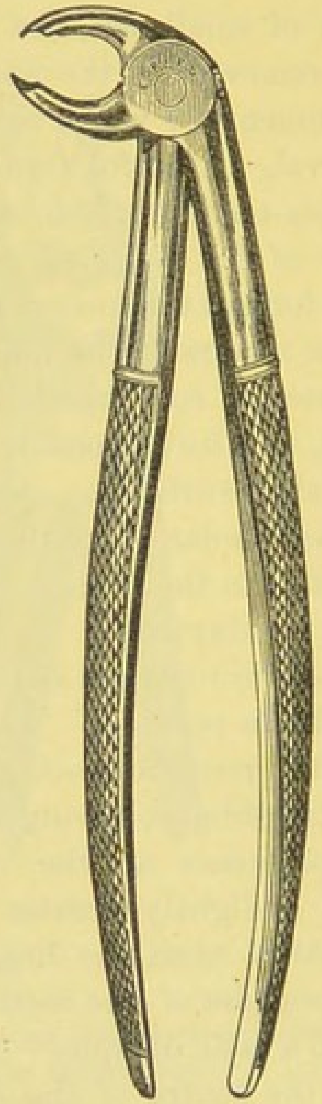


FIG. 238. —Hawk's bill forceps, the jaws of which are placed at a right angle.

sible to adapt the jaws of one instrument to fit with accuracy to the necks of both right and left lower molar teeth. The handles must necessarily be placed at an angle with the jaws of the instrument, and the angle will be determined by the plane in which the jaws are bent, For extracting the first lower permanent molars of young people, where the alveolus is likely to be tolerably yielding, we may employ small forceps nearly of the form represented in Fig. 237, with the handles curved to fit the hand; but in older people, and in all, young or old, for the removal of the second molars, forceps with the jaws bent at right angles are preferable (Fig. 238).

When, however, the whole tooth has an inclination inwards, the handles of the forceps of this last form would, in the place of being nearly horizontal, be directed upwards to an extent that would render their application a matter of difficulty. Hence with teeth which incline inwards, forceps of the form represented in Fig. 237 are found to be more convenient.

In some instances these same forceps may be used for the extraction of the third molars. Generally, however, these teeth are situated so far back in the mouth, and are separated from the corresponding members of the upper series, when the mouth is opened to its fullest extent, by so small an interval, that although a modified instrument may not in all cases be absolutely necessary, it is, at all events, more convenient. An instrument the jaws of which, in addition to standing at a right angle to the handle, are also themselves curved forward (Fig. 239), we have found particularly serviceable, not only in extracting the third, but also the second

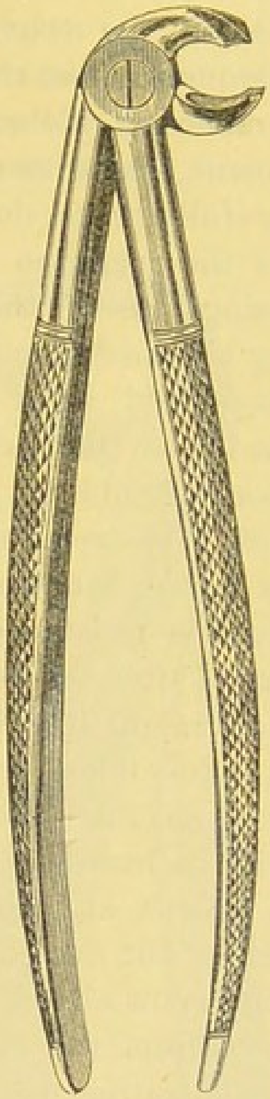


Fig. 239. — Forceps for the removal of second or third lower molars situated in the right side of the mouth.

The jaws of the instrument are placed at a right angle. The jaws themselves are curved in a manner which allows the instrument to be passed to the back part of the mouth, without necessitating a wide separation between the upper and lower teeth.

molar teeth. A right and a left pair will, of course, be required.

A deviation from the normal form is exceptional in any member of the dental series, saving in the dentes sapientiæ. In these teeth the converse holds good, the typical form is more frequently lost than retained.

In removing molars of the mandible, the blades of the instrument, whatever may be its form, should be lightly closed and carefully thrust down to the free edge of the alveoli, which part of the operation is easily effected, in consequence of the decreasing size of the teeth from the crown to the roots. Having obtained firm hold of the neck of the tooth, the first motion should be a little inwards, by which the tooth is detached from the external plate of the alveoli: afterwards the tooth should be drawn outwards and upwards, and so removed. The roots of these teeth, however, not infrequently take a curve backwards; if, therefore, a lower molar offers considerable resistance when its extraction is attempted, the movement after the tooth has been forced laterally should not be in a straight line, but in a curved direction, corresponding to the course taken by the roots.

When an instrument having blades in the same straight line with its handle is used, the operator must stand in front of the patient, and the power will be exercised by rotation of the wrist; but if a hawk's-bill instrument be selected (and this pattern is now almost universally used) the dentist in removing the tooth from the right side of the mouth will stand behind, and in operating upon the left side of the jaw, in front of the patient, or rather on the right, and slightly in advance of the patient. As in this case the handles of the instrument will project horizontally outwards from the left corner of the patient's mouth, the operator must reach across the patient with his arm, and is then, to some slight extent, in a disadvantageous position. Hence some operators, whilst almost invariably using this form of forceps for extracting lower molars on the right side, do not use them on the left side of the mouth. But a very little practice will overcome the difficulty of reaching across the patient, and the position is a far less awkward one than that adopted by some operators, who stand on the left of the chair to remove lower teeth with this form of forceps. This is indeed a disadvantageous position: it is difficult to see where the blades of the forceps are, and the operator is encumbered by his own body being between his operating hand and the patient's mouth. The same remarks apply to the use of the elevator in the lower jaw, it being the constant habit of some operators to stand on the patient's left to remove a left lower tooth. As the handles of the instrument project from the side of the mouth, the power

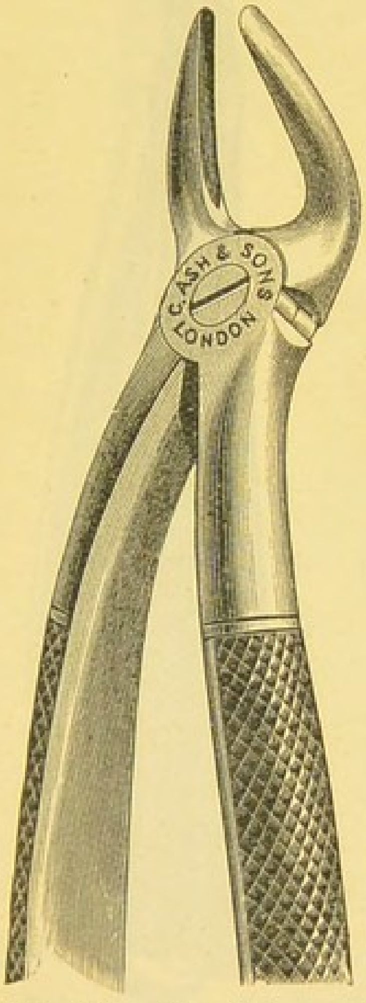


FIG. 240.—Mr. Coleman's pattern for upper stumps and roots.

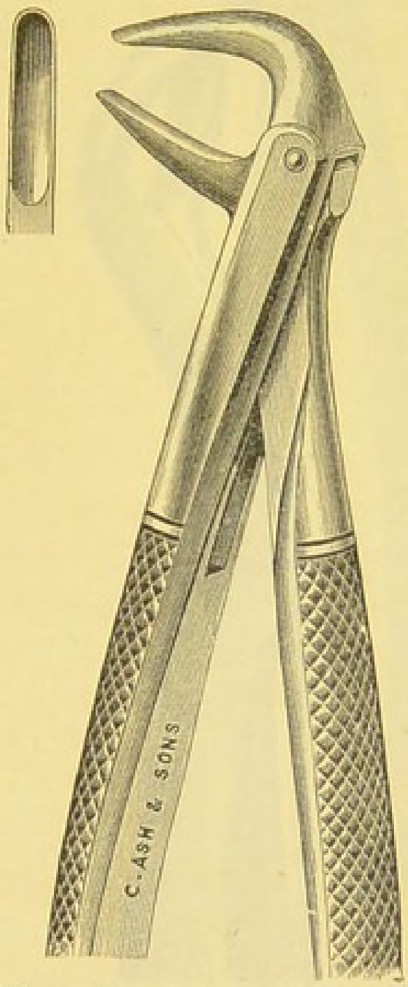


FIG. 241.—Hawk's bill forceps for lower roots and incisors.

employed in the removal of the tooth will be exercised by raising and depressing the hand; but the operator should endeavour to lift the tooth from its socket, and not to simply depress the handle, using the alveolus as his fulcrum to the very last.

These rectangular or hawk's-bill instruments are generally to be preferred. One point in the extraction of lower teeth which is too often neglected is to place the patient low enough relatively to the operator.

Another point of great importance is to firmly support the mandible and to protect the tongue and cheeks; if the tooth to be removed be upon the patient's left, the jaw should be supported by the left thumb placed beneath it, whilst the first

FIG. 242.—Forceps for upper wisdom teeth.

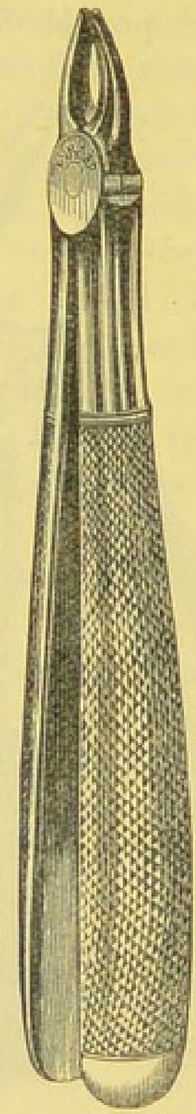


FIG. 243.—Forceps for removing the roots of single-rooted teeth situated in the front part of the upper jaw.

finger rests in the sulcus between the teeth and cheek, and the second finger between the teeth and tongue.

In operating upon patients when under the influence of nitrous oxide, the tongue often rises up and obscures the view of the teeth; but with the hand in the position just described one or two fingers are free for the purpose of depressing the tongue.

Whatever position be selected, the lower jaw must be absolutely under the control of the operator.

In the foregoing description it has been assumed that a

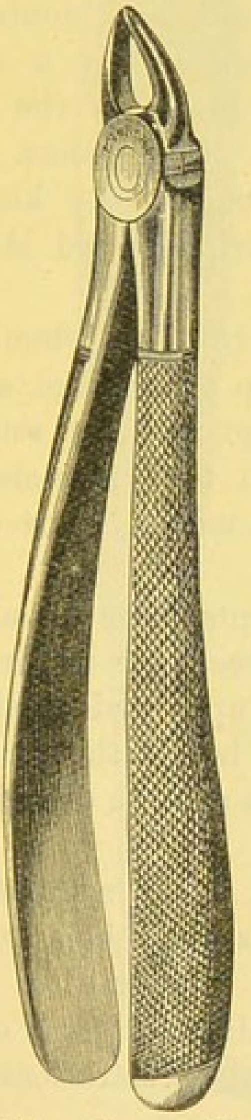


FIG. 244.—Forceps for removing the detached roots of the upper molar or bicuspid teeth. The jaws of the instrument are slightly curved upwards, and the handles in an opposite direction, in order to enable the operator to reach the back part of the mouth.

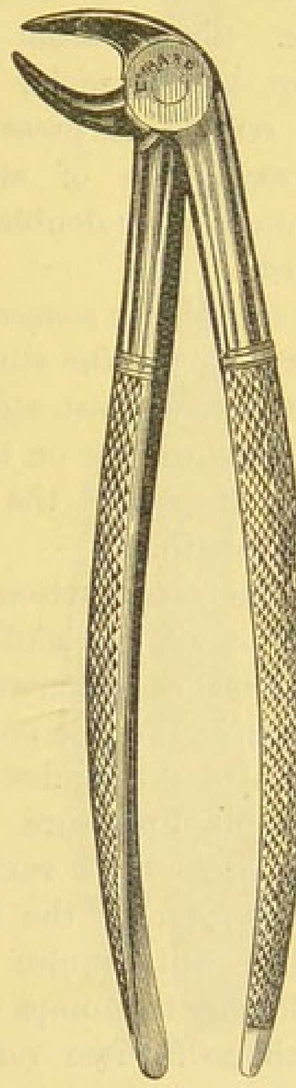


FIG. 245.—Forceps with the jaws bent at right angles, for the removal of the roots of the lower biscuspid teeth. For the extraction of stumps of the lower molar teeth, a considerable advantage will be gained by a slight curve in the blades below the joint, as shown in Fig. 239.

considerable portion of the crown remained, and that the condemned tooth, therefore, could be readily grasped at its neck. It often happens, however, that the tooth has decayed away, or been broken off to a level with or below the edge of the gum; in either case the instruments at present described are inapplicable. Stump-forceps, or the elevator, must be employed to effect the removal of such teeth.

There are two forms of stumps, single, and double or triple. Single-rooted teeth necessarily leave only a single stump, but in molar teeth a sufficient portion of the neck may remain to preserve the connection of the roots. For the extraction of single stumps we require one kind of instrument, for double another, and for triple-rooted stumps a third.

In forceps for removing single stumps the jaws should be grooved to fit the stump, made very sharp at the edge, and of well-tempered cast steel, so that the edge may be renewed from time to time on the oil-stone. When the instrument is closed, they hold the stump, and fit to a material part of its whole length.

In the construction of these instruments, care should be taken to allow a sufficient interval between the upper part of the blades, otherwise they will close upon and crush the exposed and fragile portion of the stump, before the terminal portion of the blades bears upon the part capable of resisting the required pressure.

Although little variety will be required either in the size or in the form of the blades, the relations they hold to the handles will require variation, in order to admit of their application to stumps or roots situated in different parts of the mouth. Of these varieties the succeeding illustrations will afford examples.

The edges of the blades having been rendered moderately sharp, they should be closed lightly upon the stump or root and then forced between it and the edge of the alveolus. In many cases simple pressure will carry the instrument to a sufficient depth, but in others a slight amount of rotation will be found necessary. The root, when embraced at a point capable of resisting pressure, is readily removed. The direction in which the force should be employed in effecting its extraction will be regulated by the shape of the root under operation—a point already discussed in a previous page. Occasionally the margin of the alveolus is so unusually strong that it becomes extremely

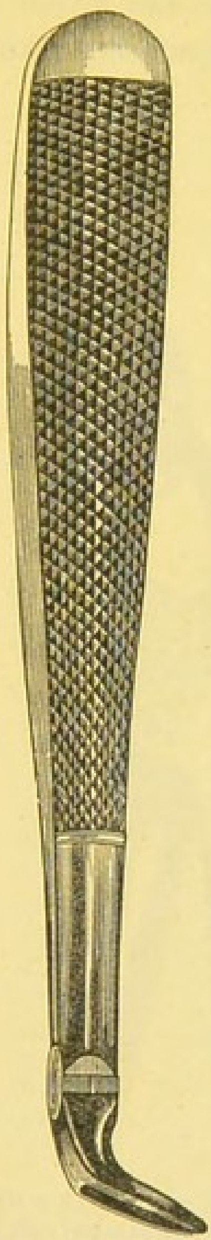


FIG. 246.—Forceps with blades bent at an angle in the same plane as the handles, for the removal of the stumps in the lower jaw.

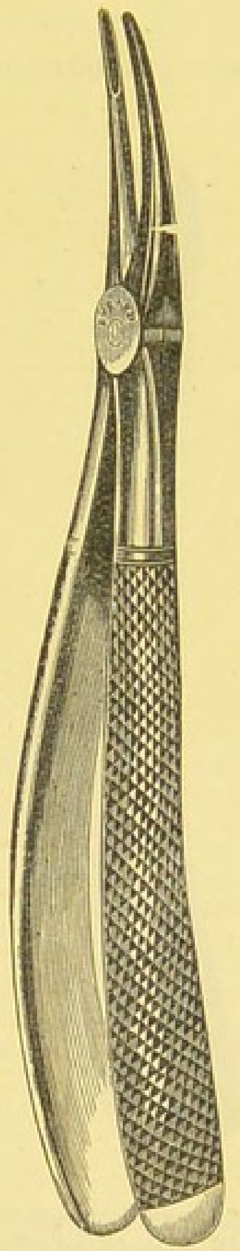


FIG. 247.—Forceps with long slender blades for picking out of the alveoli the loose roots of teeth the crowns of which have previously been removed ; somewhat stronger instruments of this form, or having the blades bent twice, are very valuable for removing upper stumps.

difficult to introduce ordinary stump-forceps, and the difficulty in operating is still further increased when the stump requiring

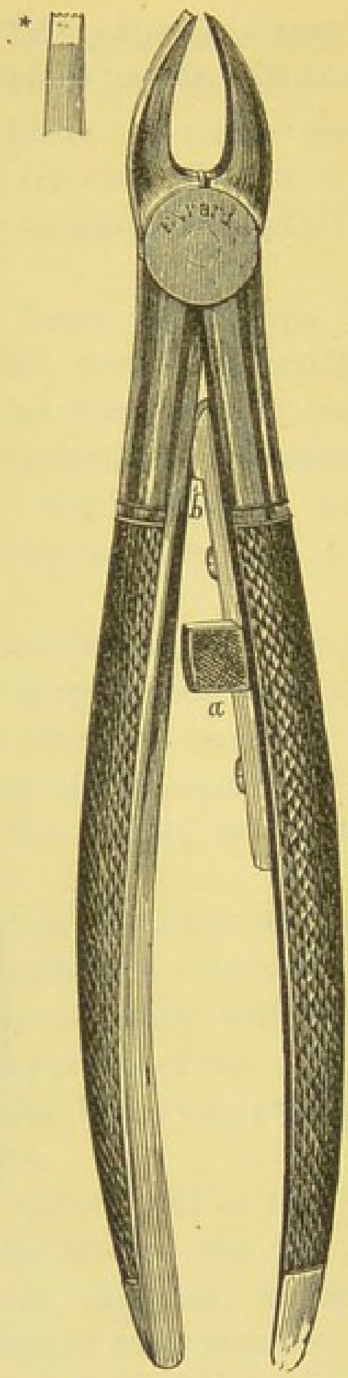
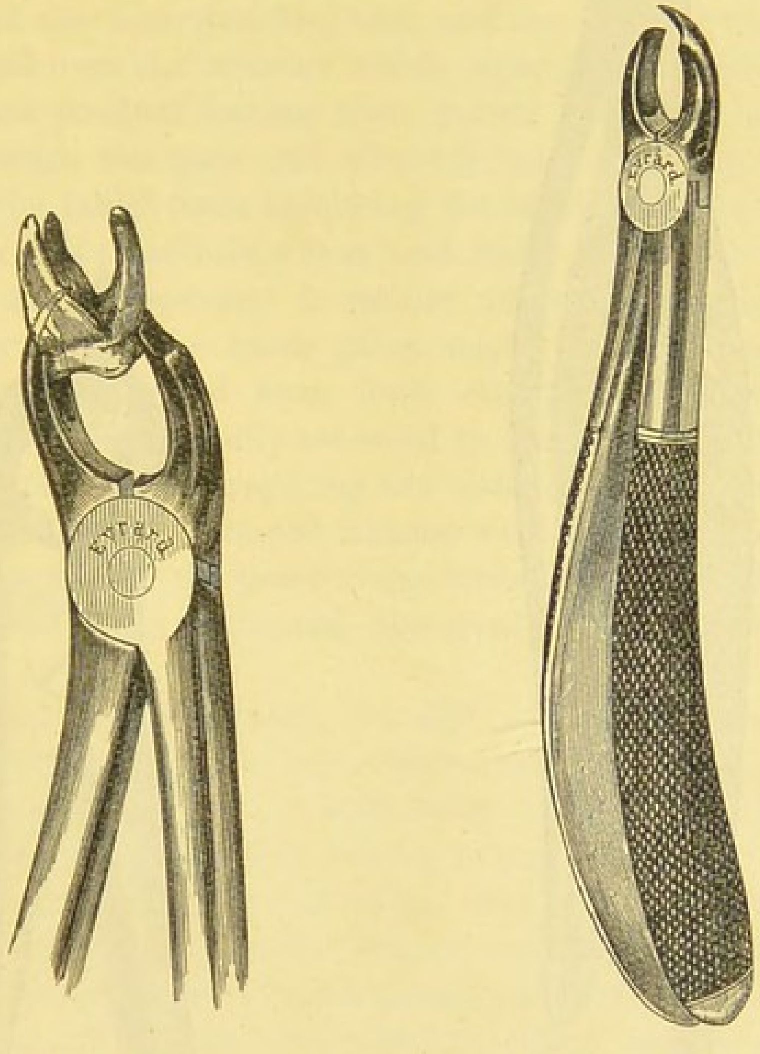


FIG. 248.—Forceps, the edges of the blades of which are cut into teeth like a saw, for the purpose of operating upon roots presenting a conical surface. The instrument is provided with a stop between the handles. The thumb-piece (*a*) is pressed upon and forces the wedge (*b*) forward, and prevents the blades from closing, the sharp edges of which, by rotation, are made to cut their way into the stump, or between the stump and alveolus. When a sufficient depth has been reached to enable the blades of the instrument to take a firm hold, the wedge is withdrawn by the thumb, and the instrument used as an ordinary pair of stump-forceps. I am indebted to Mr. Cattlin, the inventor of the instrument, for this illustration. But these forceps have not proved so useful as was anticipated; there are few teeth which cannot be removed without resorting to such a process.

* Shows the surface of the wedge, which rests against a similarly grooved surface on the handle of the instrument.

removal has been broken off on a level or a little below the terminal edge of the socket. To meet the difficulty, Mr. Cattlin devised an instrument, shown in the accompanying illustration, but the writer has never found occasion to use it.

If, instead of simple or single, we find compound roots—the



FIGS. 249 AND 250.—Forceps for removing upper molar teeth, the crowns of which have been broken off, while the connection between the three roots has been preserved. The peculiarity of the instrument consists in the production of a tapered prolongation of the outer jaw, capable of passing between the labial roots of the tooth. In the first figure the jaws are shown embracing a crownless tooth; in the second the instrument only is shown.

roots of molar teeth united by the presence of a portion of the neck of the tooth—an advantage will be gained by adopting a form of instrument different from any at present described. For removing the compound roots of an upper molar, an instrument will be required similar, as respects its general form, to that

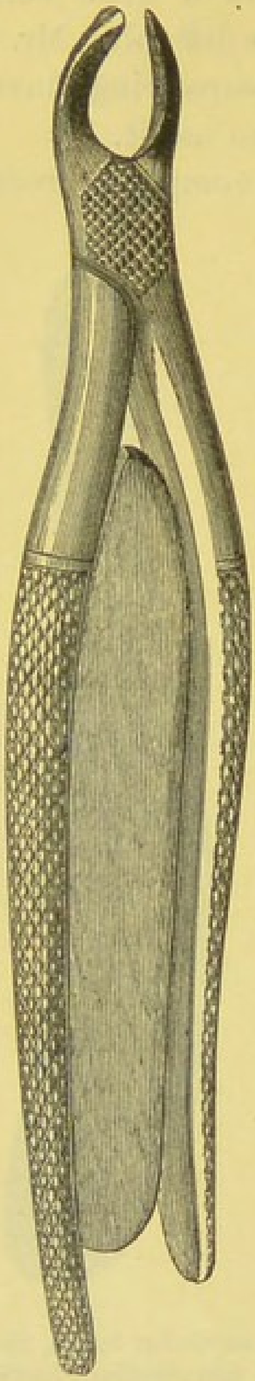


FIG. 251.—Stump forceps, the outer blade of which terminates in a sharp point, like the elevator figured on p. 577.

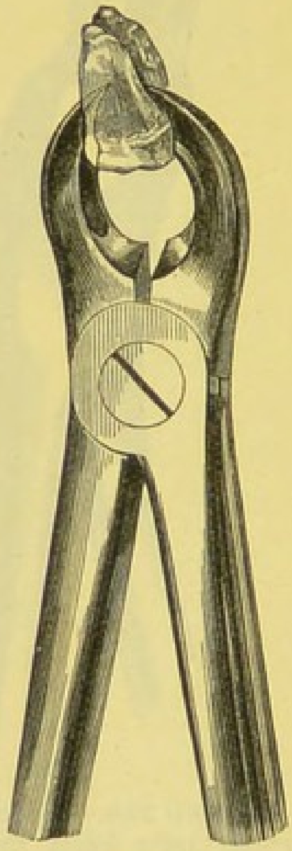


FIG. 252.—Forceps for removing lower molar teeth, the crowns of which have been broken off through the lower portion of the neck, leaving the two roots firmly connected. The blades are lengthened into points, which converge and pass between the roots of the tooth.

which would be used for the extraction of the tooth, but with the outer or labial blade prolonged into a sharp point.

The palatine blade has, at the suggestion of Mr. Coleman, undergone a slight modification. The terminal portion is somewhat reduced in thickness, and turned a little outwards in a direction corresponding to the course taken by the root of the tooth as it enters the alveolus.

In operating, the palatal blade must be pressed into the alveolus of the corresponding root, and the point of the labial blade placed over the interval which separates the two labial roots. This position having been gained, the point must be driven through the gum and alveolus into the space which separates the labial roots by closing the handles of the instrument. By this procedure a firm hold upon the triple root is obtained, and its removal is readily effected, unless the connecting portion of the tooth gives way. In that event the roots become separated from each other, loosened in their socket, and are then readily removed by a more simple form of stump-forceps. Before applying the instrument, it is desirable to make an inverted V-shaped incision over the labial roots of the tooth, to receive the point of the labial blade of the forceps. If this precaution be neglected, the gum may be torn needlessly.

But although such forceps, as well as the corresponding pattern which is made for lower teeth, and which cuts its way through gum and alveolus on both sides, are perfectly efficient in getting the tooth out, their use is to be deprecated except in cases of most extreme difficulty. For the bone and the gum, more crushed than really cut, do not heal readily, and the patient is likely to have much subsequent pain; the alveolar bone is not at all tolerant of this sort of injury, and is apt to inflame when subjected to it.

The forceps which the author greatly prefers to any others are represented in the preceding figure (Fig. 251); the outer blade ends in a point like that of a spear-pointed elevator, and is kept thoroughly sharp; it was the intention when the forceps were constructed to use this blade as an elevator to split the roots, but in practice it is found to be so efficient used otherwise, that one blade need not be employed alone.

The sharp point is placed at the middle of the labial margin of the root, and when forced up, which it always can be, it passes somewhat between the labial roots. If the roots are so far separated that they cannot be brought out together, it separates them very completely, but more commonly it brings out two, or all three, and it very rarely fails to bring out any at all.

Other methods of extracting an upper molar stump may be resorted to ; one, which is very often successful in bringing away all three roots together, is to apply forceps of the forms represented in Figs. 240, 243 to the palatine and anterior buccal roots, with a view to extracting these together, and leaving the posterior buccal to be dealt with separately. Another method is to separate the three roots by forcing a sharp spear-pointed elevator (see Fig. 254) into the centre of the stump, and thus splitting it, when the separated roots can be individually removed without difficulty. A pair of cutting-forceps intended to effect this object has been designed by Mr. Harding, in which the external blade is replaced by a vertical cutting edge, and quite a variety of forms have been devised to meet the difficulty of dealing with broken-down upper molar teeth. But the nerve in such teeth is almost invariably dead ; and the operation may generally, if it appears unlikely that the roots can be extracted together, be done far more neatly by employing a sharp spear head in the engine to cut the roots apart. It is not necessary to absolutely complete their severance, as the stump-forceps, with which the several roots are grasped, will do this if the union between them be greatly weakened.

The double root, which remains after the crown of a first or second molar of the lower jaw has been reduced to the level of the gum, may be removed by an instrument constructed upon similar principles to that which is used in extracting the triple roots of the corresponding upper teeth, differing, however, in having each blade terminated by a point. The points are destined to pass between the roots of the stumps ; and when a sufficient portion of the neck of the tooth remains to act as a guide, they may be forced into that position without passing through the labial and lingual plates of the alveolus. The occasional irregularity in the disposition of the roots, more especially of the second molar, must in this, as in all operations upon the teeth, be borne in mind.

The most generally useful instrument for extracting the roots of teeth has yet to be mentioned. There is scarcely a root, or even a tooth, which cannot be removed by the elevator. The instrument consists of a blade terminated by a spear head, or other selected form, and a stout shaft mounted in a strong handle. The minor modifications to which this instrument has been subjected in order to meet the exigences of a particular case or the views of the operator are endless. Fig. 254 shows one of the more useful forms of the instrument. Independently of the form, the following conditions should be observed in constructing the instrument. The blade and shaft must be made of good steel, and reduced to a spring temper. The handle should be full and strong, and the whole instrument sufficiently stout to bear, without bending or springing, any force the operator may employ.

In operating, an elevator may be employed as a simple lever. The edge of the blade having been made sharp, it is thrust down between the root of the tooth and its alveolus; the handle is then depressed with a slight rotary movement, and if the motion be judiciously directed, the round part or back of the blade will rest upon the margin of the socket, while the edge of the blade cuts into and takes a hold in the surface of the root. It cannot be too strongly insisted upon that the edges of the elevator should be sharp: as sharp as an enamel chisel, so that it fairly cuts into the root and gets a good grip of it. The instrument becomes a lever of the most simple kind, the short end of which takes its bearing on the tooth; the alveolar processes, or perhaps the neck of a contiguous tooth, form the fulcrum, and the long end of the lever is in the hand of the operator. By the depression of the handle the tooth is raised in its socket; but simple depression will not in all cases be sufficient to secure the full effect. A slight degree of rotation of the instrument is generally necessary, otherwise the edge of the instrument, instead of entering, may slip over the surface of the tooth. Many teeth, more especially the lower wisdom-teeth, may be forced or prized out of their

FIG. 253.—Right lower wisdom tooth. The nodule at end of roots formed a distinct hook. The tooth was an extremely difficult one to remove.

sockets by a single effort, but the second or even the third application of the instrument may be required. A tooth may be so placed with respect to the jaw or the neighbouring teeth, that, after it has been moved in its socket, a change in the direction of the force becomes necessary in order to complete the operation without inflicting needless injury on the adjoining parts.

An elevator may, however, be used otherwise than as a lever. A root, the implantation of which is not very firm, may be forced out by pressing the point of the instrument against it, the direction of the force being such as will favour its escape from the socket. If, for example, the root of a bicuspid on the right side of the upper jaw requires removal, the operation may be performed in the following manner :—Let the patient's head be well thrown back, and placed immediately in front of the operator. The upper lip may be raised by the forefinger of the left hand. The point of the elevator should be passed upwards between the gum and the tooth until a sound portion of the root is reached. At this point the extremity of the instrument should be pressed into the root sufficiently to take a firm bearing, and the handle of the elevator at the same time brought up to the side of the cheek. When this position is gained the offending root may be pushed out of its socket. A thin-edged grooved elevator is useful for removing the broken apex of a single-rooted tooth ; the point is placed between the edge of the root and its socket, and pressure applied. This procedure frequently succeeds in detaching the remnant of a root otherwise extremely difficult to remove.

Although the instrument under consideration admits of being used upon either of the foregoing principles, it would be found very inconvenient in the treatment of a case to insist upon the adoption of one method to the exclusion of the other. Not uncommonly the operation may with advantage be commenced by using the elevator as a simple lever, and completed by using it for pushing the loosened tooth out of its socket.

Whenever the elevator is employed, the forefinger of the operator's hand should lie along the shaft, and the point of the elevator should not reach more than three-quarters of an inch beyond the tip of the forefinger. If any slip should occur, the instrument is well under control, and those lacerations of the gum, or even the cheeks and tongue, that happen when this precaution is neglected are obviated.

It is undesirable to use the elevator for the extraction of upper wisdom-teeth which occupy their normal position, as from the direction in which the force is applied the tuberosity may readily be broken off.

Teeth may often be advantageously removed by combining the use of the elevator and the forceps, using the first-named instrument for raising up and loosening the roots, and forceps to complete the extraction.

The roots of lower molars may often be removed by inserting the point of an elevator behind the posterior root and prising it up from its socket: the removal of the anterior root will then be easy; or if the anterior root be first removed, the posterior may be very easily reached by inserting the elevator into the vacant anterior socket and thrusting it boldly through the septum, so that its point catches the posterior root quite low down. Elevators, with the blade set at an obtuse angle with the shaft and curved either backwards or forwards, are specially made for the removal of a remaining posterior or anterior root of a lower molar tooth (Fig. 255).

Elevators as generally sold by the instrument makers are far too large and clumsy: the great size of the points renders very great force necessary to make the instrument enter the socket, and needless pain is inflicted on the patient.

The spear-pointed elevator represented in the accompanying figure is by far the most generally useful form, and is quite large enough for any purpose. Sometimes, however, owing to the inability of the patient to open the mouth widely, it may be difficult or impossible to reach a lower wisdom tooth with a straight instrument. For such cases a very useful form is sold, the blade of which is shaped like a single jaw of a pair of thin and sharp stump-forceps; this blade is inclined to the shaft at an angle somewhat greater than a right angle, so that it can be applied without necessitating the mouth being very widely opened.

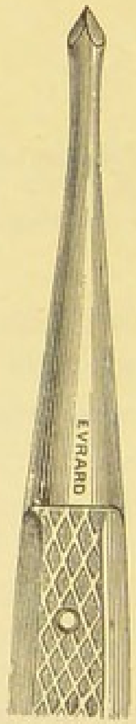
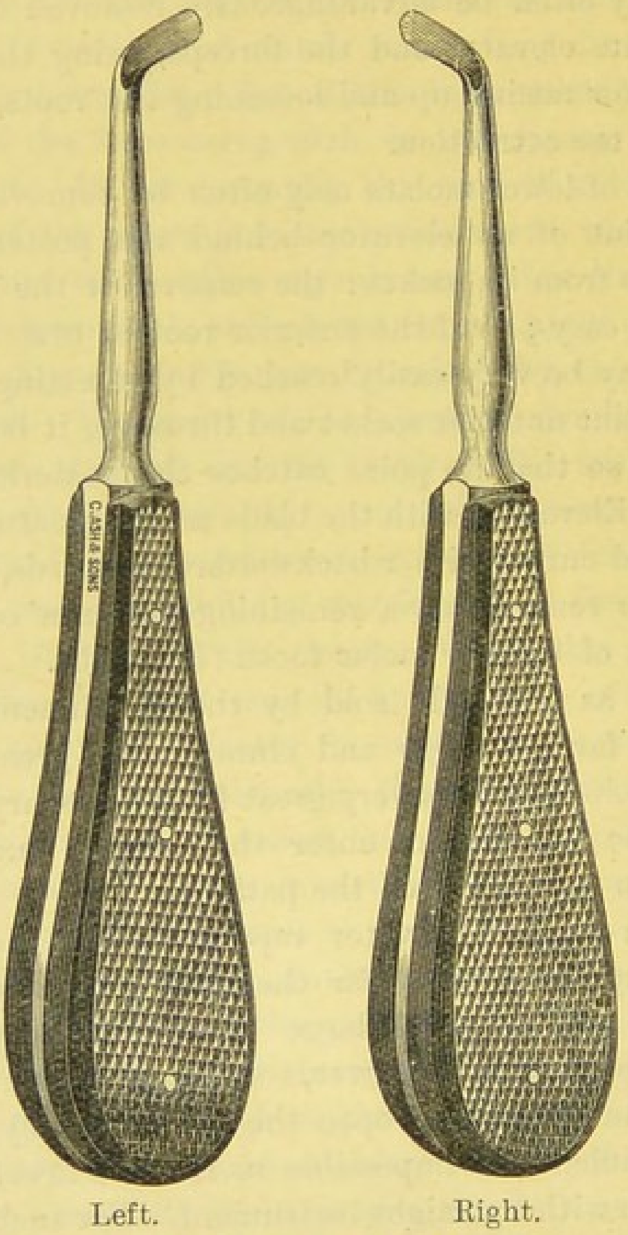


FIG. 254.

Somehow or other a great clumsy elevator, such as has never been used either by Sir John Tomes or Mr. C. S. Tomes, has come to pass under the name of "Tomes' elevator," within the last few years. We have rarely had occasion to use any other form than the one here figured.

The practitioner, it is presumed, will be well acquainted with



Left. Right.

FIG. 255.—Curved elevators.

the normal forms of each member of the dental series, but the normal character of the crown does not necessitate a similar condition of the root of a tooth, and the irregularity is discovered only when the operation of extraction is attempted.

It is not unusual for the roots of the inferior molars to be curved backwards, and now and then the curve is produced into a positive hook (Fig. 256).

Had the extraction of either the first or second molars shown in the accompanying illustration been attempted, either the ends of the roots would have been left in the jaw or a large piece of the alveolus brought away with the tooth. The former accident would probably have occurred, the tooth, to use a patient's words, would have broken in the jaw.

The question as to what shall be done with the roots of such a tooth, when broken in the jaw, is at once raised. We

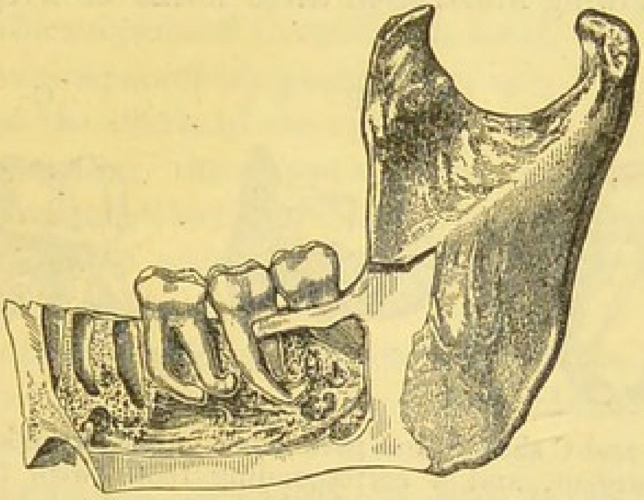


FIG. 256.—A lower jaw, the external portion of which has been removed, so as to show the position of the roots of the molar teeth, which in this example are curved backwards, with the points turned upwards.

invariably allow the extremity, or even the lower third, to remain, unless it is clearly the subject of disease. If it be loose, its removal is readily effected, and should it have been connected with an alveolar abscess, its removal will not be attended with difficulty. The digging out—if the expression be allowed—of the terminal third of a sound and firmly-attached root is productive of great pain and a considerable amount of injury to the alveolus; but the presence of the end of root, if undisturbed, is very rarely indeed followed by any inconvenience.

In the example figured, the roots of the teeth, though curved, are comparatively small, and might probably give way under a force which would not strike the operator as being greater than that required to effect the dislocation of firmly-implanted teeth. But it occasionally happens, from some unseen cause, that a tooth for a time remains unmoved, although a force more than sufficient to remove an ordinary tooth has been employed.

It is when placed under this difficulty that the knowledge and skill of the operator are put to the test. The roots of the tooth may be curved, or they may be unusual in size or number, and the tact to recognise the direction in which the resistance lies, and the knowledge of the irregularities of form to which the several roots of the teeth are liable, become highly valuable.

In the following illustration three forms of irregularity are

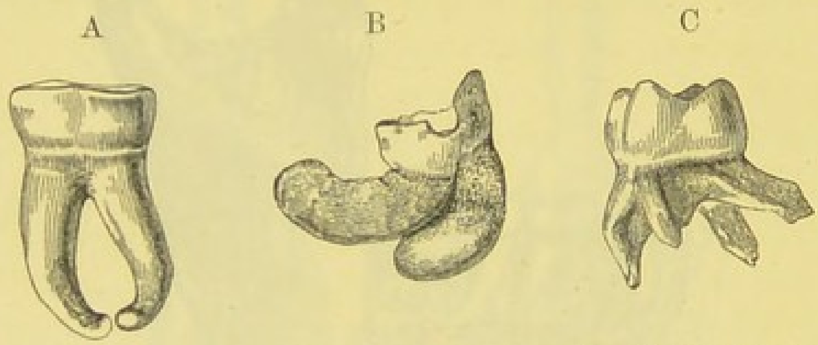


FIG. 257.—A and C show a first permanent molar of the lower jaw with roots convergent, and a corresponding tooth with four divergent roots. B, a wisdom-tooth, with the roots curved backwards, and thickened by hypersophy of the cementum.

shown. The tooth with the convergent and that with the four divergent roots would be removed by force employed in the usual direction. In the one case the operation would result in the fracture of one or both roots, or the withdrawal of the portion of the alveolus enclosed by their convergence; in the other, in the fracture of one or more roots, or perhaps in the removal of a portion of the labial or lingual wall of the alveolus. But if a similar course were pursued with the wisdom-tooth, it would break off at the neck, or the tooth would effectually resist the efforts of the operator. With the forceps it would be very difficult to extract such a tooth, but by adopting the elevator the tooth could be gradually prised out of its socket without difficulty.

In operating upon teeth in the upper jaw, similar difficulties may arise. An unusual size of the one, or the occurrence of several roots, even in a bicuspid tooth, will sometimes embarrass the operator, by raising a doubt as to whether the tooth will give way under the force he is employing. Similar difficulties, consequent upon similar causes, will arise with respect to the molar teeth of the upper jaw, when the application of the usual force is not attended with the usual result.

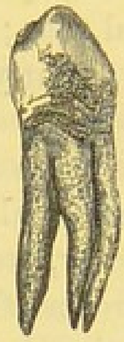


FIG. 258.- Shows a first bicuspid of the upper jaw with three distinct roots.

The remedy will consist in steadily increasing the force and varying its direction—feeling our way, as it were—until the tooth is separated from its socket.

The wisdom-teeth of the upper jaw, though frequently the subjects of irregularity, being implanted in comparatively porous bone, very seldom resist the efforts of the operator.

When extracting these teeth under an anæsthetic care must be taken that the mouth is not propped too widely open, lest difficulty be found in applying the forceps.

The irregularities of form to which the teeth are liable having been described in a preceding part of this volume, need not be again particularised.

The malformation described by Mr. Booth Pearsall as

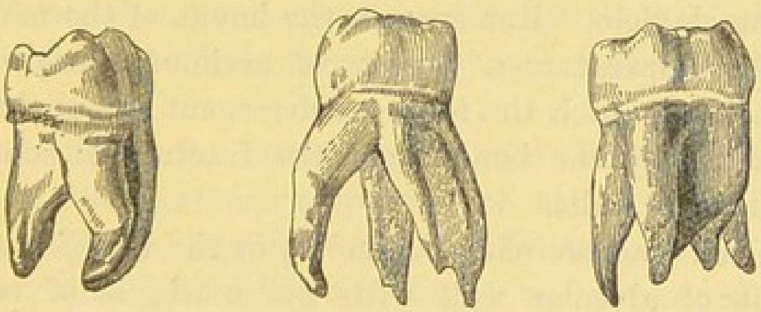


FIG 259.

"oblique-rooted upper molar" may lead to difficulty in extraction of these teeth. In these teeth the two buccal roots do not stand upon the same plane, but the posterior root lies much inside its normal position. Hence the ordinary upper molar forceps will fail to touch it at all, and will not take a good grip of the anterior. If the malformation, which is not accompanied by any unusual shape of the crown, be recognised beforehand, the tooth can easily be removed by employing a pair of upper bicuspid forceps, and taking hold of the palatine and anterior buccal roots.

Not infrequently the palatine root will be found blended with the posterior buccal, and occasionally with the anterior buccal root; the roots thus joined are usually broad, grooved, and slightly curved, and offer considerable resistance to removal.

Owing to an unusual thickness and strength in the alveolus, the removal of a tooth is sometimes attended with unusual difficulty, and the operator is still further embarrassed when the crown of the tooth so circumstanced is broken off on a level with the alveolar margin. Generally the stump-forceps or the elevator may be made to enter the alveolus, but exceptional cases may arise. To meet these, Mr. Cattlin proposes to cut away with a small trephine a portion of the outer plate of the alveolus. The root is then readily dislodged, but we have never had need of such a proceeding.

Mention has already been made of a case in which the greater part of the floor of the antrum was torn away by a blacksmith in the endeavour to extract an upper molar, and of another in which a large portion of the external alveolar plate was broken off the lower jaw with a key instrument, the fragment descending the neck in a series of sinuses, and finally being removed below the clavicle. But even in the hands of the most careful and skilled operators a variety of accidents may occur. A molar tooth of which the roots are divergent can obviously only be extracted by the bending or the fracture of some portion of the alveolar walls.

A limited fracture of the alveolus, or the bringing away of a fragment of alveolar wall with the tooth, is of very small moment in a healthy subject, seeing that this alveolar border has to be subsequently removed by absorption. In some instances, however, the adhesion of the tooth to the bone is so firm that a large portion of that surrounding the roots is torn away. In two recent instances the tuberosity of the upper maxilla was brought away in the extraction (with forceps) of the wisdom-tooth; on examining afterwards, it was found that the bone was so strongly adherent to the roots that it could only be detached in small fragments. It was to this cause, and not to the shape of the roots, that this mishap was due.

The late Mr. Storer Bennett recorded a case (Trans. Odont. Soc.) where extreme difficulty in extraction was due to the anchylosis of the roots of a tooth to the surrounding bone. Such a condition is extremely rare, but there can be no doubt of its occasional occurrence.

An almost unique example of the roots of teeth being attached to a bone-like tumour was shown and described before the Odontological Society in May, 1905, by Mr. John Murray, who removed the mass at the Middlesex Hospital. In this case both roots of the second left lower molar and the anterior root of the wisdom-tooth were imbedded and intimately blended with a bony growth the size of a large walnut. This growth was of a peculiar structure, resembling bone, but considered by some to be of the nature of a cementoma. (*Cf.* p. 736.)

Mr. Salter[1] records a case where, in the endeavour to extract an upper central incisor, the bone was fractured along a line corresponding to that which separates the intermaxillary from the maxillary bones in the palate, and along a horizontal line at the base of the nose. There was a wound in the palate, from which there was some little hæmorrhage. Happily, however, no untoward result followed; the fractured bone speedily united, and the tooth was cut off level with the gum, so as to enable the patient to wear an artificial substitute.

Mr. Salter also mentions an instance of the horizontal ramus being entirely broken through by an operator of skill and experience.

A patient under treatment at the Dental Hospital presented a very extensive fracture of the alveolar portion of the jaw. He had applied to a chemist to have the first lower molar on the right side removed, in an unsuccessful attempt to remove which tooth with forceps the fracture occurred. The line of fracture had run forwards at a level corresponding to the apices of the roots of the teeth, so that the portion of bone containing the premolars, the canine, and the central and lateral incisors was detached, and only held in position by the soft parts.

[1] British Journal of Dental Science, vol. xiv., p. 160

A gutta percha cap was adapted to the crowns of the teeth all round the lower jaw, so as to keep the fractured bone in its place, and every attention was paid to the thorough cleansing of the wounds with injections of diluted Condy's fluid (the fracture being, as is usual in fracture of the jaw, compound in the mouth). Nevertheless, extensive necrosis supervened, and abscesses formed beneath the jaw, so that there seemed but little hope of saving the teeth. The patient was eventually lost sight of, and we do not know what was the termination of the case.

FIG. 260.

But the most severe accident is recorded by Mr. Cattlin[1] in the following words: "The gentleman who operated in this case had the misfortune to break off the crown of the tooth, and in endeavouring to extract the root with the elevator, the instrument slipped and broke away the tuberosity of the maxilla, with a part of the floor of the antrum, and a portion of the sphenoid bone. In the efforts which were afterwards made to remove the fractured portion of the bone with a pair of stump-forceps, the tooth and the hamular process were also separated, and fibres of the external and internal pterygoid muscles were torn away, and may be seen in the specimen attached to the pterygoid plates. The ultimate results of this accident were that the patient, after suffering in health for some time, became perfectly deaf on the injured side, and the movements of the jaw were permanently restricted. The inflammation had undoubtedly extended into the eustachian tube, and had also involved the ligaments and muscles attached to the inferior maxilla."

It has not been deemed necessary to enter specially upon the **extraction of temporary teeth,** but a complication sometimes arises to which attention may with advantage be directed. It has happened on two occasions which have come under our notice that in extracting a second temporary molar of the lower jaw the permanent successor has come away, embraced by the roots of the temporary tooth. In each instance the gum had been inflamed as a result of disease set up in the pulp of the temporary tooth, and it is probable that the alveolar

[1] Transactions of the Odontological Society, New Series, vol. iii., p. 138.

processes had in each case also been greatly reduced, if not altogether removed, by absorption. It is well to bear in mind that such an untoward accident may happen when the gum and alveolar periosteum have been for some time inflamed, but we do not know that any precautionary measures can be adopted.

Temporary teeth are, as noted by Mr. Salter (*loc. cit.*), sometimes united to one another by fibrous tissue around their necks; but the removal of more than one tooth in this way is a matter of no practical moment, as it could only occur where the roots were for the most part already absorbed.

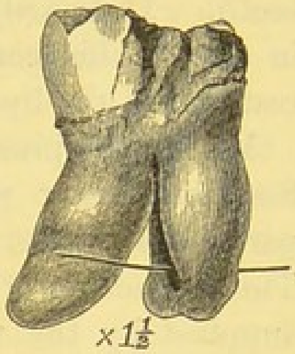


FIG. 261. — Lower wisdom-tooth (Mr. Sewill's case). The bristle passes through a hole in the anterior and a groove in the posterior root, occupied by the inferior dental nerve and vessels.

It often happens, when the crown of a tooth has been long lost, that the teeth on either side of it overhang the space, and numerous instances have occurred of a sound tooth (most generally a bicuspid) being unintentionally forced out of its socket during the removal of the stump. Where this seems likely to happen, the finger or thumb should be firmly pressed on the imperilled tooth, and the stump withdrawn from whichever side affords the best prospect of avoiding the other tooth.

The passage of a tooth-root into the antrum during an attempt at its extraction has already been noticed (see Diseases of the Antrum). A precisely similar accident, where, however, the tooth-root escaped into an abscess-cavity in the bone, instead of into the antrum, has been recorded by Mr. Salter in the paper already several times alluded to. In the event of either of these accidents happening, the root should be sought for and removed, bearing in mind, however, that if the opening be large, it is likely to gravitate towards the opening of itself, so that its removal becomes easy.

In the Dental Cosmos, 1877, is related a case of disappearance of a lower wisdom-tooth during an attempt at extraction. It is probable that it tore up the mucous membrane, which is loose on the inner side of the jaw in this region, and lay between it and the bone. At all events, eleven months later it was removed from this region, having set up profuse and long-continued suppuration between the jaw and the base of the tongue. In this article reference is given to a similar case reported in the Detroit Review of Medicine, 1876.

Mr. Salter gives examples of loss of sensation in the regions supplied by the inferior maxillary nerve, consequent on the bruising of this nerve in difficult extractions of the wisdom-teeth. Ordinarily this numbness passes off in a few days, but in one of his cases normal sensation has never been quite restored to the lip and chin.

Mr. Sewill presented to the Museum of the Odontological Society a lower wisdom-tooth one root of which is actually perforated, whilst the other presents a groove upon its side. The extraction of this tooth resulted in paralysis of the area supplied by the mental nerve, which is a pretty conclusive proof that the inferior dental nerve passed through the hole.

We have met with deep grooves in a similar position in a tooth, the extraction of which gave rise to marked numbness. It would appear that the normal procedure for a lower molar root, which is approaching the roof of the inferior dental canal, is to turn horizontally backwards, thus avoiding it (see Fig. 256), but that it sometimes may go on growing till it passes it on one side, or may even come to embrace it, as in Mr. Sewill's case. As a rule, sensation slowly returns to the area affected, as indeed it often does when it is not wanted to, where the nerve has been intentionally divided in cases of neuralgia.

A remarkable case of dilatation of the pupil and impairment of vision, following the extraction of an upper bicuspid, has been recorded by Tierlink: the symptoms disappeared after application of extract of opium in the socket.

Fatal syncope has been known to follow upon the extraction of a tooth. At Marseilles, in 1881, the extraction of a woman's tooth was attempted, but desisted from on account of alarming syncope; a second attempt was made, or, more strictly, was about to be made, as fatal syncope ensued before it was actually touched. The necropsy revealed nothing, save a slight degree of cerebral congestion.

A case of fatal syncope in the dental chair from apprehension, nothing whatever having been done, has also been recorded.

In conclusion, it must be added that some degree of ostitis may follow upon an extraction, however skilfully performed; and it is, as has already been mentioned, much more likely to happen when much injury is done to the alveolar bone, which appears to have very little recuperative power.

When teeth have to be extracted, there is very commonly some degree of inflammation existing about them, and, instead of quieting down, this may run on to the exfoliation of small fragments. Treatment consists of keeping the socket and mouth as clean as possible.

For this purpose a simple antiseptic mouth wash should be frequently used, such as "Sanitas" or Condy in weak solutions; the following is a prescription of a useful mouth wash in these cases:

℞. Acidi carbol pur., ℈iv.
Liquor potassæ, ʒvi.
Aquam ad ℥iv.
M. ft. lotio. The mouth wash.

Sig.—Add one teaspoonful to half a tumblerful of warm water, and rinse the mouth every three hours.

If necessary the patient should attend daily to have the inflamed socket carefully syringed. A little finely powdered sulphate of copper, silver nitrate, or strong carbolic carefully applied on a pledget of wool will be of service in shortening the duration of the pain and inflammation. Should the pain be unusually severe, opiate fomentations may give relief, or cocaine may be applied.

The operation of tooth extraction is so rarely followed by any untoward results, that it is apt to be conceived that when they do arise it is due to the fault of the operator, and from time to time groundless actions have been brought against dentists. We are acquainted with one instance in which a gratuitous patient, having suffered from some exfoliation after the extraction of an inflamed tooth, threatened an action, and the operator, to save trouble and expense, actually paid him some compensation. In other cases, actions have been brought by impecunious litigants, who, after losing their cases and costs, had not the wherewithal to pay the costs, and so the dentist was left at considerable expense, though he had fully established that he was blameless.

In the case of one patient, a delicate lady, inflammation and slight exfoliation have repeatedly followed the extraction even of loose teeth, in spite of every antiseptic precaution having, in view of previous experiences, been adopted.

All instruments should be sterilised and kept scrupulously clean; in addition it is our habit to wipe the jaws of forceps or the points of elevators with strong carbolic acid immediately before the operation; the excess is wiped off, but some left. This does no harm to the gum, but of course it is then necessary to be careful not to touch the patient's lips with the instrument.

The tongue may be wounded; if so, its treatment should be conducted on general principles, and hæmorrhage may usually be checked by pulling it forcibly forwards, so that its own longitudinal muscular fibres may make pressure on the vessels, which run parallel with them. If an artery of any size be wounded (sometimes the ranine artery has been wounded), it may be twisted.

HÆMORRHAGE FOLLOWING EXTRACTION.

Hæmorrhage from the Alveoli.—Ordinarily blood ceases to escape from the socket within half an hour of the removal of the tooth; but isolated instances, in which the bleeding has ceased only with the life of the patient, have been at long intervals recorded; and cases in which the flow of blood has been checked with considerable difficulty, and only after the patient has been greatly collapsed, though not common, are by no means rare.

Before proceeding further in the description it may be useful to inquire under what condition these untoward consequences follow upon a very simple and, under ordinary circumstances, a very safe operation.

When from an insignificant wound the blood flows for a longer time and in a larger stream than the nature of the injury would lead the surgeon to expect, a state of system is denoted which may be a permanent character peculiar to the individual, or may arise from a temporary condition of the circulating fluids, or from the condition of the blood-vessels themselves. The pathology of the hæmorrhagic diathesis is, however, far from being understood,[1] want of coagulability in the blood and want of contractility in the vessels being almost all that we can predicate of it. There are those who have at all times difficulty in arresting bleeding even from a slight wound, and in them prolonged hæmorrhage usually follows the extraction of a tooth. A patient under personal observation suffered considerable inconvenience from a very loose lower bicuspid tooth, but dreaded its removal in consequence of the difficulty he suffered in controlling the hæmorrhage which had on previous occasions followed the

[1] See Mr. F. Mason, in Monthly Review of Dental Surgery, August, 1872.

extraction of teeth. The loose bicuspid was, however, removed, and the blood ceased to flow from the socket within half an hour. The patient returned home, but before he had reached the end of a short railway journey bleeding from the socket had recommenced, and many hours elapsed before the hæmorrhage was perfectly arrested. The hæmorrhagic diathesis was in this case fully pronounced, and was independent of the casual general health. The condition of the vessels or of the blood must have been different from that which usually exists in a perfectly healthy individual, but the difference was not sufficient to interfere with the general health of the patient.

In some persons the disposition to profuse bleeding occurs only at a comparatively advanced period of life; the fault then lies in the vessels themselves, the coats of which become stiffened by the presence of a deposit within their substance, and they consequently lose the power of contraction. In other examples the hæmorrhagic tendency depends upon an abnormal state of the blood—upon the presence of blood disease, as certain maladies are called.

Sea scurvy and purpura afford the most striking examples of such diseases, one peculiar feature of which is the loss of coagulating power in the blood.

In such cases hæmorrhage may occur without there being any wound at all, blood being poured out from a mucous surface, *i.e.*, from the lungs, the bowels, the fauces, the tongue, or the gums. Dr. Hyde Salter met with a case in which the patient's life was greatly imperilled by loss of blood, the chief point of hæmorrhage being the gums between the lower bicuspids, from which place blood had welled up almost without cessation for upwards of a month. After the failure of other remedies, it was finally arrested by the application of a spring clip, which had to be removed after about twelve hours on account of the pain which it caused; however, the inflammatory swelling which it had set up seemed so to have altered the vascular condition of the parts that the bleeding did not recur.

In a healthy subject the division of blood-vessels of moderate size is followed by contraction of their divided ends, and by the coagulation of the blood. By the concurrence of these changes, the escape of blood is arrested. But when the vessels have lost the normal power of contraction, or the blood its capability of coagulation, the bleeding, even from the removal of a tooth, may seriously endanger the life of the patient.

In patients of hæmorrhagic diathesis, the extraction of teeth, and indeed other operations which involve the injury of soft parts, should be avoided, unless the circumstances of the case render them absolutely necessary. But in the practice of dental surgery the existence of this state of system sometimes is learnt only by the occurrence of prolonged bleeding from the alveolus, or from the statement of the patient after the tooth has been extracted.

Sir Benjamin Richardson has pointed out (Trans. Odont. Soc., 1890) that the hæmorrhagic diathesis is much less common than it was formerly. He holds that there are two conditions which favour hæmorrhage—the too great fluidity of the blood, and the want of contractility in the vessels.

Thus in a case of purpura he found that the specific gravity of the blood was only 1035,[1] or only 15 above the urine of the same patient; the water was 860 parts in 1,000, the blood did not clot, and the corpuscles were large and pale.

The eruption in purpura is induced by very slight causes—cold, heat, bruises, etc.; in one case death ensued in three weeks after the extraction of a tooth, hæmorrhage having gone on more or less the whole time, and the gums being very turgid and purple, almost concealing the teeth. In almost all such persons there is a family history of other cases.

A form of purpura has sometimes been induced by chloral, apparently caused by an excess of salts in the blood.

Treatment.—In the cases of alveolar hæmorrhage which have come under our own care, the bleeding has been speedily arrested by matico. After clearing away the coagulated blood, a leaf of that plant, previously softened with hot water and rolled up, has been placed loosely within or fitted closely into the socket. A few folds of lint laid upon the gum, and held in position by closing the mouth, have been sufficient to retain the matico in the alveolus until the bleeding entirely ceased. On examining the mouth on the following day, we have often found the leaf held in the socket by the blood which had coagulated about its surface and within its folds.

[1] The specific gravity of blood should be from 1055 to 1062.

The degree of success attendant on the use of the matico leaf will greatly depend on the care with which it is applied. The leaf having been thoroughly softened, should be cut into strips as wide as the vacant alveolus is deep: they should be rolled up into a form resembling that of a cigar, and of such a size as to fit the alveolus. In rolling up the leaf the rough side should be kept outwards. The rolls are taken up in plugging-forceps, and passed firmly down to the bottom of the alveolus, the somewhat pointed end being introduced first. In the case of upper bicuspids, the operator should somewhat flatten the roll of matico leaf, and before introducing it carefully ascertain whether the root is bifurcated; should it be so, two small rolls should be first passed up, one into each opening. If the matico leaf be carefully applied, it acts as a plug, as well as being an astringent; and we have never known it to fail in a single case where its application was satisfactorily made. But, should it fail, a carefully constructed plug should be tried. The socket having been cleared of blood, a little matico may be introduced, and then small pieces of lint added and carefully packed one after another, so as to completely fill the alveolus. Upon the surface of the gum, folds of lint should be placed in sufficient number to allow the teeth of the opposite jaw, or the jaw itself in the absence of teeth, on closing the mouth, to produce firm pressure upon the surface of the bleeding socket. To keep up the pressure, the volition of the patient should not be trusted. It will be better to pass a bandage under the jaw and over the head sufficiently tightly to prevent the mouth from being opened.

Extract of the supra-renal gland has proved a most valuable agent in the arrest of hæmorrhage. One of the most convenient preparations for dental use is the Adrenalin Chloride Solution 1·1000 (Park, Davis & Co.'s). After the socket is cleansed by syringing with water, a pellet of wool of suitable size is soaked in the solution and packed into the tooth socket. This preparation can be employed in combination with other drugs, such as tannin. Under the name of hemisine (Messrs. Burroughs & Wellcome have introduced a solid form of supra-renal extract which keeps better than the solution. Mr. J. H. Milnes (Brit. Dental Journal, Nov., 1904) draws attention to the marked effect of calcium chloride in bleeding. He writes, "Fibrin ferment converts fibrinogen into fibrin very slowly without $CaCl_2$, but with it the time necessary is very much less. What the action of $CaCl_2$ is has not been quite settled, but it is supposed to form some chemical compound with either fibrinogen or fibrin ferment, which hastens its action. This action is obtained either by local application or by internal administration. In the case of bleeding after extraction of teeth, a small gauze plug well saturated with strong calcium chloride and firmly packed into the cavity, is an extremely useful method, and very rarely fails. The action is assisted by the addition of suprarenal extract."

The use of escharotics in the treatment of hæmorrhage is attended with this immense disadvantage : the parts with which they come in contact are destroyed, and as their action cannot be limited to the interior of the bleeding alveolus, the surface of the wound may become extended, and should the caustic fail to produce the contemplated effect, the difficulties of treatment are enhanced by the increased size of the bleeding surface.

In the case of a child who suffered from hæmorrhage after the extraction of a temporary molar in the lower jaw, lunar caustic, and afterwards spirits of turpentine were applied without success. At the time the author saw the patient, blood was oozing both from the alveolus and the surrounding gum, the surface of which had been made raw by the caustic. This case yielded to the matico leaf carefully applied in the manner already described.

For the reason given above, perchloride of iron is an objectionable application. Having been called in consultation to see a case in which extensive sloughs about the fauces had been caused by its injudicious application, the whole sloughy surface was found to be oozing; and we may add that in dental cases we have never seen it succeed in cases which had resisted other and less objectionable styptics.

In obstinate cases the socket should be firmly plugged, and nothing does this better than the extracted tooth if that is obtainable, its root being wrapped round with a very small amount of wool impregnated either with dry tannin or with a solution of tannin.

Pressure may sometimes be more effectually made by the help of a plate of shellac moulded over the gums, or of metal if there be time to make one; various elaborate apparatus have been devised with this object, something like the appliances used for retaining the portions of a fractured jaw in position, but these would be sure not to be at hand when required.

Failing these remedies, the actual cautery might be used, and in any severe case, ergot in free doses should be given, while in a person in whom hæmophilia is known or suspected, ergot and sulphuric acid may be administered for a few days beforehand; this plan of treatment was successfully carried out by Mr. Turner (Brit. Assoc. Jour., February, 1886). In any suspected person, the socket of the extracted tooth should be at once plugged without waiting for bleeding to occur, and in this way we have extracted several teeth for a youth with marked hæmophilia, with no further trouble than that the administration of gas brought on profuse epistaxis, which we had great trouble in checking.

Unless the patient's general condition forbid it, the sitting position should be maintained, and the patient's feet kept in hot water.

In some cases the depressant effect upon the circulation by the administration of an emetic has been found to be beneficial. Of course, hot drinks and stimulants are to be avoided, as causing relaxation of the peripheral vessels.

But in spite of every effort an occasional fatal case occurs; in one of those recorded it is noted that there was oozing from a large surface, but perchloride of iron had been used, and it appeared to have greatly intensified the peril; in this case the common carotid was tied with no good result, and the patient died.

A fatal case occurred in St. George's Hospital under the care of Mr. Dent in a patient, aged twenty-two, who had lost his father from epistaxis; he had had a lower molar extracted without any difficulty; bleeding occurred, and the socket was plugged a first and a second time with bees-wax, then ergot with turpentine and perchloride of iron were tried, then matico leaf, then a wooden plug. Later on the anterior wall of the alveolus was broken down, and a compress of cork dipped in perchloride of iron inserted. The bleeding having again recommenced, the lower jaw was divided, and the inferior dental canal plugged with wood. Shortly after the operation a fresh hæmorrhage set in from the wound, which was temporarily controlled by a styptic, but in the evening of this, the fourth day, bleeding came on again, and the patient died.

Were we to have the misfortune to meet with such a case in the lower jaw, we should be inclined to try the division of the contents of the inferior dental canal by means of a drill in the dental engine, just as is sometimes done in cases of neuralgia; the cylindrical hole thus produced could be easily plugged with a wooden peg, and the operation produces no laceration of the surface to speak of, so that the patient's risk could in no way be increased even if it failed in its object.

In a case treated by Mr. Stanley Boyd, at Charing Cross Hospital, the inferior dental canal was exposed and both ends plugged with satisfactory results, but it may be doubted whether the simpler and slighter operation above proposed would not have been equally efficacious.

ANÆSTHESIA.

Position.—The patient should be allowed to sit as comfortably as possible in the dental chair, with the head and neck so supported as to be in line with the body, neither thrown back nor pushed forward. The legs should either be well flexed, or resting at length, with no fulcrum for the feet to push against. Removable artificial teeth should be taken out of the mouth, and tight clothing must be loosened. The patient should have had nothing to eat or drink for three and a half to four hours.

For dental operations **nitrous oxide** is to be preferred to all other anæsthetics, inasmuch as it is far safer than any other; this, which is a matter now of clinical experience, drawn from a vast number of administrations, was clearly indicated by experiments upon animals in the early days of the introduction of the gas as an anæsthetic. For it was found that the arterial tension was but little lowered when an animal was under its full influence, it in this respect markedly contrasting with chloroform; and that even when the gas was pushed to the extent of stopping respiration, the heart continued to beat, and the animal could be revived by artificial respiration.

Dr. Hewitt is a strong advocate for the admixture of a certain proportion of oxygen with the gas, claiming that there is then less duskiness, less spasm, and a more comfortable recovery.

By nitrous oxide, according to the experiments of Pickering (quoted in Dr. Hewitt's work on "Anæsthetics and their Administration") the heart's action of an embryo chick was arrested after several minutes' exposure to the gas. A mixture of nitrous oxide with 30 per cent. of carbonic acid gas stopped the heart in 30 seconds; but a mixture of nitrous oxide with

30 per cent. of oxygen stimulated the heart, which still acted after several hours' exposure to the mixture. (See also Mr. Bellamy Gardner's paper, Trans. Odont. Soc., Feb., 1906).

When a longer insensibility is desired it can be obtained by continuing the administration through the nose, or by the addition of a small quantity of ether just as the point of insensibility is about to be reached with the gas; and if it is desired, a full ether anæsthesia can be obtained by commencing with gas, but more speedily changing to ether.

"**Somnoform**" and **ethyl chloride** have of late been extensively employed, either alone or in conjunction with nitrous oxide, to prolong the period of available anæsthesia. The former is a proprietary article and has but little if anything to recommend it in preference to the latter, of which it is largely composed. Both act with extreme rapidity, which alone introduces a source of danger; but in the hands of an anæsthetist familiar to their use, they undoubtedly are of some value, though their popularity seems to be already waning. Mr. G. D. Luke has recorded seventeen cases of death from ethyl chloride, nearly one half of which occurred during dental operations. (Brit. Dent. Journal, Nov., 1905).

Chloroform should be avoided for dental operations; whether it be that the upright position adds a danger when the heart's action is lowered, or whether there be some other cause, it is certain that quite a considerable number, quite disproportionate to the number of administrations, of patients have lost their lives under chloroform administered for dental operations. And every few months a fresh death is recorded.

Dr. Hewitt has carefully investigated this subject, and the results of his work will be found in a paper published in the Journal of the Brit. Dent. Assoc., Nov., 1896.

The writer has, in the course of his practice, only once operated upon a patient under the influence of chloroform, and habitually absolutely refuses to do so: it is conceivable that in the event of long anæsthesia being required for a very young or a very aged person, these taking ether badly, its use might be justifiable, but such cases must be rare indeed.

From chloroform, healthy adults have repeatedly died; to emphasise the opinions here expressed, it may be mentioned that a girl died under chloroform administered for a dental operation, who had less than a fortnight before in the house of another dentist taken gas with perfect safety and success.

A few deaths have taken place under nitrous oxide, but as yet in no case in which the patient was a vigorous, healthy person. One took place at Exeter, but this case is open to doubt as to whether a foreign body (part of the gag) may not have got into the larynx, and the patient was an invalid. Another took place in Manchester, but here the patient (a medical man) suffered from heart and lung disease, and gas had been administered a second time at a short interval. A third case occurred in the Dental Hospital, the patient suffering in this case from extensive cancer of the tongue, which may well have embarrassed respiration; and a case occurred in Paris where an enormously stout elderly man succumbed.

Dr. Hewitt ("Anæsthetics and their Administration," 2nd ed., p. 228) records twelve cases of deaths due partly or wholly to nitrous oxide administered for dental operations; the record is such as to leave nitrous oxide by far the best and safest for dental purposes. A remarkable case happened, however, in his practice, in which respiration became suspended and tracheotomy had to be hurriedly performed, with a successful result. In this case the patient, otherwise a healthy man, had long suffered from rigidity of the muscles of the neck, and had a peculiar carriage in consequence, but whether this had anything to do with the laryngeal spasm is not certain.

But in operating under any anæsthetic there is a source of danger which must be carefully kept in view by the dentist, and that is the passage of foreign bodies into the air-passages. This might happen even in a conscious patient, but it is very unlikely to do so, and if it did the body would probably be coughed away at once.

A fatal case occurred in the hands of the late Mr. Clover from the breakage of the gag (a spring gag made in two pieces, which broke apart). In this case the cylindrical gag passed through the vocal cords and lodged below them in the larynx, which it almost fitted. After about an hour tracheotomy was performed by Mr. Lawson, and the child did well for a few days, but ultimately sank from bronchitis.

M. Poulet (Brit. Med. Jour., August, 1879) records two fatal cases from teeth slipping into the larynx, and mentions others which were not fatal; he recounts a fatal case which occurred to Mr. Rigaud whilst operating for harelip: a milk-tooth came out and lodged in the rima glottidis, the cause of the asphyxia not being guessed at the moment.

In the American Med. Record, November, 1881, a case is recorded in which a patient, after the extraction of thirteen

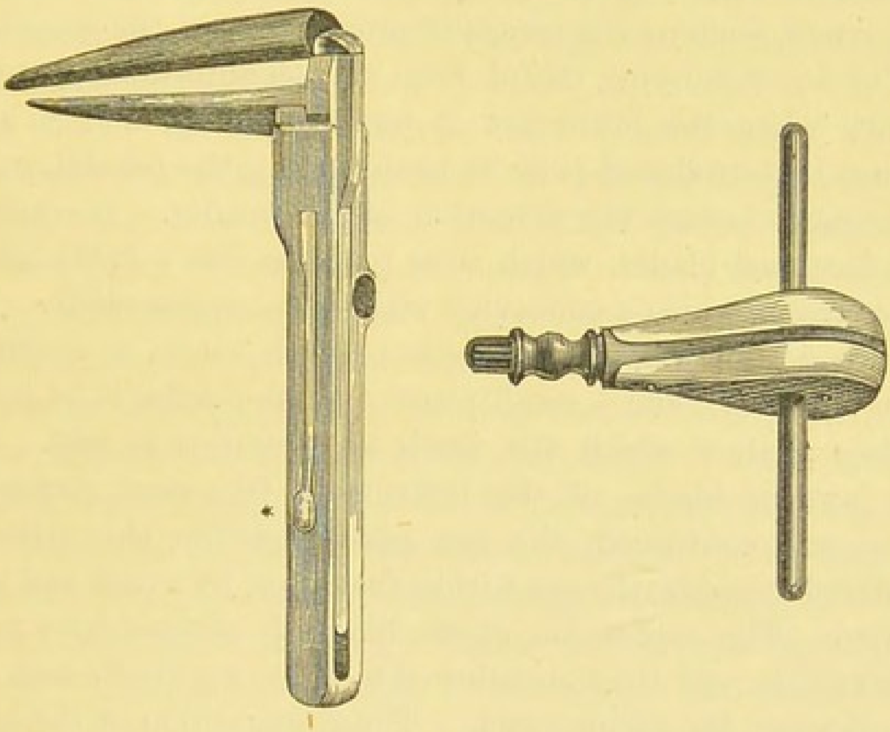


Fig. 262.—An instrument devised by Mr. Cattlin for opening the mouth, when from any cause the jaws become rigidly closed. It consists of two sliding bars, or stems, moved by a rack and pinion, and held in position by a spring catch shown at *. The blades, or jaws, are continued in steel from the two portions of the stem, and are covered with horn. The handle, or pinion, is shown detached from the body of the instrument.

teeth under nitrous oxide, suffered from slight epigastric pain, cough, dyspnœa, and nausea, and after four days, marked pneumonia set in. Six days after the extraction a tooth was coughed up, with immediate relief to all urgent symptoms, but a month afterwards moist râles were abundant, and it was six weeks before the patient was well.

But the most remarkable case of all is that which came under the care of Sir William MacCormac (Trans. Odont. Soc., 1885). In this, a pair of bicuspid forceps broke, and one blade, measuring about an inch, passed down to the bifurcation of the bronchi. Sir William MacCormac was able, after performing a tracheotomy, which involved a large wound and the laying open of a good many rings of the trachea, to grasp it and get it out, and the patient made a good recovery.

The administration of anæsthetics does not fall within the province of the dental surgeon as such, and hence any lengthy discussion is beyond the scope of the present volume. There are, nevertheless, some few points with which he is directly concerned, such as the means of propping open the mouth, etc.

The accompanying useful form of speculum for opening the mouth when the lower jaw is forcibly closed, and so a prop cannot be introduced prior to commencing the inhalation, may be brought before the attention of the reader. It consists of two flattened blades, which close together like a bird's bill, the lower passing into a concavity within the upper blade. Upon the steel, which gives strength to each blade, a covering of horn is riveted, and a small piece of gutta-percha is let into the surface against which the teeth are destined to rest. From the jaws or blades of the instrument two steel rectangular stems are continued, the one passing within the other and rendered movable, the one within the other, by a rack and pinion motion. The separation of the blades is effected by a removable handle, and they are allowed to again approach each other by releasing the spring catch. The construction of the instrument will be readily seen on referring to the figure (Fig. 262).

For ordinary cases the solid gags, manufactured in vulcanite, answer the purpose admirably, but sometimes it is difficult or impossible to find a place in the mouth in which they will rest securely, and yet be out of the operator's way.

A valuable gag designed by Mr. Hutchinson presents the additional advantage of holding the tongue down; but unless the front teeth are firm, there is a chance of their being forced out by spasmodic closure of the jaws. Indeed, this accident once happened in the writer's practice, though, fortunately, these teeth were to have been removed at a future administration of the gas, so that the patient was quite unaware that their removal had not been intentional.

Dr. Hewitt has devised a mouth prop constructed of aluminium and so shaped that it adjusts itself to the angle made by the ower jaw receding from the upper; it is furnished with detachable rubber pads, which can be renewed from time to time. When in position it engages several teeth, so that there is no chance of a faulty loose tooth being injured. Five sizes are necessary. It is the form of mouth prop almost universally used at the present day, and it has the advantage of being easily sterilised by boiling.

Some difficulty may be experienced in arranging the gag in mouths which are nearly edentulous; in this event large fine-textured corks, in each end of which a groove has been filed, will often prove serviceable.

To these matters, however, the administrator of the anæsthetic will ordinarily attend; the one point, on which the operator cannot be too careful, is to withdraw every stump or detached piece of tooth from the mouth. With the forceps this is easy, and the operator must never lose his hold of a stump or tooth until it is safely outside the mouth; but with the elevator there is an additional risk of the fragments falling back into the larynx; and such an accident is the more likely to escape notice at the moment, on account of the lividity and asphyxiated aspect so often presented by patients under the influence of the gas.

As the great danger is the passage backwards of foreign bodies, the operator must be careful not to lose sight for a moment of the tooth which he is extracting; and should he be using the elevator, the stump should be seized by the left hand the instant it is lifted out of its socket.

It is, of course, undesirable that one person should administer the anæsthetic and operate alone, as the unconscious patient requires all the attention of the administrator, without his being distracted by having anything else to do.

And in the interest of the operator it is very undesirable to administer gas to females alone—delusions upon the subject of indecent assault, which cannot be dispelled even by the strongest evidence of relatives present in the room, are not of great rarity, and it may perhaps be of service to give here a reference to a summary of a good many such cases collected in the Dental Register, Cincinnati, March, 1882.

The salts of cocaine have been employed as **local obtundents**, but so far the results have fallen far short of the expectations formed.

Cocaine is thoroughly efficient in slight operations upon the eye, when it renders the conjunctiva insensitive : in the same way it will render the surface of the gum insensitive, and enable the operator to force it out of the way or to cut it away without pain. But for sensitive dentine it is of little or no use, and for extractions it is of doubtful utility.

Some, however, have great faith in it, and they employ it by injecting freshly-made solution into the neighbourhood of the tooth to be extracted. Happening to have a somewhat tender stump in my own mouth, I experimented upon it by injecting, at intervals, two grains of hydrochlorate of cocaine in all. This had the effect of making an area of the size of half-a-crown of the gums and mucous membrane of the cheek absolutely insensitive, but the stump remained all the time slightly tender to firm pressure, so that it would have been decidedly painful had it been removed.

But the two grains had a most unpleasant constitutional effect: I was unable to walk straight, felt very giddy, and, in fact, very much as though I had been smoking my first pipe, and it was two hours before the effect passed off.

The point of the observation, for the sake of which I relate it, is that complete local anæsthesia was not produced even when a very unpleasant constitutional effect had been arrived at. Unpleasant faintness has occurred in several cases, and recently there has been a death from cocaine in St. Petersburgh : in this case, however, no less than twenty-four grains were injected into the rectum. But so far as dental purposes are concerned, it is not likely that any really dangerous amount would be administered.

A death has, however, been said to have occurred in Indiana from the injection of one grain.

Still, we know of two cases in which very alarming results ensued, as it happens, one at each of the universities of Oxford and Cambridge. In one case the patient had had the same cocaine, in the same dose, freshly dissolved at the time, and the same operator, on several occasions with perfectly good results; nevertheless, on the last occasion alarming disturbance of circulation, prostration, etc., ensued.

The other patient had it employed for the first time, passed into such condition that artificial respiration had to be resorted to, and it was twenty-four hours before his condition became satisfactory, and he could be removed to his own home.

Upon the whole, then, cocaine injection has little to recommend it, and in just those cases in which apprehension might be felt as to the administration of gas, we consider it to be strongly contra-indicated. And gas and ether may be given without untoward results in many cases of heart mischief. A patient of my own and of the late Dr. Wilson Fox, with serious aortic imcompetence, took gas and ether several times well, although he ultimately died suddenly whilst undergoing no special exertion.

Eucaine or stovaine are undoubtedly less apt to produce unpleasant after effects, and lately have been used in combination with adrenalin chloride with still more satisfactory results.

Cold is of some avail in deadening pain, especially for loose teeth with little alveolus, although it is hardly efficient in a difficult extraction.

The tubes of ethyl chloride, or mixed ethyl and methyl chloride, are very convenient for its application, and have displaced the old ether spray apparatus.

FRACTURE OF TEETH.

When the loss of substance is trifling in amount and does not materially interfere with the personal appearance of the patient, nothing further than the removal of any sharp or projecting edge, by the use of a corundum wheel or strip of stone, need be attempted. But should the fracture extend into or even within a very short distance of the pulp-cavity, a more decided course of treatment will be called for. The nature of that treatment will be determined by the direction which the fracture has taken, by the amount of injury the root of the tooth sustained at the time the injury was inflicted, and by the age of the patient.

The incisors, from their position, are more frequently fractured than the bicuspid or molar teeth. The latter are not, however, exempt from accident. When the jaws are violently driven together by a blow or a fall, a back tooth may give way. A cusp may break off, or the fracture may extend through the pulp-cavity, and detach one or other of the roots with its corresponding portion of crown. We have more than once seen in a bicuspid tooth the fissure extend from the crown through a greater portion of the root.

Molar teeth may thus occasionally be broken by a blow without the integuments being cut, their fracture being due, not to the direct force, but to the impact of the teeth of the opposite jaw.

The fracture so caused may run through the pulp-cavity, and yet the fragments remain in such exact apposition that even on careful examination it may escape observation.

A medical man, happening to be leaning forward in his carriage at the moment when it was suddenly pulled up, pitched upon his head and was stunned; for upwards of a year he suffered from occasional neuralgic pains, which were ultimately found to be due to a sound upper molar which had been split right through, the palatine being separated from the buccal roots. The pulp had remained alive, and the fracture was long overlooked, it having followed the natural fissures of the crown, and no displacement having taken place.

The force employed in mastication is sometimes sufficient to split a tooth, and in one instance which came under personal observation the bicuspid was fractured across the upper third of its root by biting suddenly upon a fish-bone. Although the tooth was rather loose, and the patient was positive he had broken it, it was tolerably free from pain, and so was left for a time, as the possibility of its being fractured so high up by such a cause was doubted. However, it became so loose that after the lapse of three weeks it had to be removed. On microscopic examination, no signs either of absorption or of deposition on the fractured surface were seen.

And it will sometimes happen that a tooth is fractured without the patient having been aware of any blow or shock, and this should be borne in mind when a tooth is found unaccountably loose and tender : it is often possible, when moving such a tooth between the fingers, to feel that it is moving upon an unduly short implanted portion.

It may be stated generally, that when the fracture extends through the pulp-cavity in the direction of the length of the tooth, the root will have been injured, and should in most cases be extracted ; and the rule will be almost absolute when the pulp-cavity of a tooth, the root of which is incomplete, has been opened, whatever may be the direction or the extent of the fracture. If, on the other hand, the crown of a tooth be broken off transversely external to the edge of the gum, there is a fair chance of preserving the implanted portion, and of rendering it subservient to the support of an artificial crown, should such a course appear desirable.

It is, however, only in teeth with single roots that the operation can be performed with uniform success. Even in the bicuspids of the upper jaw, and more especially in the first bicuspid, application of a crown is not always feasible. The roots of these teeth are not only subject to great lateral compression, but also to actual division into two or into three distinct roots. In either case the drill, in preparing a hole for the reception of a pivot, may pass through the tooth into the socket, or no individual root may be of size adequate for the insertion of a pivot-pin or screwpost: these injured roots are best treated by the application of a gold crown, if such a course seems preferable to the extraction of the root.

But in young persons the gap will generally fill up. If, for instance, a lateral incisor be broken off at or before the age of thirteen, and the root be immediately removed, the canine will come forward, and in a few years fill up the space; or if the accident occurs at a later period, in a mouth crowded with teeth, a similar result would follow the operation. A like course may sometimes be pursued in a young patient when, with the lateral incisors large, a small central tooth is injured. "Crowned" teeth may last twenty years, or even for a longer period, but such durability must be regarded as exceptional. From seven to ten years would be an average period which will intervene between the adjustment of a crown and the substitution of an artificial tooth on a plate, which latter must, for the sake of appearance and articulation, be ever afterwards continued. If, then, the space occasioned by the loss of a fractured tooth can be filled up by the gradual approximation of the contiguous teeth without seriously interfering with the personal appearance of the patient, it will be better to remove the root of the injured tooth at once.

It is not always impossible so to bind together the fragments, when the fracture has run down through the root, as to restore the tooth to usefulness, as may occasionally be done when the roots have separated as a consequence of caries. Screws may be inserted into the several roots, which are then united by being imbedded in a common mass of amalgam, or an arched wire with its ends imbedded in each root, and then fixed by cement, may be employed; or a gold band may even encircle the tooth outside; or in the case of a lower molar the roots may be separately crowned and converted, as it were, into bicuspids. But whether any of these operations offer a reasonable prospect of success must be decided upon the indications of the individual case.

The occurrence of fracture without history of injury has led to speculations upon the possibility of its having been occasioned by force from within, it having been even suggested that the evolution of gas from a decomposed pulp might have done it!

Another and more reasonable explanation, which has, however, not much to commend it, is that if the pulp has been converted into secondary dentine, this is unyielding, and a distorting force coming upon the tooth, it is split, as it were, by a wedge from within. Only a very small percentage of split teeth, however, contain the solid mass of secondary dentine postulated.

Much filled premolars and molars are apt to split, and in this connection we would draw attention to the practical utility of freely grinding down the upstanding cusps of such teeth. If gutta-percha be employed for filling roots, care should be taken that only the root canals are filled with this material, and the more binding oxyphosphate or oxychloride cement used to fill the pulp chamber and to line the cavity.

The union of a fractured root within the socket, unlikely as it might seem, does sometimes occur.

Sir E. Saunders had in his collection an incisor which shows the marks of a reunited fracture extending across the root near the junction of its terminal and middle third. A description, with a figure of this tooth, has been published.[1] And Dr. Belisario has met with a case in which reunion has apparently taken place. Professor Owen has described and figured an instance of reunited fracture in the tusk of a hippopotamus.[2] The preparation in the author's collection, from which the following illustration is taken, is of great interest, as it at once proves that in the tusk of the hippopotamus, at all events, union may take place after a severely comminuted fracture, with considerable displacement of the fractured parts. In this specimen—and probably in the two preceding examples—the union is effected by the development of cementum. These facts go to show that when a tooth is fractured within the socket, it may, under favourable circumstances, be reunited. To recognise and bring about these circumstances may in individual cases be difficult, but the knowledge that a fracture may be united should lead to a course of treatment favourable to its occurrence in cases where fracture of the root of a tooth is suspected.

[1] Lecture on Dental Physiology and Surgery.
[2] Odontography.

In a case which came under personal notice, a front tooth was broken across and a molar tooth loosened by a severe fall, in a patient under twenty years of age. The latter tooth was allowed to remain, on the chance of its regaining its original firmness of implantation. After the lapse of many months the molar tooth was still a little loose, and now and then became the seat of pain. The degree of looseness appeared to vary: at one time the tooth seemed to be rapidly recovering its usefulness as an organ of mastication, at another it appeared to be getting from bad to worse. At last the patient determined

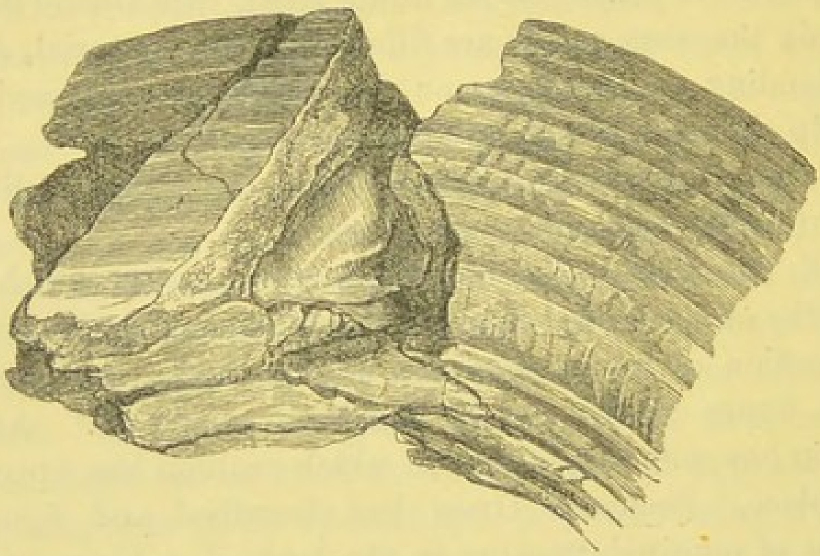


FIG. 263.—Shows a perfectly united fracture in the tusk of a hippopotamus. The tooth had been broken with the socket, with considerable separation of the fractured surfaces. The union has been effected by the development of cementum.

to submit to no further inconvenience, and the tooth was extracted. The nature of the accident was then for the first time recognised. The root of the tooth had been fractured transversely some distance within the socket, and the fractured surface had been subsequently coated over with cementum. The production of new tissue upon the broken surface must be regarded as a reparative effort, and had the tooth been by any mechanical means kept for a time in a state of rest, it is probable that an union of the fractured surfaces would have been effected.

The dentinal pulp may, however, take some share in uniting the fragment of a tooth broken within the socket. Thus, Professor Wedl, in his "Atlas" (*op. cit.*), figures two reunited fragments in which a fresh development of dentine took place; indeed, it is not to be wondered at that this should sometimes happen, for when displacement takes place during the development period, a very complete union is formed, as is exemplified in the accompanying figure; and it is no uncommon occurrence for the pulp to resume its formative functions long after the cessation of regular calcification.

And that an injured pulp may be stimulated into undergoing

FIG. 264.—Union of portion of root displaced during formation.

calcification is well seen in the specimen which has been figured on page 407.

In the Transactions of the Odontological Society (1896) Mr. Storer Bennett describes and figures an incisor tooth which had become reunited after fracture with some displacement of the fragments. The tooth was driven up and impacted in its new position, and was ultimately removed because it was causing much pain (page 410).

The pulp was but slightly exposed, and the union took place by the development of a cementum-like tissue deposited, not at the outer edges of the fracture, but quite between the fractured surfaces—indeed, in the central axis of the tooth.

The source of the new tissue thus becomes a question. It is just possible that it may have been supplied by the pulp, but it seems more probable that it was derived from the periosteum.

DISLOCATION OF TEETH.

In consequence of a blow or a fall, one or more teeth may be entirely forced from their sockets, the alveoli in some cases receiving considerable injury, and in others little or none. But violence which falls short of dislodging a tooth may cause the death of the pulp, and this should be always watched for after the infliction of a blow; or it may merely loosen the tooth, which, when allowed to remain at rest for a time, becomes firmly refixed.

Occasionally, where great violence has been used—as, for example, in machinery accidents—large portions of alveolus come away with the teeth; and the roots of the front teeth have been known to be driven through the floor of the nose. In one case an incisor was supposed to have been knocked out, which had really been driven into the antrum, where it made its presence known by causing an empyema of that cavity after the lapse of some weeks.

A few years ago a patient presented himself asking to have a lateral incisor crowned, he having, as he supposed, broken it off by a fall when hunting. It was not, however, broken at all, but had been driven right home like a nail into a board, till its cutting edge was a little below the margin of the gum.

The patient being placed under an anæsthetic, and a vulcanite splint being in readiness, the tooth was grasped with forceps with a view to drawing it down. It required, however, far more force than does an ordinary extraction to stir it at all, and then it came straight out; it was at once replaced, but appeared to have no bone in front of its root. However, after a few days it became independent of the splint, and in a week was less tender than its neighbours, which had been only shaken. Six weeks afterwards its edge, which had been chipped, was ground smooth with a corundum-point, and it was then as firm as any of his teeth. In this case the destruction of the original socket must have been almost complete, but it had apparently been reformed ; the tooth is, however, now loose.

It is a well-established fact, not only that a tooth which has been forcibly loosened in its socket will, if allowed to remain at rest, become firmly refixed, but also that teeth which have been removed may, on being returned even after an interval of several hours, become attached, and remain firm and useful for many years. A patient of the writer's fell upon a cog-wheel, and knocked out the central incisor of the upper jaw. He returned the tooth to its socket in the course of half-an-hour, and, according to his own statement, it gradually became firm, and remained so for upwards of twelve years ; at the expiration of that time it became loose and troublesome, and was extracted. When the accident occurred, the tooth had the usual length of root, but at the time of its removal the latter part had been reduced to less than half its normal length by absorption. Many similar cases, as respects the reunion of the natural connection of completely dislocated teeth, were brought forward at a meeting of the Odontological Society held in 1858 ; and many instances are known where patients, having had a wrong tooth extracted, at once replaced it, and retained it for several years. Hence, when a tooth has been dislodged it should at once be thoroughly cleansed, and the socket cleared of all coagula, before its replacement is attempted. It should then be secured in its place by ligatures, or, what is much better, by a cap of gutta-percha adapted to it and the neighbouring teeth. A cap of gutta-percha should also always be placed over teeth which have been loosened by a blow, or by the operation of torsion : it keeps them steady in their position, and protects them from the bite of the antagonistic teeth.

If much swelling and inflammation of the gums ensue, this must be combated by leeching or free incisions through the whole thickness of the gums.

Dr. Rollins, of Boston, sent the writer a microphotograph of the root of a lower molar which had been replanted and worn for four years ; a little irregular absorption had taken place near the end of the root, and also new cementum had been deposited in great abundance. The alternation of these processes indicated long continuance of the irritation which resulted in its ultimate removal.

The tolerably ready union of a freshly extracted tooth has been made available in a few regulation cases: Dr. Beers, of Montreal, successfully transposed two misplaced teeth, and Mr. Spence Bate and Mr. Coleman have both transplanted teeth from one mouth to another for regulation purposes.

There is abundant evidence to show that a tooth thus replaced will acquire a membranous connection with the socket; this is, indeed, exemplified by the operation of torsion, by the old operation of transplantation of teeth known in the time of John Hunter, and by those cases in which, more recently, teeth have been extracted, the diseased periosteum scraped off, and the teeth then replaced.

The late Mr. Sercombe placed in the Museum of the Odontological Society a pivoted tooth, which had been extracted on account of prolonged irritation in the socket, and afterwards replaced. It became tolerably firm, but after some little time became so loose that it had to be removed, when the root was found to have almost disappeared. Such seems to be a not unusual termination of cases of replantation.

When a tooth is extracted it carries with it a certain amount of adherent periosteum, and of course there is living protoplasm in its canaliculi and lacunæ: this is capable of ready reunion, as is well exemplified by recent successful cases of bone grafting operations.

It is said that the protoplasm of bone will retain its vitality for several hours, and that this is the case with cementum is indicated by the success, temporary at all events, of the operation of extracting teeth, filling them out of the mouth, and replanting them.

In the writer's own practice, an incisor, which a boy had carried all day in his pocket, was successfully replanted, after a thorough scrub with carbolic acid, ½ per cent. solution: in this case the pulp-chamber was cleared and filled from the apical foramen, and now, after the lapse of five years, the tooth is perfectly firm.

Quite recently two somewhat similar cases have been treated in the same manner with apparent success; the teeth on being replaced in their sockets were held firmly in position by being ligatured with interdental wires to a narrow strip of twenty-two carat gold, the terminal ends of the latter having been bent round the canine teeth.

And another yet more remarkable case occurred a few years ago: a boy, whose parents were on the continent, knocked out his left upper canine and lateral: he was not brought to be seen for five days, and then healing had taken place to such an extent that the teeth could not be returned to their own sockets. But the mouth was crowded, and the smaller lateral would go home into the socket of the canine, so it was inserted there, and the canine left out. So far this has been completely successful, and it has become firm.

In view of these facts, which seem to indicate that no harm would be done by a short delay, it is probably safer in all cases to enlarge the apical foramen, withdraw the pulp, and fill the pulp-cavity.

If this is done the tooth should be handled as little as possible, the cementum being protected from damage by wrapping it round with bibulous paper moistened with a very dilute solution of carbolic acid; the tooth should be held by the enamelled crown so as to interfere still less with the cementum and any soft issue that may be adherent to it.

In cases of replantation of diseased teeth it is sometimes practicable to leave the pulp-cavity unfilled and open through the crown as a means of drainage, filling it subsequently when all irritability has passed off; this, if it appeared desirable, could also be done in replanting a dislodged tooth, though it would seldom appear to be necessary, as there will not have been any antecedent suppuration.

In the management of the case it will be necessary to urge upon the patient the necessity of keeping the tooth in a state of perfect rest, and of resisting the tendency to pull the tooth about in consequence of the uneasiness felt around it.

A Hammond's splint, modified as circumstances may dictate, answers well for steadying the teeth; but it is often desirable to prop the bite to ensure rest.

But the union is liable to be an imperfect one, and the tooth will be extremely likely to become tender to the touch from the slightest cold or derangement of the digestive organs, and in a large number of cases is soon lost owing to absorption of its roots.

This result is the more intelligible if we recall the famous experiment of Mischterlich, in which it was found that the replanted tooth, which was very firmly held in, was really largely fixed by the excavation of absorption spaces in its cementum, these being occupied by the large cells and other tissues characteristic of the absorption process; there is thus the train laid, so to speak, for the resumption of the destructive process at any time.

FRACTURES OF THE JAWS AND DISLOCATION.

I. Fractures of the Jaws.

Although fractures of the jaw fall within the province of the general surgeon, rather than within that of the dentist, still, as the services of the latter are not uncommonly called into requisition, a few words respecting it will not be out of place here.

Fractures of the maxillæ are seldom met with, on account of the protected and well supported position of these bones; when they do occur the fractures are usually confined to the alveolar process, and because of the free blood supply readily unite on the parts being adjusted and kept in correct position, either by wiring the teeth or supporting the fragments by some form of splint.

Fractures of the mandible are of comparatively common occurrence, owing to the exposed position, dense structure, and loose attachment of the bone.

Causes.—Fractures are usually the result of direct violence, such as kicks, blows, lift accidents, and falls. Extensive fracture has occasionally been caused by extraction of teeth; fracture of the alveolus during removal of a tooth often happens, and is unlikely to lead to anything more serious than the exfoliation of the detached portion. Similarly the maxillary tuberosity may be broken during the extraction of an upper wisdom tooth, and the late Mr. J. Main Nicol once met with this accident during the removal of an upper second molar, the third molar being in position.

Varieties.—Fracture of the ascending ramus is usually simple, but fractures of other parts of the jaws are almost necessarily compound, as the very close adhesion of the gum renders its being torn inevitable. Fractures of the mandible are frequently multiple, and may be comminuted.

Position.—The fracture may occur at any part of the jaw, its situation depending partly on the position on which the blow and its contre-coup are received, and partly on the position of weaker places, such as that resulting from the deep socket of the canine tooth or the presence of a tumour or growth. In the horizontal ramus the direction of the fracture is usually oblique, though it may run horizontally separating a considerable portion of the alveolus from the more dense part of the bone ; when occurring at the symphysis in young persons it may be vertical.

Signs.—The signs and symptoms of fracture of the body of the jaw are usually unmistakable; crepitus, mobility of the fragments, and irregularity in the normal line of the teeth being the most prominent indications. In the ascending ramus the symptoms are apt to be more obscure; here the diagnosis may rest on the presence of an exceedingly tender spot accompanied by pain, salivation, and restricted movement of the jaw, the history also being taken into account. Excessive swelling may preclude the possibility of a correct diagnosis during the first day or two.

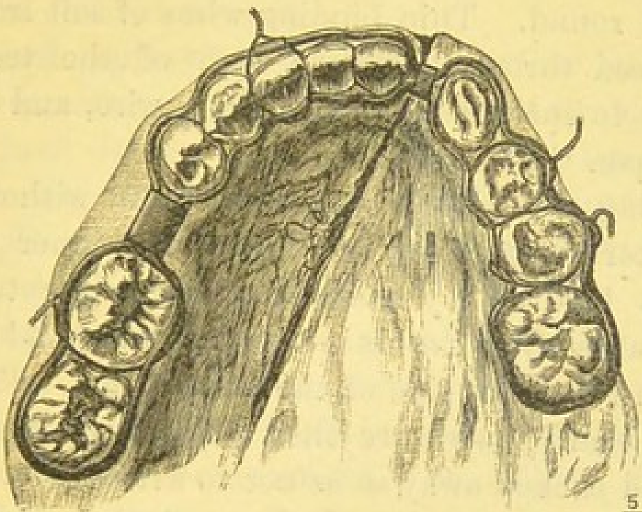
Displacement.—This varies according to the nature and situation of the fracture and the direction of the force that has caused it. Unless the fracture be multiple, or situated near the angle of the jaw, it is usually slight in amount and readily admits of adjustment. The displacement is also influenced by muscular contraction, gravity, and the interlocking of the fractured ends of the bone.

The displacement of the fractured portion has been generally attributed to the action of the muscles, and this is no doubt often a frequent cause, though Dr. St. George Elliott, who had a large experience of such fractures during the American War, thinks that their effect is overrated.

Complications.—Considering the frequent severity of the force causing the fracture, and the single blood supply of the mandible, serious complications are strikingly uncommon. Profuse hæmorrhage may occur, but in many cases treated, the writer has only once been seriously hampered from this cause. Mr. J. F. Colyer records a case in which a traumatic aneurism formed, necessitating ligature of the common carotid (" Diseases and Injuries of the Teeth," 2nd ed., p. 614). The presence of detached teeth and septic roots at or near the line of fracture, or splinters of bone, may and often do result in the formation of abscesses, the pus tending to gravitate downwards. On the slightest indication of pus formation the tender area should be freely opened from the outside; greater scarring and disfiguration will probably result from any attempt to avoid an early external incision.

After a severe fracture very profuse suppuration often ensues, extensive abscesses under the chin and in the neck may form, and portions of the bone may necrose and come away.

Thus, in a case of which there is a model in the Museum of



$\frac{5}{6}$

FIG. 265.—Showing a Hammond splint in position, with four binding wires applied and their terminal ends ready to be tucked out of the way.

the Odontological Society, the whole depth of the front of the jaw, containing the right first bicuspid, canines, and incisors, and both bicuspids of the opposite side, has been lost, and the second bicuspid of the right side has come into contact with the first molar of the left, the two halves of the jaw joining at an acute angle.

Treatment.—By a four-tailed bandage in simple cases, though it is better to add to this a gutta-percha support moulded around or under the chin.

In the early treatment of any case either a four-tailed bandage or skull and chin cap will be found useful.

In all cases where a splint is to be made it is better, if time permits, to obtain impressions of both jaws, adjust the displacement shown in the model, and fit the splint to this.

It used to be the practice of some surgeons to secure the fragments in their places by wires passed around the teeth; it is, however, an objectionable plan, on account of the irritation set up by the wires, and it is very seldom that it can be desirable, it having been superseded by the introduction of the **Hammond splint.** This consists of a stout soft iron, silver, or gold wire bent so as to lie pretty closely along the necks of the teeth on the lingual aspect; a second wire is moulded around their labial side, these two wires extending round the whole or a sufficient part of the dental arch, and their ends being bent so as to make them round and smooth; or a single wire may be carried all round. Thin binding wires of soft iron or silver are then passed through between each of the teeth at the necks, so as to encircle the inner splint wire, and are twisted up tightly upon the outer wire.

This binding wire should be passed from without inwards, over the outer splint wire and under the inner one, where it is caught hold of by suitable pliers and returned from within outwards over the inner splint wire and under the outer one, on the other side of the same tooth. The terminal ends of the binding wire are then twisted up and the ends cut short and tucked away so as not to irritate the soft tissues. Gutta-percha heated and packed round these joints of the binding wires will often secure a smooth finish. In this way, without any strain being put upon any particular tooth, the whole series are held in place by the stout splint wires holding them pressed between them. For general purposes this splint is the most cleanly, the most efficient, and the least cumbrous of any appliance in use, but there remain a certain number of cases in which, from the absence of many teeth, or from other causes, it cannot be satisfactorily applied, and in these more difficult cases resort must be had to more complicated apparatus. A very good account of such may be found in Kingsley's "Oral Deformities," and it will not be necessary to do more than notice a few of the more general principles involved.

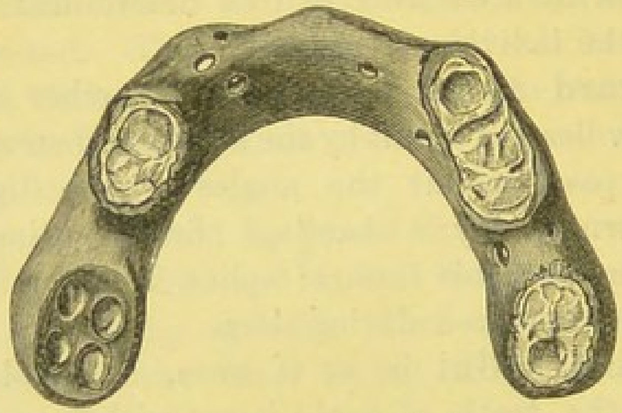
Much assistance in steadying the fragments may be derived from simple sheets of gutta-percha pressed over the crowns of the teeth; but in severe cases a more stable apparatus is required.

An impression of the jaw in wax or plaster is taken, without any special attempt to hold the fragments in position; this is cast in plaster, and the displacement remedied by sawing through the plaster model and adjusting the teeth in the divided model according to the model of the upper teeth. A gold or vulcanite plate is then made to fit the crowns of the teeth when the halves of the jaw are reduced to their proper position. In some cases it will be best to make the splint fit loosely, and to line it with warm gutta-percha at the time of introduction; but whether this course is preferable to making the plate itself fit accurately, can be determined only by the inspection of the individual case.

The **Hayward splint** consists of a further modification of the simple vulcanite splint by the addition of strong recurved wires which pass out at the angles of the lips, and are attached externally by a bandage firmly adjusted over a gutta-percha splint; this form of splint is uncomfortable and apt to become displaced during sleep.

The **Gunning splint** is, as it were, a double vulcanite splint fitting the teeth of both jaws, with intervals left to facilitate the introduction of food; it is an extremely difficult splint either to adjust or to remove. Dr. Elliott, during the American Civil War, used a roll of gutta-percha an inch thick in the same way, and found that this was quite efficient, besides possessing the advantage of being made and finished at once, holes being left in the front and at the sides for the introduction of food, and the syringing out of discharges.

The **Hern splint** is a practical and extremely useful modification of the Gunning. It consists of a simple vulcanite plate embracing the teeth and part of the alveolar border of the mandible. On each side two or more "biting blocks" extend from the upper surface of the splint to receive such upper teeth as will tend by their pressure to steady the splint. These biting blocks should be freely cupped out and filled with gutta-percha to receive the opposing teeth, the bite of which is thus quickly and correctly accommodated. The sides of the splint are freely perforated to facilitate free drainage and effective syringing. The splint may be lined with soft gutta-percha if required, but this is not often either necessary or desirable. Should one or more teeth remain upstanding above their fellows, as often happens, such teeth can readily be pressed down into line by inserting a little gutta-percha filling into the apex of the impression into which the tooth is received upon adjusting the splint. A supporting bandage must be worn with this form of splint. Mr. William Hern prefers a skull and chin cap connected by lateral elastic straps provided with buckles for ready adjustment. Whatever apparatus is employed, care must be taken to secure the easy and thorough escape of pus, and to avoid heavy pressure



$\frac{5}{6}$

Fig. 266.—Hern's modification of a Gunning's splint; sketched after six weeks' wear, and showing three biting cups filled with gutta-percha; the fourth cup has been filed down from time to time.

on the integuments beneath the chin, where abscesses are very prone to form.

Fractures in the region of the condyle are more rare in consequence of the protection afforded by the thick pad of muscles; they may be difficult of detection, and a bandage will be generally all that can be done in the way of giving rest to the fragments.

Fractures of the upper jaw are not very common, and there is generally little tendency to displacement; nor is there usually much difficulty in keeping the parts in position, though occasionally a plate will be required. Comminuted fragments should be almost always allowed to remain, as, owing to the rich vascular supply, they rarely necrose.

A somewhat remarkable case came under the writer's notice in which a loop of a bell-rope entered the mouth while the patient was bell-ringing in a belfry: it fractured the upper jaw on both sides at the region of the canines, and the fragment was displaced, so that the teeth looked horizontally forwards. It required much force to replace the portion of bone, but it had no tendency to displacement, and speedily united without the loss of any of the contained teeth.

With regard to the removal of teeth in cases of fractured jaw, this should only be done when either a tooth has become lodged between the fragments or fractured through the pulp-cavity, or when a loosened tooth in proximity to the wound is obviously septic. In any other case they should be allowed to remain, as they often become firm in apparently hopeless cases.

But teeth with pulps exposed by fracture should always be searched for, as their presence will submit the patient to much needless suffering; and it is possible that cases might occur in which the extraction of the teeth would be difficult, owing to the mobility of the fragments, and the fear of tearing away portions of the bone. In such an event we should be disposed to extirpate the nerve with a nerve-extractor.

Occasionally the great force causing a multiple fracture will have so extensively displaced the fragments that these must be coaxed up, and retained approximately in position by inter-dental wiring, before any workable impression of the parts can be obtained.

II. Dislocation of the Jaw.

This may happen during the extraction of a tooth, or even in taking a model of the mouth. The patient is then unable to close the mouth, the lower jaw is protruded, and speech is difficult. A slight hollow may be felt behind the dislocated condyle, and this is the surest guide in the less usual form of the accident —unilateral dislocation.

The readiest manner of effecting the reduction is to seat the patient upon the floor, steadying the head against the operator's knees. The thumbs, well guarded by numerous turns of a narrow bandage, are passed as far back on the molar teeth as possible. By forcible pressure downwards the condyles are disengaged, and the front of the jaw being simultaneously tilted up by the fingers, it slips into place with a jerk.

Other methods are sometimes adopted: thus, corks may be placed between the molar teeth, and the chin forcibly elevated; or a long piece of wood may be used as a lever to depress the back of the jaw.

Whatever method be adopted, the surgeon must keep in mind what has to be done: namely, to depress the back of the jaw to such an extent as to disengage the condyles from the prominence in front of the glenoid cavity; so soon as this is done the muscles will draw it up into its place.

After reduction, the movements of the jaw must be restrained for some days by the application of a four-tailed bandage.

THE SALIVA AND SALIVARY CALCULUS.

The fluid found in the mouth is a mixture of the secretion of the salivary glands and of the buccal mucous glands, and its chemical and physical properties vary as the one or other preponderate. It is a glairy fluid, containing epithelium cells, mucous corpuscles, and salivary corpuscles.

Its reaction is alkaline, though when it is scanty the reaction of the mouth may be acid; the first few drops collected from the parotid may be acid, but this is due to its having been retained in the duct for a time and having undergone change there; it serves to show how easily acids are formed in the mouth by fermentative processes.

The most abundant source of saliva is the parotid gland, which seems to discharge the function of keeping the mouth moist: it is not viscid, and contains no structural forms; it contains little or no mucin, but perhaps contains some globulin; it has one peculiarity which is not shared by the saliva from any of the other glands, and this is, that when left to itself for a few minutes it becomes turbid from a deposit of carbonate of lime taking place, owing to the escape of the carbonic acid which holds it in solution.

This fact explains the enormous deposits of tartar which are often to be seen on the molar teeth opposite to Stenson's duct; another reason for the great amount of these deposits being, perhaps, that this gland is constantly pouring forth its secretion, though not in great abundance, independently of the stimulus of food.

The submaxillary saliva is more strongly alkaline, and much more viscid, its viscidity being due to the presence of mucin in considerable quantity; it contains many salivary corpuscles, and masses of proteid matter, which show amœboid movements; it is poured out but little except in response to the stimulus of food, or of mechanical irritation such as is set up in operations upon the mouth.

The secretion of saliva is mostly a reflex act, the impulse being conveyed in the case of the parotid by way of the auriculo-temporal nerve, and in the case of the submaxillary, by the chorda tympani; the afferent impulses being conveyed by the lingual or glossopharyngeal nerves under the ordinary circumstances of taking food. But that stimulation of other branches of the fifth nerve will have the same effect, is every day demonstrated to the dentist by the gush of saliva which follows instantly upon the infliction of pain in excavating sensitive dentine.

For the relation of the sympathetic to salivary secretion in the way of diminishing the flow, while at the same time its viscidity and its activity in acting upon starch is increased, the student must refer to physiological text-books; the subject is too complex for discussion here.

The sublingual gland pours out a viscid fluid, rich in the "ptyalin" of Berzelius, and also alkaline.

In addition to the products of these several glands, we have the "buccal mucus"; according to the experiments of A. Bernard and of Dr. Magitot this also is alkaline, and is very rich in albuminous matters, which may form concretions about the teeth, as seen in fevers and certain other disorders.

The mixed saliva from these various sources is alkaline, and separates on standing into layers, the lowest of which contain epithelial cells, mucus corpuscles, fat, vibrios and cryptogams, and other accidental constituents.

But notwithstanding the alkaline nature of each and all of these secretions in health, a piece of litmus paper applied to the necks of the teeth, or to the borders of the gum, often shows an acid reaction. This is due to products of fermentation, and not to secretions originally acid; and the more the mucous element of the saliva predominates, the more fermentation will there be: the mucus being rich in albumen, and the viscous albuminous element of the glandular saliva (ptyalin of Berzelius), being also albuminous, furnish in abundance the ferment required. Moreover, the more abundant these viscous matters are, the more will food be retained in the fissures between the teeth to undergo fermentation; but this acid reaction, often present to some extent in the neighbourhood of the upper incisors, is never found on the gum in the neighbourhood of the lower incisors (Magitot, *loc. cit.*); in this situation the flow of alkaline saliva effectually neutralises any acid that might be formed, and in this way the frequency of deposition of tartar on the lower, while it is comparatively rare on the upper incisors, may be explained.

The amount of saliva secreted daily varies greatly: from 13 oz. to $3\frac{1}{2}$ lbs. have been given as estimates.

Analyses of Saliva.

Mixed human saliva contains (Haliburton, "Physiological Chemistry"):—

Water	994·10
Solids	5·90
Soluble organic matter	1·42
Epithelium	2·13
Potassium sulphocyanide	0·10
Salts	2·19

Analyses, however, vary somewhat in the exact proportions given, but within small limits.

The submaxillary saliva contains, according to Bidder and Schmidt:—

Water	991·45
Solids	8·55
Organic matter (mucin, ptyalin, etc.)	2·89
Salts (potassic and sodic chloride, 4·50; calcic and magnesic phosphates and carbonates, 1·16)	5·66

A more minute estimate of the salts (from the saliva of the dog) gives:—

Potassium sulphate	0·20
Potassium chloride	0·940
Sodium chloride	1·54
Sodium carbonate	0·90
Calcium carbonate	0·150
Calcium phosphate	0·113

Human parotid saliva contains (Hoppe Seyler) :—

Water	993·15
Solids	6·84
Organic matter	3·44
Salts	3·40

Traces of sulphocyanide of potassium are also met with in saliva.

Dr. Fenwick states that sulphocyanides are in excess in cases of acute rheumatism, acute gout, and bilious headache, and in early stages of all inflammatory disorders; in these cases there is excess of fibrine in the blood, and, may be, an excretion of unoxidised sulphur resulting from the large amount of albumen altered by inflammatory process and so rendered unfit for organization.

Some have held them to be a result of decomposition set up by decayed teeth—others that they are due to smoking—but his investigations did not lend confirmation to these ideas. (Trans. Med. Chirurg. Soc., 1882.)

It is stated by Michaels (International Congress, Paris, 1900) that the saliva may contain every soluble or crystallisable substance in the blood plasm and that its composition varies with constitutional states. He holds that in hyperacid states of the urine the saliva may become acid and that, under these circumstances, the sulphocyanides are increased and there is relative immunity from caries; on the other hand, when the saliva is very alkaline the ammonia salts are increased, the sulphocyanide diminished, and caries is rapid.

It is further alleged that during adolescence a fermentable glycogen is often present, which may account for the rapidity of caries in young persons.

The saliva undergoes great alteration in certain morbid conditions of the mouth, or of the general system.

To take the simplest example first: in stomatitis, tonsilitis, or pharyngitis, there is a greatly-increased secretion of buccal mucus; as a consequence of this there is greater acid reaction in the mouth, which is made evident not only by litmus, but by the solution, and consequent disappearance at such times, of deposits of tartar. It is also susceptible of alteration by chronic disorders of the mucous membrane, such as are generally associated with enlarged tonsils, and a granular, flabby-looking appearance of the pharynx (Magitot, *loc. cit.*).

In the course of many acute diseases the secretion of saliva is greatly affected. In small-pox, salivation, often profuse, is met with; but, as a rule, the febrile condition is associated with a dry tongue, from the suppression of the secretions of the salivary glands, and with the formation of sordes upon the teeth, due to a relatively excessive outpouring of buccal mucus. The formation of sordes around the teeth is further favoured by the temporary cessation of mastication, so that the mucus can collect and harden undisturbed.

It is in great part due to such causes that a severe illness often entails great destruction of the teeth; the thickened mucus affords a ready nidus for fermentation, and furnishes also the ferment required, so that the reaction upon the gums becomes strongly acid.

The condition of the oral secretions is markedly dependent on certain chronic disorders, of which, perhaps, dyspepsia exercises the strongest influence.

The fluid poured out by the glands is unusually rich in viscous albuminous constituents, whilst the mucous secretion is greatly increased in quantity. Hence arises that peculiar condition of saliva in which it may be drawn out into strings between the teeth or wherever the mucous membrane is touched by the finger; a condition with which, in association with most extensive caries, every dental surgeon is familiar, and which has already been noticed, so that we, in connection with the subject of Dental Caries, merely note here, that the deposition of tartar composed of carbonate of lime is almost unknown where this condition of mouth exists.

The secretion from the salivary glands may become purulent, and may long remain so. A patient of the writer has had purulent parotid saliva for fifteen years, ever since an attack of typhus (? typhoid), and has suffered no inconvenience beyond dryness and clamminess of the mouth, with very extensive caries (see Trans. Odont. Soc.).

An extreme case of xerostoma or dryness of the mouth is recorded in the Lancet, 1898. No secretion could be expressed from any of the ducts, the mucous membrane was dry, pale and glazed, the lips dry and peeling, the tongue red. No cause could be assigned. Sir Thomas Fraser (Ed. Hospital Reports, 1893) has collected nineteen cases of this rare affection.

A peculiar condition is sometimes met with it, apparently in consequence of the ducts being inadequate to carry off the secretion of the parotid with sufficient rapidity, the gland or portions of it then becoming swollen and tense with a feeling of stiffness. The swelling is induced by the stimulus of food, and passes slowly off, so that in an hour's time there is no trace of it. Hence the practitioner may be consulted about it, but not get the chance of seeing it, for in the few cases which we have met with it comes capriciously, and cannot be always produced at will by the taking of an appropriate food stimulus. We have never met with it in any other gland than the parotid, and it is at most but a small inconvenience.

There is great discrepancy in the results which have been attained in experiments upon the acidity or alkalinity of the saliva.

Thus, Dr. Cushing (Trans. Illinois Dental Soc., 1874) found in a healthy mouth a slight acid reaction to be nearly constant in the neighbourhood of Stenson's duct, and under the tongue; his experiments did not in any way isolate the saliva from the buccal mucus.

Dr. Spalding found that the saliva is alkaline in most cases of rapid decay; altogether the evidence collected by various observers is hopelessly discrepant, as others report that precisely the contrary is the case.

Perhaps the truth may be that the saliva is always alkaline, and the buccal mucus sometimes acid, but sometimes not: and that the after reactions obtained by test papers laid upon the surface are determined by the preponderance of one or the other.

The saliva, together with oral and pulmonary mucus, holds in solution various salts, which are precipitated in greater or less quantity on natural or artificial teeth, in those situations where the fluids of the mouth remain at rest. Epithelial scales and other extraneous matter that may be floating in the oral fluids, or are entangled amongst the teeth, become impacted in the precipitated salts, and thus contribute to form the concretion known as tartar.

According to Berzelius, tartar is composed of—

Earthy phosphates	79·0
Salivary mucus	12·5
Ptyalin	1·0
Animal matter soluble in hydrochloric acid	7·5

A calculus met with in the tonsil consisted of—

Water	22·07
Magnesium phosphate	1·07
Calcium phosphate	67·18
,, carbonate	8·13

But no two analyses of tartar give the same result, for the reason that it varies indefinitely in composition. For instance, if the tartar deposited near the orifice of Stenson's duct be examined, it will be found to contain much carbonate of lime, whereas that from the lower incisors will contain little carbonate, and much phosphate of lime.

Tartar has been described by dentists as of several different kinds, and named from the variation of colour and density it presents. Thus, one sort is called black, another green, a third yellow tartar. The division is not, however, so far as we know, based upon any ascertained chemical difference, and may therefore be disregarded. We conceive that in most instances these physical variations are traceable to the time occupied in its formation, or to the habits of the individual.

Thus, when the tartar collects quickly it is usually soft and yellow; and, on the other hand, when the process is slow, it is dark and hard. Then, again, in those who smoke much, the tartar is of deep brown or black colour. In teeth where one root has been necrosed, and stripped of periosteum, the surface of the dead root is often studded with nodules of very hard greenish tartar, which, during the time of its deposition, has been bathed in pus secreted from the lining membrane of the socket. This tartar is so strongly adherent to the teeth, that its removal is a matter of difficulty; it would seem probable that it is chemically distinct from that which occurs above the level of the edge of the gums, but this is only conjecture.

Many American writers draw a distinction between tartar derived from the saliva, and that which is dark in colour, nodular, and deep within the socket—which they believe to be derived from the blood, and term seruminal calculus. This, however, is by no means proven, and for various reasons appears to be highly improbable. For one thing, it has yet to be shown that any deposit of tartar ever takes place prior to the detachment of the periosteum, so that access of saliva has become possible.

In addition to claiming for it this origin, some American authors claim that such tartar contains uric acid or urates—to this it will be necessary to recur in discussing the nature of pyorrhea alveolaris, so it will suffice for the moment that this also is not proven, if indeed it be not absolutely disproved.

A very curious specimen of tartar was recently given to me which formed a compact nodule on the end of a root, simulating a calcification of an abscess sac. It appears as though moulded to the interior of an abscess sac accurately, and that I believe to have been its origin, it being a deposit entirely filling up an old abscess sac. This was examined by me for urates, with absolutely negative results.

Tartar occurs in a great variety of animals when kept in confinement, but is less common in wild animals; indeed in them it is generally a sign of disease of particular teeth, from injury or other cause, and this would suggest that its frequency in man is in a measure due to diminished use of the teeth, which is a sufficient explanation without calling into requisition alterations in the composition of saliva due to nerve stimulation.

Tartar collects in the largest quantity in two situations: behind the lower incisors, and on the outer or labial surface of the upper molars. Its formation in the latter situation is very readily explained by the fact that parotid saliva, on exposure to the air, deposits carbonate of lime. In the other situation, there is a constant alkaline reaction maintained by the parts being constantly bathed in saliva from the glands; very large depositions of tartar are only possible where an alkaline reaction exists, and hence has arisen the idea that tartar is a preservative of the teeth, whereas the truth is that it can only collect largely in a mouth the condition of which renders the progress of caries slow.

If a vertical section of a piece of tartar be carefully made, it will be found to present a wedge shape, the base of which lies in contact with the gum. The surface towards the tongue or cheek is usually smooth, but that against the gum is rough; and it is to the latter additions are mostly made. The gums become irritated and inflamed from the contact of the rough

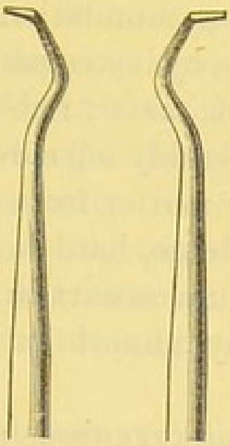


FIG. 267.—Scalers (Mr. Wm. Hern's patterns).

surface of the tartar; the alveoli become absorbed, and the gum recedes, making way for the further accumulation of the salivary salts. To the dental tissues themselves the tartar does no

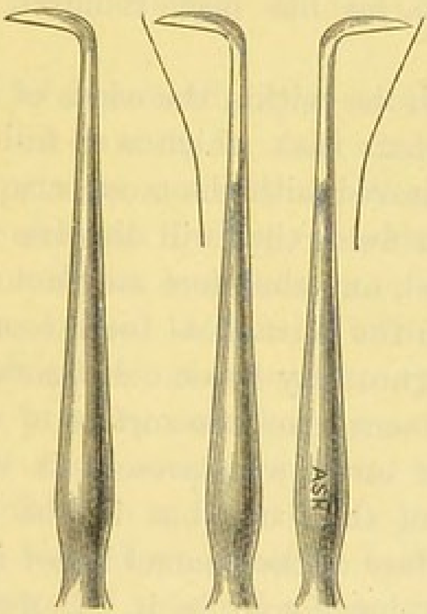


FIG. 268.—Scalers (Mr. E. Lloyd-Williams' patterns).

direct injury, but its effect upon the gums and alveoli is destructive, and hence indirectly upon the teeth by depriving them of their sockets.

This deposition may go to such an extent that not only the crowns, but the whole roots of several contiguous teeth may be hidden in one shapeless mass of tartar. The friction of mastication does much to hinder its deposition, and careful daily brushing will do much to prevent the accumulation of tartar on the teeth, but should an accumulation take place, it must be removed from time to time by instruments fitted for the purpose.

Large accumulations of tartar, rich in organic constituents, render the breath insufferably offensive, and lead to the discharge of fœtid sanious matter from the gums; but the slow accumulation of a very dense, hard tartar in minute quantities along the edges of the gum, occurs in the mouths of the most healthy people, and may almost be considered as a normal occurrence.

Large numbers of micro-organisms are found in tartar, leptothrix forms being the most abundant.

The benefit derived from scaling the teeth, in great measure depends on the thoroughness of the operation; for if small fragments are left, they form nuclei for the deposition of fresh salts. In order to secure the smoothness of the scaled surfaces, they should be polished with pumice-powder on a piece of wood, after the tartar has been removed by suitable steel instruments.

The tartar which lies within the edges of the gum is tenfold nore destructive than that which is in full view, and must be sought for and removed with the most scrupulous care.

Tooth powder or fluids that will dissolve the tartar will also dissolve the enamel, and therefore may not be used.

In young people the permanent teeth soon after their appearance through the gum may become disfigured by the deposition of dark-green pigment upon the surface of the enamel near its terminal edge. If tartar were present it would project from the general level of the tooth, but in the cases of green discoloration the surface of the enamel is not raised.

Mr. K. Goadby has found in it, *B. fluorescens motilis* and *B. non-fluorescens motilis.*

The habitual use of the tooth-brush and the act of mastication gradually rub off the pigment, and the teeth are restored to their proper colour. If, however, the disfigurement remains after the teeth are fully developed and the enamel has acquired density, the unsightly appearance nay be removed by rubbing the part with a piece of soft wood loaded with fine pumice-powder.

As to the nature of this green discoloration, the most diverse views are held : in the tenth edition of Harris's "Principles and Practice of Dentistry," it is said to erode the enamel with great rapidity; but this does not accord with the experience of most writers, who have found it to be perfectly innocuous. It is sometimes met with amongst the lower animals, both domesticated and wild, in whom caries is very rarely seen; and the colour, which is perhaps of vegetable origin, probably occupies the substance of the enamel cuticle; on the other hand the enamel is sometimes found roughened and chalky-looking under it.

It must be remembered that syphilis may be communicated by means of the saliva; out of 1,200 cases 94 per cent. had the primary sore upon the genitals, but 3 per cent. had it in the mouth; and apart from the existence of primary sores infectious discharges may exist. Thus, a sailor tattooed twenty-two people, wetting his needles with saliva, his mouth being at the time covered with sores; out of these no less than fifteen acquired syphilis (Dr. Harlan, Illinois State Dental Soc., 1881).

Kissing, the use of borrowed pipes, tooth-brushes, and the like, have been known to carry it, and whistles, tin trumpets, etc., sold in the streets are not without their dangers; whilst a wound from an elevator during the extraction of stumps from a syphilitic mouth has been known to infect the operator.

In the Western Dental Journal (1890), Dr. Parkes, of Kansas City, records a case of secondary syphilis observed in a young lady, the primary sore having arisen in the socket of a tooth extracted some months before: the gum had been cut around the tooth with a blunt knife prior to the extraction, and a chancre formed which never healed. A gentleman to whom she was engaged acquired a chancre on the lip.

It therefore behoves the dentist to use every precaution as to cleanliness in his forceps, scalers, etc., and for the sake of his patients, as well as for his own sake, to observe all possible precautions in operating upon any suspicious-looking mouth.

The mouth lesions in adults come on rather late as a rule, after six months or a year; they then present themselves as white or slightly excoriated patches, or as simply raised patches; when there is ulceration they are far less tender and painful than their size would lead us to expect, so that painlessness comes to be one of the diagnostic signs of a syphilitic ulcer; after the lapse of longer periods more or less scaly patches, like icthyosis, are met with.

Mouth lesions in the form of mucous patches may occur within a few weeks after birth in children with inherited syphilis.

ABSORPTION OF THE ALVEOLI AND PYORRHEA.

The gradual wasting of the alveolar processes, accompanied by a corresponding recedence of the gums, keeps pace with those general changes which attend the advance towards old age. The necks of teeth become exposed, the gum continues to sink lower and lower till the whole of the roots are uncovered, and the teeth at last fall out. Then the alveolar ridges waste, till, in some instances, the upper jaw becomes nearly flat, and the lower is reduced to a mere bar of bone, almost flat topped. Sir G. Humphrey found that forty-seven centenarians had an average of 4 – 5 teeth each.

Were this only met with in advanced age the dentist might well look upon it as a thing altogether beyond remedy, but unfortunately it frequently antedates any other indication of senility, and even comes on in middle life. Thus, in a middle-aged patient, without any apparent wasting of the gums, the whole of the upper front teeth became excessively loose and fell out. The alveoli were altogether absorbed, or were greatly enlarged; but the presence of any manifest disease, either in the teeth themselves or in the surrounding parts, could not be detected. The gums were not more vascular than would be considered consistent with health, and in the teeth there was a total absence of that horn-like appearance of the roots sometimes seen; indeed, the cause of the malady was too obscure to admit of recognition.

Sometimes, however, the destruction of the socket is more partial.

The more prominent of outstanding teeth are those the sockets of which are most liable to become absorbed; teeth, in fact, the roots of which are but thinly covered by bone and soft parts. This is shown in the case figured. The right upper canine has lost the whole of the anterior wall of its socket, while the contiguous lateral incisor, which lies back, has retained the corresponding part of the alveolar investment.

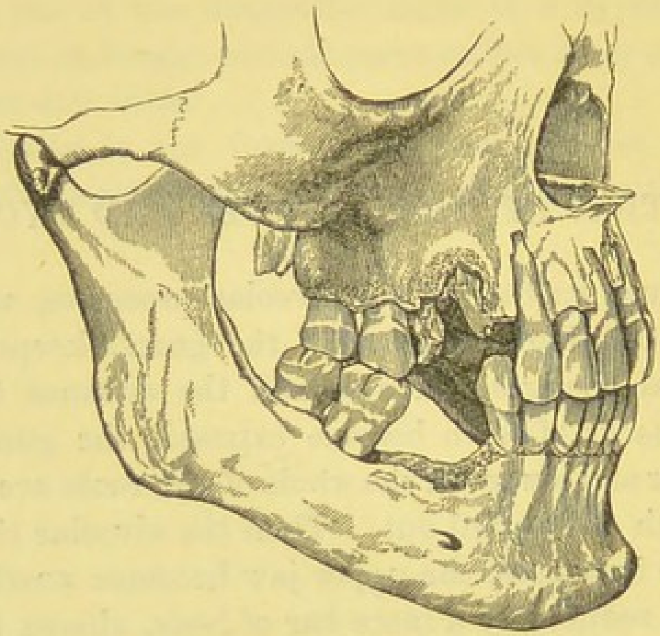


FIG. 269.—The upper and lower maxillæ, from a subject aged thirty, showing extensive absorption of the alveolar processes of the front teeth.

The canine teeth, being the last of the front teeth to take their position, in a contracted jaw are likely to stand in advance of the dental arch. The course taken by the root can be readily

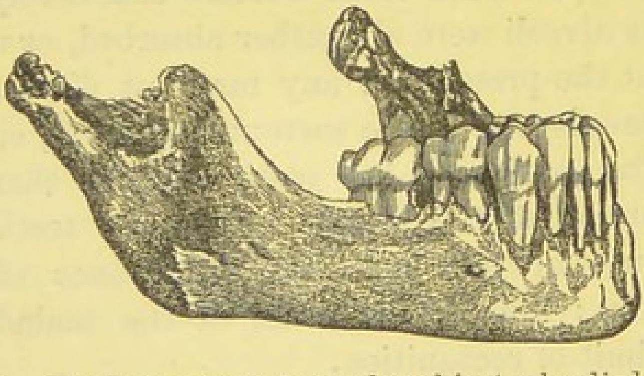


FIG. 270.—The lower jaw of a male subject who died at the age of six years, showing the results of absorption of the alveoli of the temporary teeth.

traced, and the small amount of bone and gum by which its anterior surface is clothed recognised. It is from the roots of a tooth so placed that the anterior and projecting wall of the socket most frequently disappears. The labial surface of the root becomes exposed throughout the greater part of its length, leaving the tooth dependent upon the posterior or lingual wall of the socket for its retention in the jaw. A prominent and comparatively unsupported position would seem to offer an explanation of the early disappearance of the outer plate of the alveolus, but cases are now and then seen to which this explanation could not be satisfactorily applied. A specimen in the author's collection exhibits the full complement of teeth in the upper jaw, sound and well arranged, but from a bicuspid tooth the whole of the labial plate of the alveolus has been absorbed.

It is in many cases very difficult to discover a satisfactory cause for the premature disappearance of the alveolar processes. The presence of inflammation of the gums, or of the alveolar periosteum, or of collections of tartar about the necks of the teeth, and the consequent irritation of the edges of the gums, are followed as a secondary consequence by absorption; but as will presently be seen, these causes do not always seem to account for it. The excessive use of a hard tooth-brush may hasten the wasting of an outstanding socket, the corresponding gum of which has the appearance of being stretched in a thin layer over the neck of the tooth. In such a case it is well to note that the gums are hard and healthy, and it is more than probable that the teeth would not have so long remained in functional activity had it not been for this seemingly over-zealous brushing to which they had been subjected.

Heredity.—When the alveolar loss is general throughout the mouth, it will, on inquiry, very commonly be found that a similar misfortune has befallen other and antecedent members of the family—that the predisposition to an early failure of the teeth, from the recedence of their sockets, is hereditary.

Loss of Function.—Teeth which have no antagonists in the mouth are perhaps more liable to be lost in this way than those which are in full use; and it is not unusual for the bicuspids and molars to be thus shed, whilst the teeth in the front of the mouth remain fairly firm.

The remarks which have so far been made have reference to the loss of teeth in advancing age; but there is a class of cases in which this loss is very premature, and in which it takes place with a rapidity and an amount of inflammatory disturbance which have gained for it a specific name. The discharge, which is a prominent symptom in the more acute cases, suggested the name **pyorrhea alveolaris**, which has passed into general currency, while the warm advocacy of a particular form of treatment, and the consequent attention drawn to its advocate in connection with the disease, has led to the frequent use of the term Riggs' disease; this is to be regretted, as we might as well call small-pox Jenner's disease.

This so-called pyorrhea alveolaris is a progressive periodontitis of a toxic nature, and one of its earliest indications is a reddish coloured thickening and rounding of the edge of the gum, which ceases to be closely adherent to the neck of the tooth, the latter being usually embraced by a ring of hard dark tartar.

In this sulcus or pocket between the neck of the tooth and the free edge of the gum there is generally a little pus, and as the disease progresses, the tooth becomes detached from the soft parts to a considerable depth, so that a chisel-edged piece of hickory wood may be passed up between the root of the tooth and the alveolus. At this stage there is usually a considerable amount of peculiarly offensive discharge, and the breath of the patient has a nauseating odour, by which it is often possible to diagnose the disease before inspecting the mouth at all.

There is sometimes a considerable amount of *neuralgic pain* attendant upon this condition, which is very commonly attended with chronic inflammation of the gums, and may arise as a consequence of scurvy or of mercurial salivation.

On passing an instrument down between the edge of the gum and the neck of the tooth a *thin rim of tartar* will very often be detected, even in those cases in which there is no visible deposit above the level of the gum, and the frequency of its occurrence has led some observers to attribute the whole disease to the irritation set up by its presence. But there are many cogent arguments against the acceptance of such a view: in the first place, in those most acute cases in which the progress of the disease is very rapid indeed, some of the most trustworthy observers have found no tartar at all; whilst, on the other hand, its occurrence in such a situation, if only the gum be parted from the tooth for a long enough time, would be almost a matter of certainty, and therefore much may be argued from its occasional absence and little from its very general presence.

But the causes and pathology of the disease are very obscure; it often arises in thoroughly healthy persons who have hardly passed the period of middle life, and whose teeth have been exceptionally free from caries.

While it must be acknowledged that the pathology of the disease remains uncertain, yet there is good reason for supposing that its original seat is either the edge of the bony socket, or what amounts to almost the same thing, the junction of the gum with the periosteum of the tooth socket; and it bears some little resemblance to a very limited caries of bone, a resemblance which is at least not diminished by the light thrown upon it by the results of treatment.

If a skull, whether of an animal or of man, in which alveolar absorption is going on, be closely examined, it will be found that round the neck of each tooth affected there is a sort of gutter; that is to say, the loss of bone has taken place to the greatest extent close to the neck, and to a much less extent at a little distance from it; in other words, the outer and inner alveolar plates of the jaw resist and stand up like rims.

This appearance is very marked in the early stages of the disease, and strongly suggests that the primary mischief is not in the gum, in which case the outside of the bone might be expected to suffer at all events equally with the immediate surroundings of the tooth, but in the alveolo-dental periosteum.

And if in such skulls the teeth be looked at with a view of ascertaining what relation the tartar (which is not lost by the ordinary processes of maceration, etc., but is always to be found intact) bears to the absorbing sockets, it will be found that there is always, at all events until the disease is very far advanced indeed, a very material interval between the tartar and the surface of the bone, this interval being always beautifully clean; that is to say, the tartar does not approach the bone sufficiently nearly to render it probable that it can directly affect it; if the tartar be a primary cause at all, it must act upon some of the soft tissues, and these in their turn upon the bone.

And it is quite certain that the ordinary light-coloured tartar, such, for instance, as that so abundant upon the backs of the lower front teeth, does not set up the process; on the other hand, the form which is of dark colour and lies within the edges of the gums, between them and the teeth, which is open to more suspicion, could never have got there until the gum had departed from health and had already begun to peel away from the necks of the teeth. Hence we must admit that the loosening of the gums, which we recognise as an early

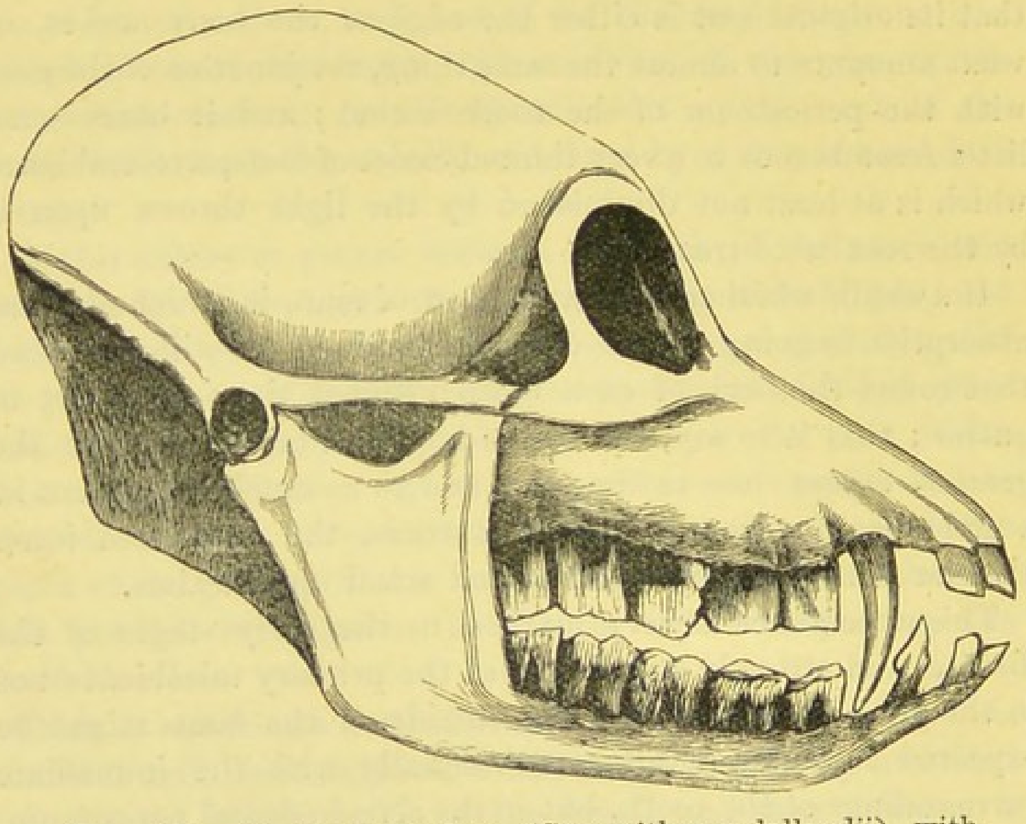


FIG. 271.—Skull of monkey (Cercopithecus lallandii) with extensive loss of alveoli.

symptom of the disease, was antecedent to any influence of tartar.

Mr. Bland Sutton has described the jaws of a monkey (which he has presented to the Museum of the Odontological Society), in which he believes that the very extensive alveolar waste has been due to the effect of tartar, and this is the more significant inasmuch as he is an advocate in general for the existence of a constitutional type of the disease. Although not occurring in man, the case is one of such significance that we have borrowed the figure for reproduction here, though unfortunately it is too rough in execution to show all the points of the case. One side of both upper and lower jaws is almost free from disease, whilst upon the other the teeth are exposed almost to the ends of their roots. The cupped appearance already alluded to is very well marked, the outer and inner plates of the jaws standing up with sharp margins: while there is no appearance of inflammatory affection of the bone beyond the edges, the waste has gone on with singular uniformity along the whole length of the jaws, and there is a great deal of tartar upon the teeth. But there is this peculiarity which would only strike the eye of a dental practitioner—the tartar is mainly of the soft, light-coloured kind, and it extends up upon the working surfaces of the teeth, so that it proves conclusively that this side of the mouth was out of work in the way of mastication for a considerable time prior to the animal's death.

To us therefore it appears quite clear that the bulk of the tartar was deposited after the teeth had become so loose and tender that the animal had ceased to use that side of the mouth, and if the other side be carefully searched the commencement of the disease may be clearly seen upon the sockets of teeth which are apparently quite free from tartar.

Consequently this skull does not appear to us to lend support to the idea that the tartar really was a cause, but rather that its presence was an effect.

In the Museum of the Odontological Society there are skulls of two gorillas, both wild animals, in which teeth have been lost by absorption of the alveoli without other signs of disease.

The opportunity of observing the state of the teeth once occurred to the writer in the followingmanner: a patient, aged only thirty, whose teeth were very seriously and very rapidly attacked, and some of them loosened to the degree that their extraction was needed, partly from impatience and partly as involving less expense and less frequent visits to the dentist, which his circumstances rendered difficult, urged very strongly the extraction of all the remaining teeth of the upper jaw, some few of which were as yet only in the incipient stage, so that he might at once resort to a suction-plate. Although it was a severe case, these teeth which were not as yet greatly loosened, but still presented all the characters of the disease in the way of discharge from around their necks, etc., were absolutely free from tartar.

Mr. Bland Sutton, in one of his exceedingly interesting papers upon comparative dental pathology, has adduced instances of the premature loss of teeth in animals which were affected with general constitutional diseases (Trans. Odont. Soc., 1884).

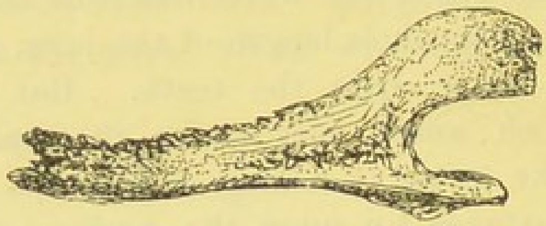


FIG. 272.—Lower jaw of an opossum (*D. cancrivora*) from which the teeth peeled away in the mucous membrane. From Sutton. Trans. Odont. Soc., 1884.

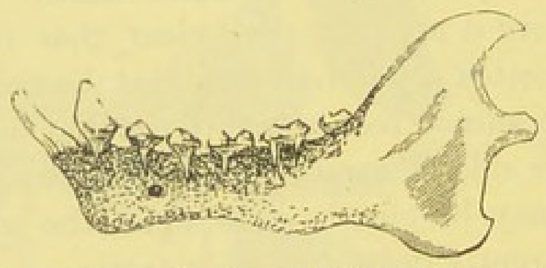


FIG. 273.—Lower jaw of a lemur (*Perodicticus polta*) showing alveolar absorption. From Sutton.

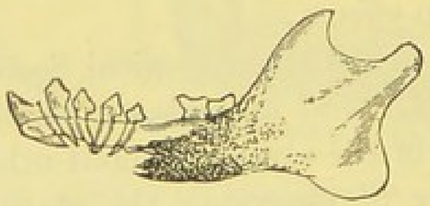


FIG. 274.—Lower jaw of a marmoset showing alveolar absorption. From Sutton.

He instances a crab-eating opossum (*Didelphys cancrivora*), in which the teeth all peeled away with the gum like a row of nails driven through a piece of leather, the bones being so soft that they could be twisted and bent like gutta-percha; all the long bones were affected, the disease being like mollities ossium. In a lemur also, and in a marmoset, the teeth were falling out, and the animals presented unmistakable evidence of general rickets. "With this array of facts before us—and be it remembered these cases are only selections from numbers which come before me—it must be conceded that in animals premature falling out of the teeth is associated with constitutional diseases. Do the same facts apply to the human subject ?"

The following is a remarkable case in point in Mr. Sutton's own words: "During the present year I presented to the Museum of the Middlesex Hospital a skull of an old woman which presented the following peculiarities. The entire skull had suffered general diminution in size and thickness ; its weight is fourteen ounces, as compared with twenty-four ounces, the weight of an average European skull. The alveolar margins have suffered atrophy to such an extent that in the superior maxilla the alveolus is on a level with the hard palate, whilst the lower jaw is nothing but a slender rod of bone weighing one ounce, as compared with three and a half ounces, the weight of a lower jaw of a lad of twenty years. All the bones were affected by this peculiar osteoporotic process.

"In my previous paper on this subject I have expressed myself cautiously as to the probability of premature absorption of the alveolus in man being really not a local affection, but associated with some general disturbance of the osseous system."

Further enquiry into the question has strengthened that conviction. He then goes on to say that there are two kinds of destruction of the alveoli met with in animals: one where there is not a trace of tartar, the other where there is a great deal of tartar: in the former group of cases there is general affection of other bones, in the latter the disease is purely local.

After all it must be confessed that the pathology of the disease remains very uncertain ; there is much to support the idea that a *constitutional* cause is at the bottom of it, for instance it usually occurs with some near approach to bilateral symmetry, and the teeth first affected are often not those most liable to the deposit of tartar.

And even if it be regarded as a purely *local*, and as it were an accidental occurrence, this does not involve the assumption that tartar starts it, and so far as it is possible to draw a conclusion from the imperfect knowledge of the condition which is to hand, we are inclined to assign to tartar a merely secondary influence in the progress of the disease which comes into operation only after the mischief has begun.

A good deal of attention has been given of late years to what is termed the **uric acid theory** of pyorrhea.

The most strenuous advocate of this view, Dr. Pierce, holds that two varieties of deposit are formed upon the teeth, one derived from the saliva, the other from the blood, the latter taking the form of dark, strongly adherent deposit far up upon the root. This latter form of deposit he believes to be in close relation with pyorrhea, and to be a direct result of uric acid in the blood, and claims that in a large proportion of cases of such deposits uric acid can be detected.

Dr. Pierce's paper (New York Odontological Society, 1894) differentiates two forms of pyorrhea—one commencing at the gum margin and extending downwards, which he attributes to calcium phosphate tartar; and a form of pericemental inflammation commencing at or near the apex of the root, without communication with the gum margin, which is affected last, and accompanied with calcic deposits which he refers to the blood, and not to the saliva. These calcic deposits, he says, consist of calcium and sodium urates, and hence he attributes a gouty origin to the whole process.

Uric acid or urates having been found by Dr. Black and others in tartar, it was at first claimed that the deposits deep down in the socket, the dark so-called seruminal tartar, consisted, like chalk stones, of urates, and some perfectly fallacious tests such as the evolution of ammonia on dry distillation, a reaction which would occur in the presence of any proteid, were relied upon.

Later, however, the advocates of the uric acid theory have limited their claims to the presence of a trace of urates, the reactions obtainable being in most cases very feeble; and, it having been recognised that the resemblance between crystals of calcic phosphate and uric acid is close, the murexide test can alone be relied upon.

It has lately been alleged that there is a nucleus of uric acid or of urates, and that the rest of the concretion has formed round this, and this has been said to have been shown by the murexide test.

We are at a loss to see how this can have been done: uric acid does not give the murexide colour test itself, but it has first to be oxidised by means of nitric acid into alloxan and urea, and the alloxan to be subsequently split by heat into alloxantin and other bodies, and it is the product alloxantin which gives the purple colour with ammonia by forming the murexide or purpurate of ammonia.

Hence the tartar under examination must have been brought into solution and evaporated to dryness again, and the original distribution of the salts it contained lost.

The advocates of the hypothesis, and also Dr. Black, who is not an advocate of the hypothesis, say that urates may be detected in a large proportion, if not in all cases; Dr. Talbot, who has had a large number of deposits examined, apparently with every possible care, by two independent chemists, says that it is only present in quite a small percentage of cases (five per cent.) (Dental Cosmos, 1896, pp. 151, 310, 359, 526, 660). There is thus great discrepancy in the results of chemical investigation, which is met by the advocates of the theory by discrediting the accuracy of the observers who do not agree with them, upon the ground that the reaction (murexide) is so delicate that it can easily be missed when quantities are small. But if the deposits "consist of calcium andsodium urates with free uric acid," the reaction would not be a delicate one at all, and could not be missed by any one with the smallest familiarity with chemical manipulation. And if they do not so consist of urates, but only contain a trace of them, thereby they differ from gouty deposits elsewhere, so that it would seem more logical to attribute the effects of the deposits to the substances of which they chiefly consist rather than to those of which they contain traces.

Moreover, there are other bodies which give a coloration like murexide, and such bodies are not at all unlikely to be present in a case which has been treated. Thus, salicin and salicylic acid, and many other bodies belonging to the phenol group so largely used as disinfectants, give a colour not distinguishable (in small quantity) from the murexide.

It may then be granted that in a certain (though disputed) proportion of cases uric acid can, probably in minute quantities, be detected in these deposits, but even were it present in all, it by no means follows that it is the true cause and origin of the disease.

For it must be remembered that uric acid is always present in the blood in small quantities in health : that it is present in increased quantities not only in gout, but also in anæmia and albuminuria : and that we do not know as much as could be desired as to its formation, though it is certain that it is not formed in the kidneys, but only excreted by them. Uric acid is one of the products of the metabolism of proteids, but it is not one of the usual products of proteid putrefaction. And even though a trace of uric acid or of urates—and in small quantity it would be impossible to say in which form it occurred—were found in a deposit of tartar, it by no means follows that it was there originally, for uric acid brought by the blood may have combined with calcium salts already there. But though this is an interesting speculation, and may even hereafter be established, it nevertheless remains for the present a speculation, and there are many weak links in the chain of evidence.

To begin with, there is no proof whatever that deposits do take place without any detachment of gum margin and without possible access of saliva. In mouths affected with pyorrhea, detachment of the gum margin as ascertained by a probe exists over many teeth as yet apparently healthy, and we know of no sign whatever by which any form of pyorrhea can be diagnosed in the absence of such detachment. How then are we to say that it has commenced at or near the apex ?

In Dr. Talbot's large series of examinations the well-marked cases of lithæmia were not the ones in which the murexide test gave a result. And he strongly holds the opinion that gout has nothing to do with the disease, at all events in this direct manner.

Dr. Galippe has performed ("Journal des Connaissances Médicales," November, 1896), as check experiments to those in which he altogether failed to find uric acid or urates in tartar, others in which tartar was similarly treated, but to which a single drop of a solution of uric acid (1 gram to 1,000 grams water) was added. This minute trace of uric acid, about $\frac{1}{1000}$ of a gram, gave distinct colour reactions, thus proving that the test was amply delicate for all purposes. When, however, only one drop of a solution containing 1 gram to 2,500 grams of water was added, the reaction failed, though it succeeded in water or in saliva, so that it was, in this extreme dilution, masked by the other organic and mineral substances present. Dr. Galippe, a most competent chemist, as well as a dental practitioner, has examined a large number of specimens of tartar, and failed entirely to find uric acid by the murexide reaction ; and the author has examined some twenty specimens of dark nodular tartar with the like negative results.

And whilst the question must be regarded as still undecided, we incline to agree with Dr. Galippe : neither from clinical experience, nor chemical examination of specimens of dark tartar, can we see adequate reason to adopt the view. It is claimed that appropriate gouty treatment has been most beneficial in some cases, but this again may arise from improvement of general health without the disease being due to the irritation of urate deposits. And it must not be forgotten that urate deposits, as we know them elsewhere, are easily tolerated, and are not sources of violent irritation, neither is it their habit to set up suppuration.

Another theory of its origin, to which Dr. Galippe gives his adherence, is that it is due to **bacterial infection** ; there is not a doubt that bacteria play an active part when the disease is once started, but whether they can initiate it is a question.

Dr. Miller has, in the examination of twenty-seven cases, found no less than twenty-two different organisms present, and Mr. Roughton has found in the pus of pyorrhea several pyogenic staphylococci and streptococci. Mr. Goadby mentions a short bacillus in addition to staphylococci, which latter appear to differ from the ordinary laboratory culture of that organism. So far as it goes, the treatment found most advantageous lends support to this idea : thus Mr. Roughton has found the most marked and speedy advantage from packing pledgets of wool dipped in a 1 to 2000 sublimate solution into the pockets ; indeed, he complains that the benefit is so immediate that the patient regards it as a complete cure, and is with difficulty induced to persevere with it.

Its constitutional effects may be severe ; a case of septicæmia (reported as pyæmia) from neglected pyorrhea is described by Mr. Verrinder (Brit. Dent. Assoc. Journal, 1896), in which the patient was suffering from rigors, constipation, giddiness and headache, and foul breath, with a temperature of 103° : his teeth were all sound, but he was suffering from profuse pyorrheal discharge. All his symptoms disappeared on the mouth becoming more healthy.

As an example of the effect of a mechanical irritant, it may be mentioned that in America the barbed crowns of *Hordeum jubatum* break into pieces, penetrate the gums of cattle near the teeth, and produce swelling, suppuration and ulceration of the bones, the teeth being so loosened as to drop out.

The cavities of the bone become so filled with broken crowns that they protrude, and may be pulled out with the finger or forceps, and the bones become distorted and enlarged (Nature, January 2nd, 1895).

In the way of **treatment,** the first thing to be done after extracting all teeth which are obviously beyond any reasonable chance of saving, is to remove the tartar, especially that which is within the margin of the gum, for this is at all events capable of preventing the gum from resuming its proper relation with the neck of the tooth.

Where the separation extends far down the root, this may be a matter of very great difficulty. It was claimed by the late Dr. Riggs that the edge of the bone was always in a state of disintegration, and that it should be scraped so as to get a fresh surface; for this purpose he devised a set of instruments somewhat of the form of the pluggers figured upon page 344 (Fig. 158), but larger and having the cutting edges variously disposed, so as to keep a sharp point always, and a sharp edge towards the tooth while there is a safe side towards the gum. This is passed down parallel with the root, and the point used to scrape the bone, an operation which gives a good deal of pain.

There is not the least doubt that a conscientious application of Dr. Riggs' method will in a large proportion of cases effect at least a great temporary improvement, much more than ordinary scaling will effect, and this seems to lend colour to the view that the seat of trouble is at the edge of the bone. But we have seen tolerably severe cases which have seemed to be on the high-road to complete cure, and yet six months afterwards have been worse than ever. Notwithstanding the extravagant claims of some practitioners as to their results, it is but seldom that treatment does more than retard the progress of the malady.

There is certainly no sufficient evidence to support the belief expressed by certain operators that the lost bone is ever reformed.

The use of escharotics is an obviously similar line of treatment, and the pouches between the gum and the teeth may be cauterised; thus Dr. Atkinson advised when the recession is great, and dark bloody pus is exuding, that a caustic paste, made by rubbing together equal parts of carbolic acid and of caustic potash without any water, be passed down to the bottom of the pouches; other writers have recommended chromic acid, and others aqua regia, or solid chloride or iodide of zinc. For less severe cases, iodoform or aromatic sulphuric acid are favourite remedies; Mr. Whatford advises powdered sulphate of copper, with which many operators have had some success, and Mr. Roughton's use of sublimate has already been alluded to.

Mr. W. Hern, in addition to such treatment, advises that a little common salt should be picked up on a wet tooth brush and thus applied to the gums and necks of the teeth daily, or on alternate days; the salt certainly has a marked beneficial effect in reducing the discharge, destroying the offensive odour, and drying up the spongy gum margins.

Frequent and vigorous massage of the gums, by passing the finger firmly over the position of each root in the direction of the crown of the tooth, is often of great advantage: it acts no doubt by tending to free the gum-pockets of discharge, and by inducing a more active circulation of blood in the tissues concerned.

Mr. Kenneth Goadby (Brit. Med. Assoc., 1905, reported in Brit. Med. Journal, Sept. 9, 1905) has carried out some very interesting investigations and experiments in the supplemental treatment of pyorrhea with *vaccines*. This method of treatment has already been described in some detail in the chapter on Bacteriology (p. 216). In Mr. Goadby's hands the cases of pyorrhea thus treated by vaccine injections improved rapidly; in every instance the suppuration along the gum margins diminished and in several cases entirely ceased.[1] As yet this form of treatment can obviously only be safely carried out by

[1] See also Trans. Odont. Soc., March, 1906.

those well acquainted with bacteriology, serums, and the use of vaccines.

Where the patient is young, and the disease has supervened after a period of ill-health which has passed by, the prognosis is more hopeful.

In one case, for example, in which treatment of various kinds was conscientiously carried out, the four upper incisors were lost after ten years from the first appearance of the disease ; from our own experience we regard this not as a failure, but as a relatively successful result.

It must not be thought, from what has been said in the preceding pages, that treatment is of no avail ; there can be no doubt that much may be done to retard the progress of the disease, and that teeth may be preserved for a good many years beyond the period at which they would otherwise have succumbed.

But real and lasting cure is so rare a result that many of the most cautious observers are of opinion that palliation is all that can be effected.

DISEASES OF THE GUMS AND ALVEOLAR EDGES.

Considering their exposed position, the gums are less liable to inflammation than might have been expected. Leaving out of consideration purely local affections of limited areas as a result of inflammation spreading from the root of the diseased tooth, the gums are, however, liable to general forms of inflammation.

It is, perhaps, somewhat difficult to draw the line between inflammation which may be considered to belong to the gums and those in which the gums and the alveolar periosteum both participate.

Chronic inflammation of the gums is often the result of dyspepsia, and it is interesting to note that it is frequently met with in stall-fed animals ; and it is more common in the lower classes, who pay little attention to their teeth, than in the upper classes. Scurvy, syphilis, or the abuse of mercury in the treatment of syphilis, is a not unfrequent cause of the disease in its more general form ; whilst in some persons pregnancy appears to induce a red, angry-looking appearance of the gums, particularly at their edges.

In the mouths of syphilitic persons mucous patches are very common, and there may exist upon the gums as well as upon the mucous membrane of the cheeks patches of psoriasis ; and even something like condylomata may occasionally be seen.

In persons who have been subjected to the influence of lead the gum has a characteristic blue border, caused by sulphuretted hydrogen, derived from decomposing matter, having combined with lead brought by the blood-vessels.

The late Dr. Hilton Fagge (Transac. Med. Ch. Society, 1876) found the discoloration to be in rounded loops corresponding with vascular papillæ, and to consist of granules in and around the smallest blood-vessels.

It may perhaps occur in persons who show no sign of lead poisoning, being then due to a very minute quantity of lead which has obtained entrance into the body.

In a person who kept the teeth very scrupulously clean it might probably be absent, for the sulphur might not be in sufficient quantities; the colour is often distributed in dots, and is most abundant in the processes of gum between teeth: when in an interval teeth are absent there is no lead line. But as it is not very rare in persons who are not known to have been exposed to lead, it is possible that other metals with black sulphides, *e.g.*, bismuth, might cause it.

A condition of inflammation of the gums sometimes occurs under plates carrying artificial teeth, and has, when observed under red vulcanite plates, been attributed to the vermilion with which this material is coloured.

But it occurs also under black rubber, and under gold plates, so that there is really not the least reason for attributing it to this cause.

There is a singular modification of chronic inflammation of the gums, in which, instead of becoming thickened and irregular on the surface, they seem rather to decrease in size, and assume a very red, smooth and polished surface and mottled aspect; at the same time the disease may extend over the surface of the hard palate. The malady is attended with acute intermittent pain, which may be confined to one side of the mouth, or even to half of the upper jaw; it very commonly comes on in the evening, and keeps the patient awake half the night. The patients suffering from this complaint who have come under our notice have been, for the most part, poor middle-aged females, in whom menstruation was becoming irregular, or had altogether ceased; and they have always been cured by the use of a mild aperient—such as sulphate and carbonate of magnesia, given in small doses twice a day. Under this treatment the pain in the gums will probably cease within a week or nine days, and their restoration to a healthy condition will speedily follow.

Chronic inflammation of the gums may assume characters altogether different from those which have been described. Instead of presenting thickening and induration, the tissues may be loose, spongy, and highly vascular, bleeding freely on the slightest touch, and very tender; the gums rise up and cover over a considerable portion of the crowns of the teeth. The papillæ which stud over their surface become greatly enlarged, the vessels which, in their looping and inosculations, form so pretty an object when subjected to microscope examination, become, if not more numerous, greatly lengthened and dilated. The author was indebted to Mr. Roberts for the use of a beautifully-injected preparation of an inflamed and, as it would be called, scurvied gum. It is not from the human subject. After injecting a monkey, he found that the vessels of the thickened and inflamed gums had received the injection. From the preparation so obtained, the illustration is taken.

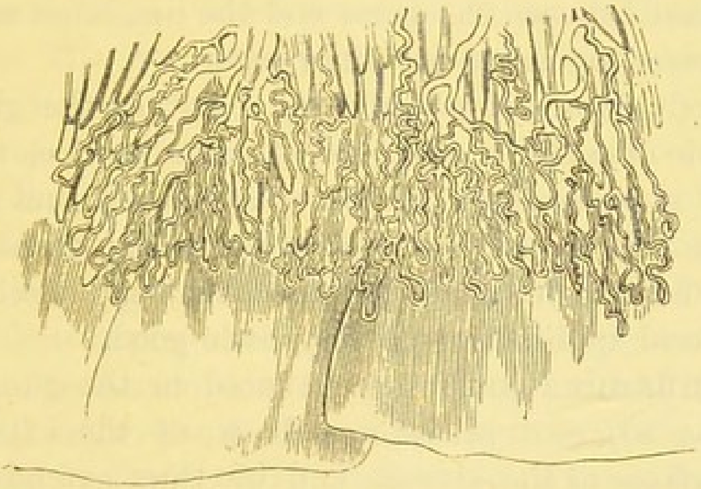


FIG. 275.—Shows the injected vessels of gums inflamed and sufficiently enlarged to cover over and obscure the greater portion of the labial surface of the incisor teeth. The preparation was obtained from the mouth of a monkey, by Mr. Roberts, to whom we are indebted for this illustration.

The condition which has been described may arise in connection with, and as a consequence of diseased teeth; the causes and the complaint itself being in that case strictly local. But in certain states of the system attended with an altered condition of the circulating fluid—in blood diseases, as they are often called—the whole of the gums become similarly affected, and in maladies partaking of the nature of sea scurvy and purpura, this peculiar condition of the vascular tissues about the teeth forms a characteristic feature.

In scurvy the gums are greatly affected; the appearance of the mouth is very peculiar, as the lips and tongue are pallid, and contrast strongly with the blotchy, dusky purple gums rising up between and even over the teeth, and bleeding on the smallest touch.

In severe cases, blood continually oozes from the gums, and these may even slough and lay bare the necks of the teeth and alveoli. The teeth become rapidly loose, and finally fall out.

Scurvy has even been mistaken at first for a sarcoma of the gums : in some cases the hæmorrhagic tumours of the gums are actually large enough to hang out of the mouth. Scurvy is now rarely seen in adults, but it occasionally occurs in children fed upon proprietary foods in infancy, in which case a proper diet brings about a speedy cure.

A somewhat similar appearance is met with in purpura ; in it the contrast between the gums and the lips is not so marked, and the severer lesions do not often occur.

Washes of chlorate of potash, and painting the gums with the glycerine of carbolic acid, are of some service, and when the patient is recovering, the use of astringent and stimulant applications will hasten the restoration of the gums to their normal condition ; but until the constitutional mischief is on the wane, local applications do very little good.

Acute inflammation, when situated in the gums, rapidly involves the adjacent periosteum both of the external and internal surfaces of the alveoli, and by thus extending, tends to mask the original character of the disease, the nature of which, if the case be not seen in an early stage, may be involved in considerable obscurity. The malady, however, extends in another direction, and by so extending its nature becomes declared. The inflammation, at first limited to the mucous membrane of the gums, spreads to that of the mouth. The salivary glands become affected, and pour out an excessive amount of secretion, the flow of which becomes a conspicuous feature in the disorder. When this takes place, the patient is said to be salivated. Although cases of spontaneous salivation are recorded, well-marked examples are rarely met with. As the result of remedies administered for the cure of disease its occurrence is common, but not so common as in former years, when mercury was more frequently used, and its effects were pressed further. In cases of inflammation of the gums so induced, an opportunity of watching the disease from its commencement is afforded.

In *salivation produced by mercury*, the effect is first discernible upon the gums. Some hours previous to the occurrence of the metallic taste, and the fœtor of the breath, and also the soreness and discomfort to the mouth which mark the influence of mercury on the system, the gums show indications that these conditions are about to appear—that the patient will in a few hours be salivated. The state of gum about to be described is, in fact, a premonitory sign of ptyalism, for should it appear, and the mercury be immediately discontinued, yet salivation will come on. The sign is this :—the adherent portion of the mucous membrane of the gums assumes an opaque white colour, contrasting strongly with the non-adherent portion, which preserves its natural hue or becomes more red. The free edge of the gums is movable, but that part which lies over the edge of the alveoli is firmly tied down to the periosteum ; and as the edges of the alveoli present a festooned line, so the whitened mucous membrane presents corresponding undulations. Again, where the mucous membrane is loosely reflected from the gum to the cheek, the natural colour is preserved. The whiteness of gum is produced by an increased secretion of epithelium, which, from being thicker and more opaque than in the healthy state, renders the colour given by the vessels to the subjacent tissue less apparent.

The surface of the mucous membrane, when deprived of epithelium, is studded over with innumerable small conical elevations or papillæ. The thickened epithelium is readily rubbed off the tops of the papillæ, while it retains its full thickness in the intervening depressions ; hence, if closely inspected, the gums will not be seen to present a uniform white hue, but a mottled aspect.

With the increased thickness there is a decrease of tenacity between the scales that form the epithelium, for the surface may be much more readily rubbed off than when in its natural state.

When the condition of mercurial salivation is fairly established, the gum and palate becomes markedly swollen, as does also the tongue, so that it is deeply indented by the teeth. The breath becomes intolerably offensive, and the mouth can only be opened with difficulty.

In bad cases ulceration and consequent hæmorrhage occur ; sloughing and necrosis of the bone may supervene, so that it is not uncommon for the mouth to be permanently closed by cicatrices consequent on the sloughing process.

Aperients should be given, and chlorate of potash both internally and as a wash for the mouth, while Condy's fluid forms an excellent wash for cleansing the mouth and deodorising the breath.

Occasional scarification of the gums, and the topical application of iodine, will assist in restoring them to their normal condition.

In **syphilitic stomatitis** there is no greatly-increased flow of saliva ; the disease tends to destructive ulceration of the gums and superficial necrosis of the jaw. Shallow ulcers form beneath the tongue, and mucous patches appear on the cheeks. Although other evidences are generally present to aid the diagnosis, they are not invariably present. The disease readily yields to iodide of potassium; but it may be noted that in some persons a few doses of iodide of potassium will set up coryza and a profuse flow of saliva, though in this case there is no inflammatory affection of the gums.

The gums are liable to several forms of inflammation which are apt to run into ulceration.

Simple stomatitis is characterised by slightly elevated, reddish, glistening patches, which may coalesce so that the whole surface presents the characters of inflammation. Occasionally whitish patches occur on these surfaces, due to desquamation of the epithelium, or, in some instances, to exudation.

It is very common during the period of first dentition, and is then accompanied by febrile symptoms, but it is probable that the constitutional disturbance is independent of the stomatitis. It may also be produced by irritants, such as stimulating food, and is not unfrequently caused by gastric irritation, drunkards being particularly liable to this and more severe forms of stomatitis.

Its treatment is simple : a dose of aperient medicine, and emollient mouth-washes, being generally efficient in curing it; if the patient be an infant who is being brought up by hand, a little lime-water should be added to the milk.

A **membranous stomatitis** (Journal of American Medical Association," March, 1898) has been described clinically resembling diphtheria, but *streptococcus pyogena* was abundant and no diphtheria bacilli were found and in other cases *Streptococcus P. aureus* has been discovered.

Treatment by application of silver nitrate followed by washes of potassium chlorate effected a speedy cure.

Thrush.—In its early stage this is quite indistinguishable from simple stomatitis; but the patches very speedily become coated with a very characteristic exudation, which is at first closely adherent; but after the lapse of a few days it peels off, only to be replaced by a fresh membrane.

It is a rare disease in adults, but is common in children. It is contagious; but in a healthy child, or in a child suffering from acute disease, it is of little moment; when, however, it supervenes in a child exhausted by chronic disease, it often foretells a fatal termination at no very distant date.

The membrane which gives to it its characteristic appearance is in great part made up of the mycelium of a fungus—the *Oidium* (*Saccharomyces*) *albicans*. As might be expected, it is very amenable to local treatment; such applications as borax, alum, or nitrate of silver speedily curing it; but perhaps the best applications are the alkaline sulphites, or even sulphurous acid itself.

Follicular Stomatitis.—In the first instance, the individual inflamed follicles may be seen as isolated red specks; but they very speedily soften down, and pass into small, round, sharp-edged ulcers. Or the first thing noticeable may be a vesicular, herpetic eruption, the bursting of the vesicles leading to the formation of small ulcers, exceedingly painful, and generally surrounded with a narrow, bright red zone of inflammation.

The ulcers are seldom or never single, and are oftenest found about the frænum, in the sulcus between the lips and gums, or on the lower surface of the tongue.

It is a trivial disorder, accompanied usually by no constitutional disturbance; but it is productive of great discomfort to the patient, on account of the excessive tenderness of the ulcers.

We are inclined to think that some of these cases in which pain quite disproportionate to the local mischief exists, and in which crops of ulcers from time to time re-appear, are really a true herpes, dependent upon disturbed innervation, and analogous to shingles, and should not be considered as follicular in their origin. Of the four or five cases of this kind with which we have met, all were situated on the hard palate.

An occasional touch with nitrate of silver will relieve the tenderness of the raw surfaces, and the use of astringent washes will serve to accelerate their healing. When it occurs in the sulcus between the lips and gums, the teeth must be kept scrupulously clean, and it will often prove advantageous to paint around their necks the glycerinum acidi carbolici; as an application to the surface, the following may be used, applying it on a slip of lint, which is allowed to lie in the sulcus for a short time:—

℞. Acidi carbolici glacialis,
Liq. potassæ, āā ʒj.
Aquæ ad iij.

Though follicular stomatitis is most frequently met with in children, it is not peculiar to early life, but is met with at all ages.

Instead of meeti ng w it u ster of ulcers, we not uncommonly find a single deeply-excavated, small, round ulcer in the sulcus, at the junction of the gums with the mucous membrane of the lips, or on the free mucous membrane. But that the ulcer is single, it might be described as follicular stomatitis; and though it is insignificant both in extent and duration, it is extremely sensitive and troublesome, rendering the movement of the tongue and the act of mastication painful.

If the surface be touched with nitric acid, or nitrate of silver, an almost instantaneous cure is effected; the tenderness is entirely removed, and the patient will feel no further inconvenience.

Ulcerative Stomatitis.—This form of stomatitis is one which frequently comes under the notice of the dental surgeon.

Commencing at or near the edges of the gums, more frequently in the lower than in the upper jaw, and usually on one side only, it may spread till the whole interior of the mouth is a mass of ulcers. The edge of the gum becomes thickened and congested, and has often a pimply appearance; it assumes a deep purple colour, and bleeds at the slightest touch. Ulceration speedily succeeds to this condition; commencing on the edges of the gum, it extends deeply into its substance, in severe cases laying bare the necks of the teeth and the alveolar processes. The mucous membrane of the cheek, where it comes into contact with the ulcerated surfaces, often becomes the seat of similar lesions, so that a line of ulceration corresponding to the position of the teeth runs along the inside of the cheek, as though the ulcers were contagious.

In severe cases ulceration occurs also upon the palate, and upon the margins of the tongue where it touches the ulcers around the teeth.

The malady generally originates in the front part of the mouth, and it is only in severe cases that it extends much to the molar region.

It is said that exudation precedes the occurrence of ulceration. In its fully-developed form, the ulcer is marked by the following characters: the surface is covered over by a dirty white or yellow material, which on removal by a current of tepid water, leaves exposed numerous scarlet points on a yellowish ground, which is made of débris of various sorts. The edges of the ulcer are sharp and ragged, of a colour ranging from violet to a brilliant vermilion, and the ulcers are at first superficial, but as the disease progresses they become deeper.

In cases of any severity, the side of the face is apt to be swollen, and the lymphatic glands enlarged and tender; there is, however, nothing like the extreme induration of the cellular tissue met with in cancrum oris.

The disease may run on for some months, in which case its cure becomes troublesome, and, once well established, it is very prone to recur.

In a subject predisposed to the disease, trivial sources of irritation will serve as its starting point, such as an abrasion, or a carious tooth or a half erupted wisdom-tooth; fracture and necrosis of the jaw have likewise been known to set it up.

Although adults are by no means exempt from attacks of ulcerative stomatitis, the disease occurs very much more frequently in children, especially between the ages of five and ten years. The cases which have come under personal notice have occurred in young people living in crowded localities, and who have been imperfectly clothed and fed. According to Dr. West, however, "it is by no means a constant occurrence for any special derangement of the general health to precede an attack of ulcerative stomatitis, though the children who are affected by it are seldom robust, and in many instances are such as have suffered from deficient food, or a damp and unhealthy lodging, or both." In young children who are but indifferently cared for, the disease in its earlier stages is overlooked, until the suspicion of the attendant is aroused by the fœtid state of the breath, the dribbling of the saliva, and the unwillingness of the child to take into the mouth food or anything that is calculated to produce pain in the ulcerative surface. When the disease is unchecked by treatment, it may lay bare a large portion of the alveoli of several teeth, which, with their sockets, become dead and blackened, and these serve to keep up the malady.

The Treatment of ulcerative stomatitis is usually attended with well-marked success. Local treatment is by Dr. West regarded as of secondary importance, and might, he says, in many cases be omitted without prejudice to the patient. He says, "Lotions of alum, or the burnt alum applied in substance, or the chloride of lime in powder, have all been used locally, with more or less benefit. It was my custom also to prescribe these remedies in ulcerative stomatitis; but since I became acquainted with the virtues of chlorate of potash, I have learned to rely upon it almost exclusively. It appears, indeed, almost to deserve the name of a specific in this affection, for a marked improvement seldom fails to be observed in the patient's condition after it has been administered for two or three days; and in a week or ten days the cure is generally completed. Three grains every four hours, dissolved in water, and sweetened, is a sufficient dose for a child three years old; and five grains is the largest quantity that I have administered to a child eight or nine years old." The general health of the patient must at the same time be watched, and a purgative administered if the bowels require relief. Nutritious food should be given, and in the feeble subjects quinine or other tonics prescribed. In the cases which have come under our own treatment, the administration of these remedies has been followed by the rapid recovery of the patient.

The application of nitrate of silver to the surface of the ulcer at once changes its character, by forming a superficial slough, after the separation of which a healthy granulating surface is left. The excessive tenderness, too, is almost instantaneously relieved. The use of a wash composed of five or six grains of chlorate of soda to one ounce of water will suppress the offensive odour. Teeth which are hopelessly loose, and productive of irritation, should be removed.

Patients suffering from constitutional syphilis are occasionally subject to ulceration in the mouth, indistinguishable from ulcerative stomatitis. The inner surface of the upper lip may be affected, and an ulceration corresponding to each tooth form, and spread on to the gums. There is some risk of adhesions forming between these contiguous surfaces during cicatrisation, so that the patient should be directed to continually keep a slip of lint, steeped in some disinfectant solution, between the affected parts.

Those cases which we have seen have all yielded to the administration of iodide of potassium.

These syphilitic ulcerations are not characterised by the extreme tenderness met with in the ordinary form of the disease.

Galippe has recorded a case of gingivitis in an anæmic girl in which the teeth were quite buried in the swollen gums. General infection, endocarditis and death ensued, but inasmuch as there was a history of alveolar abscess (which, however, had become chronic) it is not certain that the general infection was referable to the gingivitis alone.

A good many deaths have occurred amongst the kangaroos at the Zoological Gardens from an ulcerative stomatitis leading to suffocation through extension of the inflammation to the region of the glottis, but we are not aware that such a result has been recorded in the human subject.

Gangrenous Stomatis. (Noma, Cancrum oris, Phagedæna oris, etc.)

Although this is a disease which would not fall within the province of the dental surgeon, nevertheless he should be able to recognise it, as the only chance for the patient lies in the immediate and decisive treatment of the sore. The course of the disease is frightfully rapid, and the termination almost always fatal, though it is, happily, far from a common disease.

The first thing generally noticed is swelling of the face: this swelling is peculiar in its character, the skin being very tense and shining: the swelling is very hard, dense, and circumscribed, but remarkably free from tenderness; in its centre is a blotchy-looking red spot.

If the mouth be examined, there is seen to be an irregular ulcer, with livid red edges, sometimes in the sulcus, sometimes on the cheek. It is not very sensitive, but produces profuse salivation, and gives forth a gangrenous odour from the very first. It spreads with extraordinary rapidity, the red spot on the cheek simultaneously becoming black and sloughing, so as to open the oral cavity. The destruction of the tissues of the cheek takes place with extraordinary rapidity, and the death of the patient generally ensues in the course of a week. One of the strangest features of this frightfully destructive disease is the absence of pain, and even of great constitutional disturbance: food is usually taken well, even to the very last. The disease occurs in children of debilitated constitutions, and sometimes presents itself as a sequela to acute diseases, its subjects generally being from two to five years of age.

Constitutional treatment can do but little: so soon as the disease is recognised, the ulcer should be freely destroyed with fuming nitric acid; not a moment should be lost, as if gangrene has once fairly set in the case is almost hopeless; some practitioners prefer hydrochloric acid. But as the access of the disease is not always attended with much pain, it is often not treated until it is too late.

ODONTALGIA AND NEURALGIA.

When pain is distinctly referred to a tooth or teeth we speak of it as Odontalgia, but when the tooth is itself free from pain, or the suffering in other parts is so great as to distract attention from it, we speak of it as Neuralgia.

Although toothache is not in itself a disease, but is rather the symptom of many other diseases, it may be convenient to group together the various causes which may give rise to it, referring the reader, for the more minute description of such causes, to the various parts of the book in which they are to be found.

Like all other pain, toothache is more or less intermittent; it is seldom that it is perfectly continuous, or if it be, it will vary greatly in intensity at different times. The character of the pain, as well as its severity, is greatly affected by the condition of the patient; a low condition of bodily vigour, whether produced by over-fatigue, prolonged abstinence, or exhaustion of the system by other causes, will tend to produce pain of a diffused rather than a distinctly localised character, and will markedly increase its severity.

The ordinary **causes of toothache** may be grouped under the following heads:—

1. Morbid conditions of the tooth-pulp.
2. Morbid conditions of the alveolar periosteum and exostosis.
3. Morbid conditions of the periosteum of the jaws.
4. Irritation of the dental nerves by causes not productive of visible local lesions.
5. Ulcerations and inflammation of the mucous membrane and submucous tissue.

Of course, such a classification is merely approximate, and serves only to give some method and arrangement in dealing with the subject.

Under the first head would be included irritation, acute and chronic inflammation of the pulp, pressure from confined matter in the pulp-cavity, and deposit of secondary dentine in its substance. Probably, also, the exposure of sensitive dentine gives pain by setting up irritation of the pulp, as may also caries in its early stages.

Under the second head would come inflammation of the periosteum, acute and chronic alveolar abscess in its various forms, and those lesions which are mainly manifested by alterations of the roots of the teeth, such as roughening by absorption, or increase by exostosis.

Under the third head, traumatic, rheumatic, strumous or syphilitic periostitis.

Under the fourth, cases of malposition of wisdom-teeth, retarded eruption of wisdom-teeth, pressure due to insufficient space, etc.

Under the fifth, the severe inflammation consequent upon difficult eruption of wisdom-teeth, severe salivation, sloughing from access of arsenious acid to the gum, etc.

Pain that is due to irritation, or to chronic or local **inflammation of the pulp**, is rarely continuous, and partakes more or less of a neuralgic character, so that the patient is often quite unable to point out the affected tooth. It is, more often than not, periodic in its access, and is generally absent at the periods of full vigour, as, for instance, after dinner or after breakfast. The same may be said of the irritation due to secondary dentine.

The suffering induced by acute inflammation of the pulp is excessive, particularly if it be in a closely confined space : it ceases more or less abruptly, from the consequent death of the pulp. When, therefore, a patient states that he has suffered for some few hours with a terribly severe attack of toothache, which has departed as suddenly as it came, the inference is that a pulp has violently inflamed and died ; and a careful examination must be made to prevent the occurrence of alveolar abscess, as a consequence of the passage of decomposing matters through the pulp-canal.

The pain is almost always of a violently throbbing character, and it is often attended by extreme tenderness of the whole tooth, which appears raised in its socket ; whether this is really so, is a matter of doubt, as the almost instant relief given by remedies which can only affect the pulp itself would seem to point rather to a sympathetic hyperæsthesia of the nerves of the periosteum, than to actual inflammatory changes. The recumbent posture or active exercise serves to aggravate the pain by increasing the vascular supply.

An inflamed or irritated pulp is almost always hyperæsthetic when tested by alterations of temperature, so that much reliance is usually placed upon the evidence afforded by the application of heat and cold to the tooth. Heat is best applied by contact with a hot instrument, a pellet of heated base plate gutta-percha, or a pledget of wet wool, which should be of some size, heated to boiling point in a flame, and in the event of no immediate response being elicited, it should be re-applied and kept upon the tooth till, upon its removal, the tooth feels quite hot to the finger; cold by contact with a pledget of wool dipped in cold water, or, this failing, a jet of cold water thrown upon it from a syringe.

When relief from pain is obtained by cooling the tooth down below the ordinary temperature of the mouth, and pain returns the moment it gets warm, a violently inflamed pulp with pus formed or about to form at its surface is almost invariably present. But valuable as the test of temperature is, and it is the best we have, it is possible to be somewhat misled, as it sometimes happens that a tooth with an inflamed periosteum will be rendered painful by sudden alterations of temperature, such as that produced by drinking a cup of hot coffee, and there is no doubt that an equable temperature is that which is most comfortable to a slightly inflamed periosteum. But this will be comparatively little affected by heat or cold, applied strictly to the tooth, and so contrived that its effect is not widely extended.

Acute inflammation of the nerve frequently does not come into the hands of the dental surgeon for treatment, as it has often eventuated in the death of the nerve before the patient has the opportunity of seeking relief.

In chronic inflammation, the application of chloroform, carbolic acid, creosote, or thymol to the exposed spot usually gives relief; but in most cases the tooth cannot be saved without destruction of the nerve, so that it is best to apply arsenious acid at once. Curiously enough, this application to a nerve which is already painful seldom increases the pain; in fact, it often gives relief, even before the nerve is thoroughly destroyed, and this it probably does by speedily cauterising the limited spot which is the seat of the greatest inflammation.

When irritation of the pulp seems dependent on exposure of sensitive dentine, a few applications of nitrate of silver to the surface will usually effect a cure.

The pain which is dependent on **inflammation of the alveolar periosteum** is usually not so violent as that last described; it is seldom entirely absent for long together, and is much less influenced by the temporary condition of the patient.

As it proceeds to suppuration it becomes more severe, and in the place of a dull aching, assumes a throbbing character; so soon as the matter has drilled through the bone, the pain is greatly ameliorated, general swelling of the surrounding tissues often being coincident with this amelioration.

The affected tooth or teeth are raised in the sockets, and there is a marked tenderness on pressure, or, at all events, on percussion. Slight feverishness, a furred tongue, and headache may be also present.

For the diagnosis of the various forms of periostitis, the reader must be referred to the chapter on this subject; it need only be mentioned here that rheumatic periostitis may be suspected when the pain is widely spread along the jaw, severe out of all proportion to the local mischief visible to the eye, and capable of being brought on by the changes of temperature, exposure to draught, or damp weather.

Toothache which is due to alveolar periostitis may be relieved by free lancing, and the application of hot fomentations inside the mouth, though in some cases cold gives more relief. The application of stimulants to the gum over the roots is sometimes useful, especially in the case of single-rooted teeth; tincture of capsicum, liniment of iodine, equal parts of tinctures of aconite and iodine, or adrenalin chloride solution may be used for this purpose.

But the extraction of the tooth may often become necessary, especially when the roots have been previously filled with some material not readily removable.

The diagnosis of **exostosis** before the extraction of the tooth is very uncertain, and is often, when arrived at at all, the result of a process of exclusion; though sometimes rather forcible manipulation of the suspected tooth will bring on pain in this condition. A skiagram may be of value.

With regard to malposition of **wisdom-teeth**, it may be noted that the mere fact of the tooth being in an abnormal position will sometimes cause severe pain, without giving rise to any signs of local inflammation; and the mere slow eruption of these teeth will not rarely cause great suffering, even where there appears to be ample room for them to take their place.

Why such teeth should be productive of so great suffering is not very readily explicable, but it is very possible that by

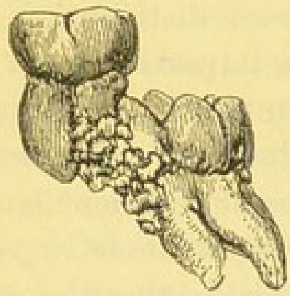


FIG. 276.—Wisdom-tooth lying below the level of the gum, which has impinged upon the roots of the second molar, and, by causing absorption, has laid open its pulp-cavity. From the Odontological Society's Transactions.

the gradual elongation of their roots, as these are formed, they press upon and displace the nerves going to the other teeth.

Pain which is really due to the wisdom-teeth is very often referred to a spot much farther forward in the mouth; the patient will often point to a bicuspid tooth as the seat of his sufferings.

The treatment of toothache is obviously, when possible, to remedy the cause.

Pain caused by difficult eruption of wisdom-teeth will seldom be cured by any other measure than the extraction of the tooth; but relief may be temporarily given by free incisions, cutting away, if possible, the tough overlying gum; and the excessive tenderness of any ulcerated surfaces may be very greatly relieved by very lightly touching them with nitric acid, and afterwards using applications of phénol sodique or cocaine.

A source of great pain, which often escapes detection for a lengthened period, is exposure of the pulp of the second molar, by the pressure of a wisdom-tooth impinging upon it below the level of the gum. The accompanying illustration, borrowed from a paper by Mr. Cattlin, will serve to exemplify this state of things (Fig. 276).

Pain resulting from a diseased condition of a part is by no means invariably referred to the spot whence it really originates, but is felt in some distinct and often remote place. A familiar example of this is afforded by the pain resulting from hip-joint disease, which is referred to the knee, or that from various hepatic disorders, referred to the right shoulder. In many cases it is possible to in some measure account for this change of locality by the known distribution of the sensory nerves, but in others it is quite impossible.

The fifth cranial nerve is very peculiar in all its relations, both as to origin, distribution, and function. It would be out of place here to describe at sufficient length to make it intelligible what is now believed about it; but recent researches, largely those of Dr. Gaskell, threw a new light upon it, and an able summary by Dr. Ferrier of its relations will be found in the Trans. Odont. Soc., June, 1889.[1]

The third, fourth, the portio minor of the fifth, the sixth, and the seventh cranial nerves appear to have once been complete segmental nerves with afferent and efferent roots; in the process of evolution their afferent roots have gone, and only rudimentary traces of their ganglia remain to tell their history.

The lost sensory divisions have, in the case of all of them, been merged in the sensory division of the fifth nerve. But not only has it taken over the sensory work of these nerves, but it has a similar, though less complete, relation with some nerves arising from the medulla.

Thus the glosso-pharyngeal, vagus, and spinal accessory are, so far as the viscera go, complete afferent and efferent nerves; but so far as their somatic (muscles and structures of animal as opposed to purely organic life) afferent fibres

[1] See also Journal of Physiology, vol. x., and Proc. Royal Soc., vol. xliii., 1888.

go, they too, are contained in the sensory division of the fifth.

Hence the very widely-spread deep origin of this nerve, from the site of the third cranial nerve all the way down to the level of the second cervical vertebra ; and the analogy which has been drawn in its case to an ordinary spinal nerve, with its motor and sensory root, proves to be utterly misleading. Its motor root is the half which remains of a once complete motor and sensory nerve, while its sensory root represents a great many sensory roots merged into one.

These facts, here presented with a crude brevity which renders them in some details inaccurate, throw great light upon the reflex pains and disturbances to which the fifth nerve is subject.

It is familiar to physicians that irritation in a viscus, short of gross changes in it, is obscure and is not felt locally, but it is apt to project itself and become expressed in a somatic region, the sensory nerves of which arise centrally close to the splanchnic nerve concerned. Thus stomachic derangement may cause frontal headache without pain in the stomach ; the swallowing of an ice will cause intense frontal pain in some persons ; and the activity of the ovaries and uterus immediately prior to the coming on of the menses will cause intense headache in some women. So, also, a general neuralgia of the fifth nerve may originate in some related visceral nerve, or in some of its own branches, such as a dental branch, without there being any local pain at the point of irritation.

Some interesting papers bearing upon this subject have been published by Dr. Henry Head ("Brain," 1893), in which it is shown that areas of superficial tenderness, sometimes even mapped out by eruptions of herpes, appear upon the skin as a result of visceral disturbance.

So far as the trunk is concerned, it is found that each area corresponds, not exactly to the known distribution of a cutaneous nerve, but to the areas or belts mapped out by loss of sensation in organic lesions of the spinal cord. These tender areas do not overlap, whereas the areas of anæsthesia belonging to each posterior root of a spinal nerve do overlap ; and Dr. Head believes that his areas represent the cutaneous supply furnished by segments of the cord from which the posterior roots in part arise.

But it is not possible here to go further into this question. It must suffice to note that certain visceral lesions do correspond to certain patches of cutaneous tenderness mapped out by pressure with the rounded head of a pin. In these areas the patient sometimes considers that he is being pricked, sometimes complains of a sensation analogous to touching a tender bruise.

In the head various organs, when diseased, give rise to tenderness in definite areas, the nose, eye, ear, teeth, tongue, larynx, and brain giving rise to these manifestations. Herpes, when it occurs, is less diagnostically valuable in the head than elsewhere, as it tends to spread over several areas.

As might have been expected, these reflex pains and tenderness, when due to teeth, are associated almost invariably with pulp irritation and not with periosteal troubles.

According to **Dr. Head's localisations**, tenderness referred from the upper incisors is found on the side of the nose and on the forehead, just to one side of the median line.

That due to the canine and first bicuspid is referred to the upper lip and alæ of the nose; that due to the second bicuspid to the temple, but sometimes to the maxillary area, even above the malar bones.

The first upper molar likewise affects the malar area, whilst the second upper molar affects the mandibular area (chiefly over the ascending ramus); and the upper wisdom-tooth is said to affect the same area, though occasionally the hyoid region is also affected.

The first and second lower molars cause pain in the ear and angle of jaw, and also tenderness in the hyoid area; whilst the lower wisdom-tooth affects the superior laryngeal region.

It is suggested that in difficult eruption of the wisdom-teeth the hyoid area is sometimes affected, owing to disturbance of the roots of the second molars.

The lower incisors and canines are believed to affect the mental area, and the first bicuspid does the like. The second bicuspid is found to sometimes affect the mental and sometimes the hyoid area.

These results, which are exceedingly interesting, require confirmation, and one cannot help doubting whether the localisation is in all cases correct.

Thus the region of the mental foramen is frequently complained of when a lower wisdom-tooth is the cause, and, less frequently, when the first and second lower molars are in fault. One would, therefore, expect that in these regions hyperæsthesia would be felt.

Again, Dr. Head's areas of tenderness affect the whole side of the face and upper parts of the neck, except the immediate region of the infra and supra-orbital nerves. This exception, if correct, is not what one would have expected, and does not agree with the foci of pain given by Valleix (p. 673).

It is further noted that the edge of the tongue is affected when the first and second lower molars are in fault.

So far as it is possible to hazard a guess at the *modus operandi* of neuralgic pain, it would seem as though a so-called radiation took place in the nerve centres, whereby nerve-cells in close contiguity with those irritated become stimulated, and a pain is felt which is referred to the peripheral nerves of these secondarily affected centres.

From a pathological point of view, the disease neuralgia probably has no existence: it is but a symptom indicative of a lesion at some point, which may be discoverable, or may be hidden from our view; and it is not indicative of any one particular lesion, but of a great variety of morbid conditions. Nor, from a pathological point of view, are we justified in separating odontalgia and neuralgia from one another, seeing that the two arise oftentimes from precisely the same cause.

In neuralgia pain is the prominent, indeed, often the only symptom; but it must be recollected that, after all, it is only a symptom, and not a disease *per se.* On this point Trousseau[1] says, "Whether the neuralgia be due to chlorosis or to a carious tooth, it is still a symptom, in the first case, of chlorotic cachexia; in the second, of the caries of a tooth. As we shall see presently, there is a great difference between these two forms of neuralgia, as regards their obstinacy and their degree of curability, but not as regards *pain.* All neuralgias, regarded as painful affections, resemble one another—with the exception, however, of that neuralgia which I have called epileptiform. It is certainly true that the cause of the neuralgia most

[1] Trousseau, "Clinical Medicine," vol. i. "On Neuralgia." New Sydenham Society's Translation.

frequently possesses a manifest influence on the recurrence, the duration, and the period of invasion of the paroxysms of pain, as well as on the seat of the pain; but the pain itself exhibits very nearly identical characters."

To take a definition of neuralgia, it may be described as "a disease of the nervous system, manifesting itself by pains which, in the great majority of cases, are unilateral, and which appear to follow accurately the course of particular nerves, and ramify, sometimes into a few, sometimes into all the terminal branches of those nerves. These pains are usually sudden in their onset, and of a darting, stabbing, boring, or burning character; they are at first unattended with any local change, or any general febrile excitement. They are always markedly intermittent—at any rate, at first; the intermissions are sometimes regular, and sometimes irregular; the attacks commonly go on increasing in severity on each successive occasion. The intermissions are distinguished by complete, or almost complete, freedom from suffering, and in recent cases the patient appears to be quite well at these times; except that for some short time after the attack, the parts through which the painful nerves ramify remain sore and tender to the touch. In old-standing cases, however, persistent tenderness, and other signs of local mischief, are apt to be developed in the tissues around the peripheral twigs. Severe neuralgias are usually complicated with secondary affections of other nerves which are intimately connected with those that are the original seat of pain; and in this way congestion of blood-vessels, hypersecretion, or arrested secretion from glands, inflammation and ulceration of tissues, etc., are sometimes brought about."[1]

To this Trousseau (*loc. cit.*) would add that there is invariably—or, at all events, so constantly that the character is available for diagnosis—tenderness over some of the spinous processes; in the case of the fifth nerve over the first two cervical vertebræ; though this statement is challenged by Dr. Anstie (*op. cit.*, p. 10), who says that these tender points "are not *characteristic* of neuralgia" (the italics being his), and that they may be present in a variety of other affections. Trousseau goes on to say, "I will give another illustration;

[1] "Neuralgia and its Counterfeits." F. E. Anstie, M.D.

in toothache, arising from the presence of a false tooth with a pivot, the spinous processes are not tender on pressure, however acute the pain may be; but if this pain, which is at first limited to the locality of the tooth—in the lower jaw, for instance—extends to the inferior maxillary division of the fifth, then to the superior maxillary branch, and lastly to the ophthalmic, the spinous processes then become tender on pressure, and the case is one of neuralgia."

The author's experience does not enable him to speak very positively as to the constancy, or the contrary, of this tenderness over the first two cervical vertebræ in cases of neuralgia distinctly dependent on the teeth, though he has more than once met with it.

Whether the exact localisation of hyperæsthesia attempted by Dr. Head will be found to hold good or not, it is certainly a character of neuralgia, proceeding from any cause, to particularly affect certain spots, which were first pointed out under the name of "foci" of pain by Valleix. In the case of the fifth nerve these are rather numerous; namely, one at the supra-orbital notch, one in the upper eyelid, one at the emergence of the nasal branch at the junction of the nasal bone and cartilage, one within the eye, and one at the inner angle of the orbit; these all belong to the ophthalmic division of the nerve, which is perhaps the one least often affected in dental neuralgia. In the superior maxillary division the following are the usual foci: infra-orbital, where the nerve emerges from its bony canal; the malar, on the front surface of the malar bone; the palatine, where the anterior palatine nerve emerges; and, lastly, the whole alveolar border.

In the inferior maxillary division of the fifth nerve we have the temporal, a point a little in front of the ear on the course of the auriculo-temporal nerve; the inferior dental, the lingual and the labial, which are more rarely seats of pain.

But the focus most commonly affected in neuralgia, due to any cause, is a point where a number of nerves inosculate, near to the parietal eminence which is known as the parietal focus. A case in which this last focus was affected has lately been under treatment: the cause of the neuralgia was irritation of an exposed pulp in a second upper molar, which however was so far protected by the position of the cavity that it was rarely touched in mastication. When, in the course of examining the tooth, the exposed nerve was touched, a paroxysm of intense pain in the parietal focus was instantly felt, for the relief of which the patient, applying both his thumbs to the spot, made pressure with his whole strength. Pressure was the only thing that gave any relief; and, according to the patient's own account, it prevented the spread of the pain from this limited spot over the whole side of his head, which was otherwise apt to occur as the paroxysm was passing off. No pain was felt in the tooth, save just at the moment when the instrument touched the pulp.

Besides manifestations of pain at various foci, congestion of neighbouring parts and hypersecretion are met with from time to time: thus a few years ago the writer saw a patient in whom, by touching an exposed nerve in a first upper molar tooth, he could at will produce injection of the conjunctiva, a profuse flow of tears, and an outpouring of saliva. With reference to the latter effect, the patient's spontaneous statement was that he had applied to another practitioner for relief from the pain he was suffering, and this gentleman had put something into his tooth which had aggravated the pain and had salivated him.

Sometimes the pain felt is referred to a perfectly innocent tooth, often the corresponding tooth in the other jaw; this perverted sensation is occasionally so definite, that it is a matter of difficulty to persuade the patient that the source of his troubles is not where he feels the pain. Thus a gentleman lately requested the writer to extract a perfectly sound second upper molar, the tooth affected being the corresponding lower molar, of which the pulp was exposed. Nitrous oxide was administered to him, and the lower tooth extracted; but, so soon as he recovered, he exclaimed, "You have taken out the upper tooth after all;" nor could he be persuaded, until he had felt the vacant space with his fingers, that such was not the case, thus affording a striking evidence of the correctness of the inference that the lower tooth had been the real cause of the pain.

Although in most cases of dental neuralgia, pain is confined to the various branches of the fifth nerve, in any of which it is common, it may extend to the side of the neck, to the shoulder, and even the arm of the affected side, which may be subject to a sense of lassitude and weariness almost amounting to slight paralysis (Salter).

A remarkable form of neuralgia has been described by the late Dr. Gross, Professor of Surgery at Philadelphia, as occurring in edentulous jaws, or in spaces from whence teeth have been removed.

In these cases the pain is generally distinctly localised, its seat being the wasted alveoli and the gum which overlies them. It occurs exclusively in elderly persons, and comes on gradually, proceeding, however, from bad to worse, until the patient's health is worn out by constant suffering. Like other forms of neuralgia, it is most severe at periods of depression, and is often temporarily relieved by the administration of quinine.

The explanation of the pathology of the affection offered by Professor Gross is, that the minute nerves distributed through the wasted alveolar border have undergone compression from the deposition of osseous matter in the canals; and some support is lent to this view by the fact that the bone was found to have a dense, ivory-like consistence, when cut down upon at the affected spots, and the overlying gum was dense and unusually adherent.

In each case recorded, Professor Gross, after the failure of other remedies, resorted to the excision of the affected portion of alveolus, which in most cases effected a permanent cure, and in all produced great alleviation of the symptoms.

There is a form of neuralgia, named by Trousseau, **epileptiform neuralgia,** which, so far as we know, has never been traced to the irritation set up by diseased teeth.[1] In it the pain is frightfully intense, exceedingly sudden in its access, and brief in its duration, passing off as suddenly as it came. In a large number of cases the attack is accompanied by severe convulsion of the facial muscles, causing the patient to make frightful grimaces. This form of the disease is met with during the decline of life, and is quite incurable, though periods of temporary relief may occur. It is not uncommon for the

[1] As a caution to the dental surgeon, it may be mentioned that Trousseau records a case in which the paroxysms were brought on by speaking, eating, or drinking, or *by touching with the tip of his finger his few remaining teeth.* These teeth were extracted without affording the least relief.

movements of the jaw in mastication to bring on che attacks, so that nutrition is seriously interfered with ; and as the disease progresses, the neuralgic foci before described become exquisitely tender. Trousseau remarks on points of similarity between this disease and epilepsy, more particularly "petit mal," and convulsions limited to a single limb ; and again on a resemblance between it and angina pectoris ; while Dr. Anstie states that it is sometimes associated with a strong family taint of insanity, and often with melancholia in the individual.

The periodicity of neuralgic attacks has been already alluded to: Dr. Cayley [1] divides facial neuralgia into two classes—the periodic and irregular. Of the former he mentions that the attacks are usually daily—when the disease is due to malaria they are prone to come on in the morning, and when due to other causes, in the evening. It may be here mentioned that the attacks, when it is dependent on diseased teeth, almost always come on in the evening.

As Trousseau ("Clin. Med.") points out, diseases of the nervous system, such as epilepsy, catalepsy, certain kinds of chorea, and many other convulsive affections, frequently assume not only an intermittent, but a periodic type; and there seems to be some little connection between these various neuroses—in so far, at all events, as the tendency to inheritance goes—for it will often be found that different members of the family will suffer from various forms of nervous disorders.

It is very generally supposed that no morbid changes in the nerve can be recognised in the majority of cases of neuralgia; this may perhaps be due to the imperfection of our methods of investigation, but in some few cases distinct lesions have been made out. Thus Wedl ("Pathologie der Zähne," p. 345), in examining several nerves which had been resected by Schuh, found that the neurilemma, the medulla, and the axis cylinder were alike occupied by granular deposits in patches; and in one case he distinctly made out that the axis cylinder was in a measure obliterated by strongly refractive calcareous masses.

Pigmentation and increased vascularity of the neurilemma were likewise observed in some few cases. Hence Professor Wedl concludes that in inveterate cases of neuralgia neuritis

[1] Archives of Dentistry, vol. i.

and consequent degeneration of the nerve structure, are apt to ensue; but he regards this as distinctly secondary, and as resulting from peripheral irritation.

Central lesions have also been observed in some few cases. Thus Schuh ("Gesichtsneuralgien," § 19) records a case of severe neuralgia, in which calcareous deposits existed in *both* gasserian ganglia; on the affected side there was enlargement of the ganglion from increased vascularity and exudation. In other cases lesions at the point of origin of the nerve have been detected. Still, in the majority of cases the most minute examination reveals nothing whatever, and the rapidity with which a perfect cure may be effected in some instances is a strong reason for regarding the derangement as more frequently functional than structural.

But the various authorities are not by any means agreed on the subject of the pathology of neuralgia. Thus Trousseau says in cases "in which a local pain gives rise to a neuralgia, the spinal cord is influenced, and then, through reflex action, excites neuralgia, in which it appears to be always involved."

Dr. Anstie (*op. cit.*, p. 110) regards the posterior roots of the nerves as the real seat of neuralgia, and holds that the essential condition is *atrophy, which is usually non-inflammatory in its origin.* But the instantaneous cure of a neuralgia, which we not uncommonly meet with after the extraction of a tooth, or even after the destruction of the pulp by arsenious acid, appears to us to clearly indicate that all the phenomena are possible without central degenerative change; or, at all events, that the central change is not enough to produce the neuralgia after the cessation of the peripheral irritation.

Amongst the **causes of neuralgia** the following may be enumerated: chronic inflammation of the pulp; difficult eruption of wisdom-teeth; secondary dentine in the pulp-cavity; decomposition of a dead pulp in a confined space; exostosis; alveolar periostitis (rarely), which may depend on the escape of decomposing matter through the pulp-canal, or on roughening of the root by absorption; exposure of sensitive dentine (rarely); and, in fact, almost every diseased condition which affects the teeth. Besides these, facial neuralgia may be due to periostitis in any of the bony canals through which the nerve-trunks pass, or to osteophytes diverting them from their course. Inflammation of the mucous membrane, or the periosteum of the antrum, may involve the superior dental nerves which pass along the antrum in open grooves, and not in bony canals, and so give rise to neuralgia.

With reference to the influence of the teeth, the late Dr. Anstie says: "It is an undoubted fact that they may cause neuralgia even of a very serious type, and attended with extensive complications—as in Mr. Salter's cases, already mentioned, of reflex cervico-brachial neuralgia from carious teeth. Looking to the extreme frequency of caries, however, as compared with the rarity of true *neuralgia* (not mere *toothache*) as a consequence of it, it is impossible not to suppose that the share of the carious teeth in the production of such neuralgia must be very small, compared with that of other influences." Whilst every one must admit the rarity of neuralgia as compared with dental caries, we think that few dental surgeons would endorse the concluding passage of the sentence.

But an explanation of such being the opinion of one who has had such extensive experience as the late Dr. Anstie, is not, we think, difficult to find; and it rests in this, that the most typical cases of neuralgia produced by teeth are just those in which—partly from the absence of all local pain, and partly from the prevalence of a mistaken notion on the subject—the teeth are never suspected. Thus, Dr. Anstie says that the pain in these cases (*op. cit.*) is far less affected by variations in bodily health, and far less amenable to relief from remedies, than in other forms of the disease; and Trousseau apparently holds the same opinion. Now, although this is perfectly true where there is any considerable amount of local inflammatory action, it most certainly does not hold good of the commonest cause of all in dental neuralgia, namely, a very limited chronic inflammation of the tooth-pulp, which will be more minutely described hereafter. Patients suffering from this are eminently susceptible to various causes tending to depress their bodily vigour; thus a too prolonged abstinence from food, over-fatigue, exposure to cold, etc., will bring on or greatly aggravate the paroxysms; and, on the other hand, they are eminently susceptible to the action of remedies such as quinine. A full dose of quinine will almost always give relief in these cases;

and if taken nightly, an hour or two before the time of recurrence, will often avert the paroxysm.

It must be remembered that the power of a given lesion to set up pains of neuralgic type varies immensely according to the state of the patient.

With the exception that diseases of the teeth very rarely set up neuralgia of the most extreme severity, we do not know of any character by which the malady thus set up differs from that due to more recondite causes; and nothing save a most minute examination of the teeth will enable the practitioner to form a correct diagnosis. There is no more fertile source of error than to suppose that amelioration, or even temporary cure, indicates that the cause is not a tooth. In fact, it often happens that the question whether a tooth shall give rise to slight local pain, which may even be altogether absent, or to neuralgia, is determined by the condition of the patient at the moment. The conditions which seem most often to predispose to neuralgia are the exhaustion of overwork; women are also specially subject to neuralgia, as opposed to toothache, in the early months of pregnancy.

In such cases the administration of a full dose of quinine, or a glass or two of good wine, will almost always effect a temporary cure.

But the preceding observations apply mainly to the neuralgia which is set up by chronic local inflammation of the tooth-pulp—conditions which are not necessarily productive of pain at all. With regard to those cases in which more extensive inflammatory mischief exists—as, for instance, round unhealthy stumps—the remarks of Dr. Anstie and of Trousseau, as to their obstinacy under general treatment, hold good.

Seeing, then, that there is no character by which neuralgia dependent on the teeth can be distinguished from the other forms of the disease, it becomes necessary to examine somewhat minutely the various morbid conditions of the teeth which are capable of setting it up.

Although these disorders of the teeth have been described elsewhere in this work, there are some few points in connection with them which call for further mention here. By far the most common cause is chronic inflammation of the pulp; and with regard to exposure of the pulp, it may be remarked that violent local toothache and well-marked neuralgia do not commonly co-exist; the local pain and the diffused pains seeming to stand, in a measure, in a complementary relation to one another. An examination of teeth which have set up neuralgia serves to account for this fact, for the pulp is generally found to be healthy save at one spot, where there will be a limited patch of chronic inflammation, superficial and of small extent. These local inflammations of the tooth-pulp, which are to be found where the situation of the cavity is such that the exposed nerve is but little subject to irritation from the chance contact of food, etc., by no means always give rise to local toothache, even though they be capable of causing excessive neuralgia.

So long as the exposed nerve escapes acute inflammatory attacks, no pain may be felt in the tooth; the patient finds that he gets relief from the use of a generous diet, from change of air, and the administration of tonics, and hence wrongly concludes that there is no discoverable local lesion. At the risk of recapitulation, let us once more insist that perfect freedom from local odontalgia, periodicity in the paroxysms of pain, amelioration, and even absolute temporary cure of the symptom under the use of quinine and the like remedies, must not be taken as indications that the disease has no local cause, and that this local cause is not likely to be a tooth.

When an exposed nerve has been the cause of such pain, it very commonly happens that a paroxysm may be brought on by the touch of an instrument, though this is not invariably the case, and it may sometimes happen that, from the partial obliteration of the pulp-cavity by calcification, it is very difficult, or even impossible, to reach the remnant of the nerve. And although a nerve which has become in great part obliterated by progressive calcification does not often give rise to pain having a diffused character, still instances of its doing so are now and then met with. A patient lately presented himself for examination, who had suffered from pain extending over the whole side of the face and head for upwards of a month, to such an extent that he had not obtained a single night's rest without the administration of sedatives; he had not the smallest abnormal sensation in any of his teeth, and only came to see the writer at the very urgent request of his medical attendant, being himself convinced that the teeth had no share in producing his ailment. The only tooth which presented any sign of decay was a bicuspid, which stood alone in the mouth; the carious cavity was fully visible on its mesial surface, but had become hard and polished by the effect of mastication, so that caries was not progressing in the tooth. No pulp-cavity was apparently left, the space which it had occupied being filled up with secondary dentine, and being perfectly insensible to a light touch of an instrument, or a jet of ice-cold water.

Nevertheless, as no other cause could be found, and as pressing an instrument firmly over the situation of the pulp-cavity caused an uneasy feeling, this tooth was suspected, and accordingly drilled into in the direction of the pulp-canal, which was opened up and a very fine nerve-extracting instrument passed in. This did not at the time cause more than a momentary sensation, but after the lapse of several minutes a most acute paroxysm of neuralgia came on. Seeing that, from the flattened form of a bicuspid, there was little chance of extirpating the remains of the nerve with an instrument, a very small quantity of arsenious acid was passed up the root and allowed to remain there. From that time the patient had no recurrence of pain, and after a few weeks the tooth was filled—a matter of some importance to him, as it served to support some artificial teeth. It may be thought that in this instance the neuralgia was due, not to the exposure of the pulp, but to the presence of osteo-dentine in the canal. This may have been the true cause; but, as a general rule, the pain due to osteo-dentine is of gradual development, whereas in this instance the pain began in nearly its full intensity; moreover, it is usual for pain due to partial calcification to be more distinctly localised, so that the patient is enabled to point out the affected tooth.

The following case will serve to illustrate the neuralgias dependent on eruption of wisdom-teeth.

A gentleman, æt. 28, had suffered for about six months from agonising neuralgic pain in the left eyeball. The attacks were strictly periodic, occurring about seven in the evening, and again about three o'clock in the morning, the latter attacks being the most severe. His health had suffered greatly from the long-continued pain and deprivation of rest, and he had ceased to gain much relief from tonics. On the left side all the teeth were perfect; but the upper wisdom-tooth, instead of occupying its proper position, where there was plenty of room for it, lay horizontally, with its crown directed outwards towards the cheek. As it was a source of irritation to the cheek, it was removed, though without much expectation of its relieving the neuralgia. However, the patient never from that moment had another attack; and on examining his mouth some nine months afterwards, the writer was greatly surprised to find that another tooth had come down, and was partly erupted in the normal position for the wisdom-tooth. That the extracted tooth lay in close relation with this second

FIG. 277.

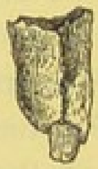


FIG. 278.

FIG. 279.

wisdom-tooth is indicated by its roots bending nearly at a right angle close to their ends.

A case of neuralgia dependent on exposure of a nerve in the second molar, brought about by the pressure of a wisdom-tooth, has already been mentioned in the section relating to toothache.

Various alterations in the roots of teeth may give rise to neuralgia: Figs. 277 and 278 represent teeth which were extracted on account of neuralgia, and were brought before the notice of the Odontological Society (by the kindness of the Council of which they are reproduced here) by Mr. Cattlin.[1] In the one case there is a nodular exostosis (Fig. 277); and in the other (Fig. 278), the end of the root has been partially absorbed, and left roughened and irregular. In the same paper is recorded a case dependent on the root of a canine tooth being prolonged to a fine point, almost as sharp as a

[1] Transactions of the Odontological Society, vol. iii.

needle: in this instance the source of irritation was detected by making the patient bite upon a hard substance with each tooth in succession (Fig. 279).

A root which is a source of great irritation may become covered over with healthy gum, and so effectually concealed that its presence can only be detected by the use of a sharp steel probe. If such an instrument be pressed firmly through an edentulous gum, so as to reach the bone, it will readily enter it, and be slightly held by it, so that there is some sense of resistance in withdrawing it; but if it come upon the hard surface of a tooth-root, it will not enter it at all. This affords a ready means of detecting a buried tooth-root; as, if the surface of the root be softened to such an extent as to be penetrable by an instrument, it rarely becomes completely buried and covered by healthy gum. We have lately seen an instance of occasional slight neuralgia kept up by a very small fragment of the end of the palatal root of an upper molar, broken off in extraction some six or seven years previously. Occasionally a minute pustule would form on the gum over it, which led down into a narrow track only large enough to admit a fine nerve-canal instrument, but nothing hard could be felt at the end of the track. However, as the patient recollected the extreme end of the palatal roof having been broken off, the track was enlarged by passing into it silk threads, carrying a paste made of potassa cum calce moistened with glycerine. By the use of this agent such a purpose can be effected, in successive applications, with surprisingly little irritation to the surrounding parts, and no pain worth consideration. In this particular instance the tooth-root descended towards the surface when room had been made for it to do so, and was easily picked out by fine forceps.

The fragment was found to have undergone partial absorption, and was much in the same condition as the tooth represented in Fig. 278.

In those cases of neuralgia in which the cause of the pain is not tolerably apparent after a careful examination of the teeth, the situation of the pain will often throw some light on the matter; though it must always be recollected that irritation applied to any part of the fifth nerve may give rise to pain at any other.

We have hitherto regarded the following situations of pain as indicative of the points of lesion. When the pain is most severe in the parietal region, or at the upper part of the temple, the affected tooth is generally in the upper jaw, and far back in the mouth. When it is referred to the eye, which is rather rare, the tooth may be found in any part of the upper jaw.

Pain referred to the ear, or the region of the temporo-maxillary articulation, is almost diagnostic of a lesion in the lower teeth, generally towards the back of the mouth. But Dr. Head's observations call for re-examination of these beliefs.

Wherever there is distinct reason for connecting one or more teeth with the origin of the pain, no dental surgeon will hesitate for one moment at removing such teeth, unless he sees his way clearly to curing the morbid condition by conservative treatment.

There are, however, many cases of neuralgia, really dependent on the teeth, in which it is almost impossible to be certain of this before their removal. For instance, there may be many stumps in the mouth, any one or all of which are perfectly capable of setting up the irritation, but there may be no symptoms to identify any particular one with the disease. Where there is the least sign of inflammation about the stumps, we should not hesitate to advise the removal of every one; and, even where no apparent inflammation exists, all useless stumps or roots are far better away in any case of persistent neuralgia.

With reference to the extraction of teeth in neuralgia, some difference of opinion appears to exist. Thus Dr. Anstie says, "I admit also, though with much greater qualification, that carious teeth may need to be extracted before we can cure a neuralgia; but even here I should put in the decided *caveat* that we must consider whether the system is in a state to bear the shock; and that, in any case we probably ought to mitigate the effects of the operation by performing it under chloroform. And I need hardly tell any one who is familiar, either practically or from reading, with the subject, that thousands of carious teeth have been extracted from the mouths of neuralgic patients, not only without benefit, but with the effect of distinctly aggravating the disease."

It is possible that in some of the cases where distinct aggravation of the pain has followed the removal of the teeth the patient may have been suffering from so-called epileptiform neuralgia, or under that form of neuralgia described by Professor Gross in edentulous parts of the jaws; but it must not be forgotten that a large number of neuralgic patients are nervous, more or less hysterical, women; and every one at all familiar with either hospital or private practice will know only too well the strong tendency to ascribe to an operation which has brought no relief, not only the aggravation, but even the original causation of the condition which it was intended to remedy. So that the patient's own statements on the matter of the disease being aggravated by a dental or other operation, must, in the absence of corroborative evidence by which the medical man can form his own opinion, be accepted with great reserve.

Schuh[1] considers that it is possible, though unusual, for neuralgia to be induced by the extraction of teeth; and Wedl, seeking to account for it, does so on the assumption that the pathological changes which have been observed in some few cases are the real sources of neuralgia. He points out that in caries, inflammation of the tooth-pulp leads to degeneration of whole bundles of the nerve-fibres, whereas in the neuritis of neuralgia only a few nerve-tubes are thus affected; and that in this difference between the two conditions, a real distinction is implied.

But, in the first place, neuralgia is more often produced by a local than by a general inflammation of the tooth-pulp; so that it is likely that, even in the tooth itself, only a few nerve-fibres would be involved: again, if the injury inflicted on the nerves in the jaw so readily effect their degeneration, how is it that neuralgia after tooth-extraction is not an every-day occurrence?

But a yet more formidable objection to this explanation of the difference between toothache and neuralgia, is to be found in the fact that the two are interchangeable: what is toothache one day may be neuralgia on the next, owing to a change in the patient's condition, and so continue to change about from time to time, as the bodily health of the patient varies; though this only happens with mild cases of neuralgia.

[1] Wedl. "Pathology of the Teeth" (Trans. by Dr. Hitchcock, 1872), p. 432.

Wedl also (*loc. cit.*) suggests that the occurrence of neuralgia after tooth-extraction may be due to the two ends of the nerve becoming enlarged and painful, as often happens in amputation stumps; and that this, through some peculiar diathesis, may take place successively in the case of all the teeth which have been extracted. To meet this supposititious condition, Dobbelin has proposed and put into practice a course of procedure which, to us at least, sounds very strange: he drills into the pulp of all the molar and bicuspid teeth alike, whether they be carious or perfectly sound, and destroys the nerves. By this procedure he claims to have effected a perfect cure of a case, for the relief of which a portion of the infra-orbital nerve had been previously removed without any benefit.

It sometimes happens that the pain of extraction will be entirely referred to the seat of neuralgia, and not felt at all at the place itself.

The removal of the exciting cause is often followed by a severe paroxysm of pain which we have sometimes been able to relieve by sponging out the socket with phénol sodique or cocaine; and these paroxysms may recur from time to time, with lessening intensity, for some days, so that it is advisable to warn the patient not to expect an immediate cure.

It has already been mentioned that the paroxysms have a tendency to periodicity, often recurring with great regularity; the coming attack may often, and indeed generally, be warded off by a full dose of quinine. But when quinine is given with this object, it must be given in large doses—from five to eight grains for an adult; small doses, frequently repeated, are often perfectly ineffective in a patient who is at once relieved by a full dose. The large dose is better tolerated if a saline purgative be given some two or three hours before taking the quinine, which should itself be administered about an hour and a half before the time at which the recurrence of the pain is expected.

In order to arrive at an opinion as to whether a neuralgia has a dental origin, it is best to *be methodical in the making of an examination*, somewhat after the following manner:—

First search carefully for cavities; failing to find any, sharply tap each of the teeth in succession, and press them forcibly home into their sockets by making the patient bite upon slips of thick visiting-card.

Next test the susceptibility of each tooth to heat and cold, in case of doubt isolating any suspected tooth by means of the rubber dam; then thoroughly heat up any large fillings by prolonged contact with a hot instrument of some size (see p. 665).

Enquire into the existence of exostosis upon the roots of teeth previously extracted.

And failing any decided response to the tests applied, remember that it is always possible that you have hit upon the time between the death of a nerve and the supervention of alveolar inflammation.

Sir Lauder Brunton is disposed to refer a large number of cases of neuralgia, even of a migraine type, to the influence of carious teeth (see "Disorders of Digestion"), but whilst naturally he is inclined to refer many things to the disease of the special organs on which his attention is so much concentrated, we are hardly inclined to go with him to the full length. Thus, in some of his cases the dental lesion was hardly of a kind which we are accustomed to see associated with remote nervous disturbance.

Neuralgias of the migraine type are not likely to be frequently referred to the dental practitioner, as the long periods of remission and the conspicuous headache renders their character tolerably obvious. Yet, in persons subject to "sick headache," it is very common to get a neuralgic condition in many branches of the fifth nerve, so that dead teeth or roots may have unusual sensations in them at the outset of an attack, just as vision is apt to be disturbed at this same period.

All dental causes having been eliminated, it remains to briefly mention what else in the way of treatment remains, and here the capricious nature of neuralgia is very strongly shown, as remedies, which the subsequent course of events prove to have failed to reach the source of trouble, are often nevertheless perfectly efficacious for the time. The electric current, constant or intermittent, usually fails to give any relief, but once in a way it will do so: thus, a gentleman who suffered from intense neuralgia of the left inferior dental nerve, brought on oftentimes by the mere movement of the lips in speaking, was advised to have the nerve divided, but meantime, first of all, to try the effects of galvanism. To our great surprise, this effected a cure of a neuralgia of several years' duration, or at all events cured it for six months, the patient having been subsequently lost sight of.

Dr. Stretch Dowse (Trans. Odont. Soc., 1888) lays down a few rules as to the employment of electricity in these cases—he employs both galvanic and faradaic currents, and employs weak currents, two, three, or four milliampères of a continuous current, for example—the positive pole is a sponge or cotton-wool in the nostril, and the negative a large pole on the cervical cord region; this is continued for twenty or thirty minutes at a sitting, and repeated daily. Sometimes the negative pole is a large sponge in the mouth. He regards faradisation alone as worse than useless, as it tends to exhaust an already enfeebled nerve. He has also made use of ergotine (injected) with marked benefit; opium, croton, chloral, and gelseminum, are the drugs from which he finds most benefit.

Where particular branches of the fifth nerve are affected, the operation of nerve-stretching, which came into great vogue but is now perhaps less practised, may be resorted to.

Trousseau mentions a case of thirty years' duration, in which repeated operations (division of nerves) were performed, so that the man became to be well known to all the Parisian surgeons, and his face was scarred all over; he got relief almost always for a time, but it might be months or only days. Sir Grainger Stewart relates another in which the pain was so agonising that the patient lost all self-control: the paroxysms could be induced by pulling the hair, or touching the gums, tongue, or skin, so that only liquid food could be taken. The infra-orbital nerve was stretched, with the result of giving a month's respite from pain, after which the pain reappeared, transferred, however, to the region of the mental foramen; the nerve was stretched there, and a perfect cure resulted, the patient having remained under observation for a year.

The general history of these nerve-stretching operations is one of temporary cure, and of repeated operations at shorter and shorter intervals, but completely successful cases are not wanting to encourage the surgeon to undertake the operation. The following case is instructive as illustrating several points common to many cases. The patient, a young man, was incapacitated from steady work by agonising paroxysms of pain in the inferior dental nerve; at times he did not dare speak nor eat for fear of provoking them, and all the teeth had been extracted from the lower jaw on that side. The writer exposed and stretched the nerve as it issues from the mental foramen through a small incision at the reflection of the mucous membrane from the jaw on to the cheek, but this gave only partial relief, and that only for a few days, and so about half-an-inch of the nerve was resected. This enabled him to talk and eat and shave without provoking paroxysms, but the pain, which was never quite cured, soon recurred with all its former intensity. The inferior dental nerve was then divided at a point a little behind the site of the wisdom-tooth by the method originated by Dr. Hodgen, of St. Louis. This consists in entering the bone with a spearhead drill about $\frac{1}{8}$ inch diameter upon the summit of the alveolar ridge, its point being directed towards the angle of the jaw. The drill, which is worked in the dental engine, can be felt to crush into the cancellous tissue after it cuts through the denser bone of the shell of the jaw, and keeping it carefully in the middle line of the jaw, it can be felt to meet with increased resistance and again to crush into the inferior dental canal. This is thoroughly broken up and its contents destroyed by working the drill about a little, and it is then withdrawn; the wound being practically almost subcutaneous, does not give the least trouble, and there is no bleeding to matter; generally there is not a quarter as much as would follow an ordinary extraction.

In the particular case this gave absolute cure for six months; then the pain began to return, and the patient expressed himself as ready to shoot himself. Though advised by Sir James Paget, and the writer, that another operation would probably do no good, he begged and entreated that it might at once be done, even for the chance of but a few days' relief. The relief given was very transient, and subsequently he consulted the late Mr. Durham, who exposed the nerve where about to enter the canal at the inner side of the jaw and stretched it severely. This gave temporary relief, but the patient was afterwards entirely lost sight of both by Mr. Durham and the writer.

It is pretty clear from the sequel that in this case neither the first, the second, nor the third operation could have attained to the site of mischief, yet we gave relief for a greater or less time, and this is a common story in operations undertaken for the relief of neuralgia.

It would almost seem as if violence done to the nerve, even at the wrong place, corrected for the time being its vicious habit, whether by altering its nutrition, or by depriving it of the ordinary functions of transmitting centripetal impressions and so giving it rest; or else by transmitting a severe shock to the centres where it orginates.

A patient at the Dental Hospital under the care of Mr. Canton suffered from intense neuralgia in an edentulous alveolar border; it being in the upper jaw, the division of the nerve could not be practised otherwise than by a comparatively severe surgical operation, so at the writer's suggestion Mr. Canton drilled four or five large holes into the bone at the region which appeared to be the focus of the pain. This simple measure effected, so far as is known, a complete cure; nine months afterwards the patient was perfectly free from neuralgia.

It does not seem likely that the drill, except by the merest chance, reached and removed any definite local trouble, and it seems far more probable that it succeeded in some such way as that suggested above.

Sir Victor Horsley and Mr. Rose have several times removed Meckel's ganglion for neuralgia of extreme severity affecting all the branches of the fifth, and with success; and the operation, or a similar one, has been performed with success on a few other occasions (Dental Record, 1882).

So far as we know, pain has not returned in any case in which Meckel's ganglion has been removed, or partly removed, but the operation is a severe one, and in one case, at least, has been followed by the loss of the eye on that side.

In another case of neuralgia, which was at first, whether rightly or wrongly, attributed to teeth, Mr. Heath removed the infra-orbital nerve right back to the back of the orbit. He found no difficulty in holding the eye-ball up so as to be out of the way, and the cure was complete when last the patient was heard of.

It has been proposed by Dr. Grout, of Rouen, to divide with the actual cautery, a chisel-shaped cautery in a sheath being used, the auriculo-temporal nerve: the curative effect which has sometimes been obtained is attributed to the shock given to the nerve centres (Trans. Odont. Soc., 1887). It is so trifling an operation that in these cases of exceeding severity it might be tried, as it leaves but little mark ("Neurotomy of Auriculo-Temporal Nerve": Grout. Mètieres, Rue Jeanne d'Arc, Rouen, 1887).

In a recent paper on "Tic-Doloureux," Dr. Ewart (Brit. Med. Journal, 1896) has laid much stress upon the gouty origin of the disease, and somewhat deprecates operation, upon the ground that the cures effected by it are only temporary, unless the very severe operation of ablation of the gasserian ganglia be resorted to, and that medical treatment can show similar temporary successes. As he well points out, the extreme local tenderness, as well as the results of surgical treatment, prove that the pain is closely bound up with the peripheral sensory function, a temporary interruption in the peripheral conduction by division of the nerve causing only temporary cessation in the pain until the return of sensory function in the part, whilst a permanent interruption in one branch does not protect against its extension by a peripheral subsequent extension, whether vicariously or by overflow.

He attributes the disease rather to some ill-expressed gouty condition than to definite lesion of parts of the nerve, and has been successful in a large majority of his cases in procuring alleviation by anti-gout treatment. Alcohol he usually forbids, and finds that a somewhat vegetarian diet, attention to all hygienic conditions, and the administration of such drugs as the salicylates, benzoates, ammonium chloride, and taraxacum are all useful, but that the salts of iodine and of mercury are the most efficacious (20 minims of the solution of mercuric chloride and 6-10 grains of potassium iodide). In one case he got distinct alleviation of pain even after repeated and only temporarily successful operations on the nerves (though not on the gasserian ganglia).

REFLEX AFFECTIONS DUE TO THE IRRITATION OF DISEASED TEETH.

The resemblance, not to say relationship, which appears to exist between the various neuroses, such as epilepsy, chorea, neuralgia, and the like, has been already alluded to; and, having in view the frequent association of neuralgia with all sorts of secondary disorders, it is a question whether these might not have been advantageously considered under the head of neuralgia. Still, it perhaps conduces to greater convenience of reference to group them together, and hence a separate section has been devoted to their consideration[1].

The reflex disturbances productive of a sense of pain have already been mentioned, and, incidentally, their influence on motor and secretory apparatus has been alluded to. Besides this, the nutritive processes may be profoundly modified, as not very uncommonly happens in the eye.

The close connection of the fifth nerve with the sympathetic through the ciliary, otic, spheno-palatine, and submaxillary ganglia, serves to show in some measure the course through which these influences might travel so as to modify nutrition.

It has already been mentioned that in cases of neuralgia tonic or clonic spasm of the facial muscles, sometimes affecting one or two muscles only, sometimes the whole side of the face, is not very uncommon; these may graduate almost imperceptibly into typical epileptiform seizures.

[1] In writing this section of the book much assistance, which we take this opportunity of acknowledging, has been received from the very complete list of cases drawn up by Professor Wedl ("Pathologie der Zähne," p. 353 *et seq.*); from cases related in the Lancet (1859 and 1861) by Mr. Hilton and Mr. Hancock; from an article contributed by Mr. Salter to Guy's Hospital Reports (Third Series, vol. xiii., 1867); from papers by Mr. Henry Power (Trans. Odont. Soc., 1883), Dr. Stretch Dowse (*loc. cit.*, 1888), Dr. Ferrier (*loc. cit.*, 1889), Mr. Job Collins (*loc. cit.*, 1891 and 1894), and Dr. Maughan (*loc. cit.*, 1893).

Thus Mr. Coleman (Brit. Journ. Dental Science, 1863) has reported four cases in which convulsions were relieved by the extraction of carious teeth. The convulsions were slight, and in some instances confined to the face and arm; tingling sensations and a variable degree of paralysis of the arm are also noted. In the same place may be found a reference to a case of Dr. Baly's, in which epilepsy was apparently cured by the removal of a carious tooth.

Epilepsy.—It is remarked by Dr. Brown Séquard, in describing his experiments on epilepsy artificially produced in lower animals, that after various injuries had been inflicted on the spinal cord of guinea-pigs, very slight irritation of the branches of the fifth nerve was sufficient to bring on an epileptiform convulsion, in some instances mere tickling of the skin producing this effect. Bearing in mind also the fact that epilepsy has been in several instances due to the irritation resultant on tumours pressing on nerves, and has been cured by section of the affected nerves, we shall be less surprised to find that in some few cases it has been almost indubitably connected with diseased teeth. The connection between the convulsions arising at the period of the first dentition and the process of cutting the teeth is most clearly shown by a great number of cases (*cf.* page 22); and Portal [1] mentions that the extraction of sound teeth at this period had, after all other means had failed, at once arrested the convulsions.

Convulsions arising at the period of second dentition are very rare; cases have, however, we believe, been met with in which epileptiform attacks have accompanied the eruption of the second set of teeth in a child previously healthy, and ceased with the completion of that process.[2] But difficult eruption of the wisdom-teeth has, in several instances, been clearly traced to be the exciting cause of epileptiform convulsion. In one case, related by Portal (*op. cit.*, p. 206), these convulsions were limited to one side of the face; they were very violent, and were accompanied by extremely severe pain. In this instance the tooth was not removed, but the attacks, which had commenced coincidently with the commencement

[1] Portal, "Observations sur l'Epilepsie," p. 333.

[2] Ashburner, on Dentition; Dr. West, on Nervous Disorders of Childhood; Wedl, "Pathologie der Zähne."

of the eruption of the tooth, entirely ceased when this was completed.

Portal (*op. cit.*) mentions a second case, in which the convulsions were general; the disease, which was accompanied by severe facial neuralgia, was completely cured by the extraction of the second molar, it having been found impossible to remove the wisdom-tooth itself.

Dr. West (*op. cit.*) relates an instance of convulsions (with temporary delirium after one attack) of frequent repetition, which were clearly traced to difficult eruption of permanent teeth; in this instance not the least derangement of health was produced, the boy at once resuming his occupation when the spasmodic movement ceased.

Dr. Ramskill (Med. Times and Gazette, 1862) relates the following case :—

"A boy, æt. 13, has had frequent attacks of epilepsy for the last eighteen months. Latterly his mother has noticed that some days he rubs his left cheek, complaining of face-ache, after which the fit follows. On examining the mouth, there is to be seen a molar tooth considerably decayed, with a swollen gum around it, and partly growing into the cavity; it is not very tender to the touch, and the examination does not give rise to toothache. On questioning, I find the sensation which the boy experiences before a fit does not seem to be one of pain, but rather of an indefinite uneasiness. He always has a fit the night this comes on. Has never felt it during the day; it is always about seven or eight o'clock. I desired the mother to have the tooth extracted, and ordered a simple saline with a quarter of a grain of belladonna, to be taken twice daily. This was in June. The tooth was extracted next day. I saw this boy once a fortnight from that time for four months, but he has had no recurrence of the fit.

"In this case, I believe, an unfelt aura commenced about the gum, surrounding the tooth, and was not recognised till some degree of inflammation arose; thus a modification of pain became associated with the aura, and directed attention to it."

Two cases have occurred under the author's own observation, in which epilepsy was consequent upon diseased teeth, the most prominent feature being exostosis of the roots.

A lad, a farm labourer, from Windsor, was admitted into the Middlesex Hospital for epilepsy. The usual remedies were tried for six weeks without effect. His mouth was then examined, and the molar teeth of the lower jaw found to be much decayed, the roots of some alone remaining. Although he did not complain of pain in the teeth or in the jaw, the decayed teeth were removed, and the roots of each were found to be enlarged and bulbous from exostosis. During the eighteen months that succeeded the removal of the diseased teeth, he had not suffered from a single fit, though for many weeks previous to the operation he had two or three per day. This is a case of singular interest, inasmuch as there was no complication of maladies, and hence there could hardly be doubt as to the cause of the disease, seeing that it immediately subsided after the removal of the teeth; and it is further instructive, as showing that local irritation sufficient to produce grave functional derangement may exist without pain being felt in the seat of mischief.

A similar, though less marked case, occurred shortly afterwards in the person of a policeman; he had fits which were greatly relieved by the removal of a lower wisdom-tooth, the subject of caries and of exostosis.

In looking over the records of such cases, it is noticeable that local pain is not often mentioned, but that the presence of neuralgic pains is very frequently and pointedly recorded.

The reflex affections of the nervous system may manifest themselves in other ways than by epileptiform seizures.

Thus, Remak [1] has seen a case in which disease affecting the wisdom-tooth gave rise to violent palpitation and cardiac distress; whilst Lederer gives cases of vomiting and cardiac pain, and Dr. Anstie of alarming stoppage of the heart's action, consequent upon the operation of crowning a tooth.

This last-mentioned operation has even been followed by death from tetanus, as in the following case [2]:—

"———, æt. 25, tall and thin, but apparently in very good health. On his marriage trip he visited Paris, and there had the misfortune to break off a front tooth. Wishing to conceal the accident from his wife, he went immediately to a dentist.

[1] Sydenham Society's Year-book, 1868, p. 120.

[2] "Lectures on Dental Surgery and Physiology," by John Tomes, 1848, p. 321.

The tooth was crowned (and we have no doubt, carefully, for the dentist was one with a great and just reputation), and the necessary concealment seemed ensured. From the time of the operation, however, he had severe pain in the stump, which pain increased for four or five days, when he left Paris for Rouen. Upon arriving there the pain had become excessively severe; he consulted a medical man, but it was too late; trismus came on within twenty-four hours, and was soon followed by tetanus and death."

A case of tetanus has also been recorded by Döbbelin,[1] which came on immediately upon the extraction of a tooth.

As, however, tetanus is now believed to be due to bacterial infection, these cases might have been more appropriately placed with the results of abscess; and Döbbelin's case becomes perplexing, unless, indeed, by the word "immediately" a short interval is meant.

Hysterical attacks, delirium, and even temporary insanity (Esquirol) have been traced to the irritation caused by the eruption of the wisdom-teeth; and, although such cases are extremely rare, the authorities by whom they are quoted are such as to preclude the probability of the observers having been deceived.

Dr. Tyler Smith believes that certain cases of sympathetic pain in the uterus, and even of actual abortion, have been brought about by dental irritation; and that such should be the case is hardly more remarkable than that strangury should be caused in children during first dentition.

Mr. Sercombe (British Journal of Dental Science, vol. iii., p. 221) has recorded a very interesting case of obstinate leucorrhea, and uterine pain, cured by the extraction of a tooth; touching the tooth with a probe, and its subsequent extraction, brought on most acute paroxysms of uterine pain.

Deafness during attacks of neuralgia has been elsewhere noticed; and limited space precludes the relation of more cases of functional reflex disorders, though many more interesting examples might be collected from the pages of current medical literature.

Affections of the Muscular System.—Various reflex affections of the muscular system are from time to time to be met

1 "Pathologie der Zähne," by Professor Wedl, 1870, p. 353.

with; thus, in the section devoted to the consideration of neuralgia, mention is made of its frequent association with a sense of lassitude, and even paralysis of the arm of the affected side.

In the case of Mr. Salter's (*op. cit.*) there was total inability to raise the arm, or grasp with the hand, which could not be used to hold a fork at dinner, or for dressing; there was continuous pain in the limb. The extraction of a carious impacted wisdom-tooth gave immediate relief. In a second case, likewise accompanied by constant aching pain in the arm as well as in the side of the face, the symptom disappeared within a few hours of the extraction of the wisdom-tooth.

Spasmodic closure of the jaws resulting from the eruption of the wisdom-teeth in an already crowded jaw is, in a slight degree, of very frequent occurrence; and cases where the fixation of the jaws is almost complete are not very uncommon; thus Mr. Hancock relates an instance of severe pain in the ear and closure of the jaws being cured by extraction of the first lower molar.

In one of Mr. Salter's cases, the trismus, of four months' duration, passed away within twenty-four hours of the extraction of the second molar, which was removed in consequence of the impossibility of reaching the wisdom-tooth. The posterior root of the second molar was much eroded by the pressure of the wisdom-tooth.

The continued application of steady force will generally cause the muscles to yield at least sufficiently to enable an examination of the mouth to be made; and even in the event of considerable inflammation and ulceration having taken place, the difficulty in opening the mouth is still generally in great part due to muscular spasm, and will be found to yield to prolonged traction on the administration of an anæsthetic.

Amongst the most interesting examples of disordered muscular action is one related by Mr. Hancock in the Lancet[1]; the patient, a young woman, had suffered for upwards of six months from spasmodic wry-neck, and had submitted, without avail, to the usual treatment of counter-irritants and various internal remedies. No evidence of any diseased condition being found, Mr. Hancock advised the removal of a stump and

[1] Lancet, January 22, 1859. Trans. Odont. Soc., 1869.

a carious tooth on that side of the mouth, these being the only discoverable sources of irritation; after a few days she was entirely cured of the wry-neck. In this case the teeth had caused no pain to the patient. It is noted by Dr. Anstie, in his work, that these peculiar spasmodic affections are not frequently directly associated with trigeminal neuralgia; but that they are met with only in highly neuralgic families.

Dr. Ormond has also placed upon record[1] a case of spasm of the sternomastoid, which was apparently due to the irritation set up by diseased teeth; after their removal the spasms entirely ceased.

An unusual form of spasm, which for want of a more appropriate place may be introduced here, has been met with by the writer. The patient was suffering from difficult eruption of a wisdom-tooth, with much swelling and ulceration of the adjacent gums; whenever in closure of the mouth the upper wisdom-tooth touched these inflamed tissues, the mouth was violently dragged open. This spasm was of so painful a nature that the patient went about with a cork between his teeth, so as to prevent any contact, and in this way he could obtain sleep, which was otherwise impossible. It seems probable that the spasm was rendered the more distressing by the fact that the comparatively weak muscles which open the mouth were violently tugging against the powerful closers of the jaws.

Reflex affections of the muscles connected with the eye are also met with: thus Mr. Job Collins mentions reflex spasm of the orbicularis; just as spasm of the masseter arises through reflex action descending through the motor part of the fifth nerve, so it may descend by the motor seventh, and the peculiar relation of the sensory portion of the fifth mentioned on page 668 renders this easily intelligible.

The affection of blepharospasm is apt to be tonic, with clonic exacerbations; and Mr. Collins admits the probability of spasm of the external rectus arising in the same way. Lagophthalmos (spasm of the muscle of Müller) he also admits as being caused in the same way, but he doubts the occurrence of paralytic affections of the muscles of the eye or of the lids, partly on the ground of physiological difficulties in the way of conceiving a reflex paralysis, and partly from the want of conclusive

[1] Trans. Odont. Soc., 1869.

observed cases. Cases of ptosis, supposed to arise from diseased teeth, have often been recorded, but they are usually of an inconclusive nature, such as that recorded by Mr. Main Nicol (Trans. Odont. Soc., 1895).

Some difference of opinion, as will have already been gathered, exists upon these points: thus Mr. Power attributes to the teeth a very large and varied influence upon ocular affections, whilst Mr. Job Collins disbelieves, and gives grounds for his disbelief, in all but reflex muscular spasm.

Still, one of the most common forms of reflex disturbance of the muscles of the eye, which has been attributed to diseased teeth, is a partial paralysis.

Mr. Hancock gave a case of strabismus of three years' and a ptosis of two weeks' duration, which were found to depend on carious upper molars, and were cured by their removal; the patient was an adult. And Fox, in his "Dental Surgery," relates a case of excessively severe neuralgia, in which only fluids could be taken because any pressure upon the teeth brought on a paroxysm. Profuse salivation and ptosis were present, and the ptosis disappeared after the extraction of a carious upper molar, though the case was not cured till after the extraction of all the remaining teeth, the roots of which were all affected by exostosis. And Mr. Power enumerates paresis of the ciliary muscle bringing about want of accommodation, paresis of the iris causing a dilated and motionless pupil (mydriasis); paresis of one or other of the ocular muscles leading to squints, or paresis of the orbicularis, in which case the eye is widely open (lagophthalmos) or of the levator palpebræ (ptosis).

Mr. Sewill (Trans. Odont. Soc., 1883), in conjunction with Dr. Ferrier, records a case of neuralgia, local hyperæsthesia, and muscular spasm of the right side of the face. The spasm of the orbicularis was so great that the right eye could only be opened by great effort, and the lens was nearly opaque. Dr. Ferrier was inclined to attribute all his symptoms, even the cataract, to the neglected state of his teeth, and Mr. Sewill found numerous roots much inflamed, a vulcanite plate much encrusted with tartar which had not been removed for years, and an enormous mass of tartar in the lower jaw.

After extraction of the upper teeth and treatment of the lower, the neuralgia and the muscular spasm disappeared, but there was no improvement in the state of the eye—indeed there hardly could be.

A somewhat unusual form of disturbance has been placed upon record by Mr. Hutchinson (Trans. Odont. Soc., 1885). The patient had suffered for some months from spasm of the left eyelid, which was drawn up by constant contraction of the levator palpebræ to such an extent as to expose the white of the eye all round the iris. Four carious molars were extracted, which cured a neuralgia but did not relieve the lagophthalmos.

For a year things remained thus, and then Mr. Hutchinson removed a large amalgam filling, beneath which was found a minute pulp exposure. The tooth was extracted, and the patient's appearance at once began to improve; at the end of six months no casual observer would have noticed any difference between the two eyes. "Thus in this case reflex irritation of the third nerve had been caused by irritation of a branch of the fifth, and this in the absence of any symptoms obviously referable to the teeth."

Although recent writers, notably Mr. Job Collins, have thrown doubt upon the causation of other reflex disturbances of function, and have pointed out that with the use of the ophthalmoscope and more rigid and close recording of cases, these cases of supposed reflex disturbance have not increased, but on the contrary have greatly diminished, and that many of the recorded cases date back to periods before the general use of the ophthalmoscope, yet no account of the subject would be complete without a reference to them, even in some detail, as the question is by no means settled.

It is supposed that the nutritive functions do not always escape participation in the disturbance set up in neuralgia of the fifth nerve, which is probably transmitted through the medium of the ganglia in connection with it; the frequent occurrence of an excessive outpour of saliva, or of tears, has been already noted, but to these may be added some yet more curious manifestations of the disease.

The late Mr. Hilton[1] had several times remarked a tongue furred on one side only, to be dependent on structural or

[1] Lectures delivered at the Royal College of Surgeons. Lancet, 1861.

functional disorders of the fifth nerve. In the first case related, the disease was tubercle affecting the gasserian ganglion; in the other, the unilateral furred tongue seemed to depend on the presence of carious *upper* molars, seeing that the peculiarity in each instance disappeared shortly after the extraction of the teeth. Mr. Hilton remarks that these phenomena, of the existence of which he is satisfied, would be more easily explicable if dependent on carious lower teeth, seeing that the tongue derives its nerve-supply from the third or inferior maxillary division of the fifth nerve; nevertheless, the varied seats of neuralgic pains show how closely the whole nerve is connected, and how easily irritation is transmitted from one part of its course to another. A curious instance of disordered nutrition, due to the same cause, is given in this lecture, in which the hair covering one temple became perfectly white in a patient suffering from dental neuralgia. Two years ago the writer met with a somewhat similar case in private practice; the patient was a man aged 45, who positively affirmed that intense toothache in a left lower bicuspid caused the patch of white hair in his beard in the course of two or three nights whilst in Central Africa, where he was unable to obtain medical or dental aid. In the person of the late Dr. Addison, this reflex disturbance of the nutritive function was believed to have gone so far as to cause an offensive purulent discharge from one ear, proceeding from a slight ulceration in the auditory canal. This condition of things was entirely and speedily remedied by the extraction of a carious lower molar.

Rumbling sounds or neuralgic pains in the ears may be caused by diseased teeth. Harvey saw an instance of severe pain and offensive discharge from the outer ear proceeding from the presence of a carious wisdom-tooth.

A very large number of well-authenticated cases have been recorded, in which not only functional, but organic disease of the eye has been attributed to the presence of diseased teeth.

In the opinion of V. Stellwag, the irritation is transmitted through the ciliary ganglion, and by inducing hyperæmia and hyperæsthesia, may lay the foundation of serious organic mischief.

Mention has already been made of congestion of the conjunctiva caused by irritation of the fifth nerve, and if this irritation be kept up for some time, a condition of chronic inflammation may result.

The most complete account of the relation between dental lesions and diseases of the eye is in a paper already quoted by Mr. Power (Trans. Odont. Soc., 1883), in which there are many suggestions as to the probable mode of causation; thus it is laid down as well-known that injuries affecting the branches of the first division of the fifth pair are prone to affect the eye of the same side, and there are good reasons for believing that affections of other branches of the fifth pair may be the cause of ophthalmic troubles.

After mentioning that wounds of the supra-orbital nerve are occasionally followed by amaurosis, he quotes later on in the paper the experiments of Von Hippel and Grunhagen, who found that compression of the aorta caused increased intra-ocular pressure, and if now the fifth nerve were stimulated the pressure was greatly augmented, and well-marked pulsations were observed. Whatever the exact chain of events may be, it is sufficient for our purpose to note that stimulation of the fifth is thought capable of disturbing the tension of the eyeball. If this were proven, it ceases to be wonderful that dental irritation should be able to disturb the eye.

Mr. Coleman (Trans. Odont. Soc., 1875) recorded a case of temporary loss of sight in one eye following upon the pivoting of a tooth. Mr. Lawson, who saw the patient, did not think that it was due to this cause, attributing it to constitutional causes, and found the eye to be suffering from iritis; but the patient herself was exceedingly positive on the point, having noticed the exact coincidence of the dates, and Mr. Coleman shared her convictions fully.

Mr. E. Kenneth Campbell (Lancet, July 22, 1905) calls attention to several cases of iritis, not of syphilitic or rheumatic origin, cured by attention to the mouth.

Somewhat sudden amaurosis has in a good many cases been apparently due to dental irritation, as is illustrated by the following case, now almost classical, related by Professor Galezowski:

"F. P——, thirty years of age, possessing a good constitution and enjoying good health, with the exception of pains in the head and limbs, which never lasted long, suddenly experienced in the autumn of 1825 a violent pain, shooting from the left temple to the eye and the side of the face. He ascribed it to cold. This pain lasted several days, then lessened and reappeared from time to time, without being sufficiently severe to induce the patient to seek medical aid. In about two months it suddenly increased in intensity—occupying the eye particularly—with a feeling as if it would pass out of the orbit. F. P—— now discovered that he was blind with that eye, and applied to a neighbouring physician, whose treatment, although continued for two months, did no good. The pain, however, was no longer continual; it assumed a somewhat periodical character, leaving the patient easy for some hours of the day. At the end of the following six months the pain increased, the cheek swelled, some spoonfuls of bloody matter were discharged by a spontaneous opening in the lower eyelid, after which the swelling subsided and the pains nearly disappeared, although the blindness remained complete. The discharge was renewed from time to time during the following six months, and there was no great suffering. But in the autumn and winter (1826) the pain, particularly in the eye, became so violent that F. P—— came to Wilna in the beginning of 1827, determined to have the organ extirpated, if no other remedy could be found. Professor Galezowski found the left eye totally insensible to light, with the pupil dilated, and no other visible alteration. The pain, not then so severe, consisted in violent occasional pricking and darting sensations in the left temple and parts round the eye. There was discharge from the lower eyelid. The first molar tooth of the left side was carious. It had not caused much uneasiness, and the toothache, when it existed, had not coincided with the pains in the temple and eye. The Professor determined on removing the tooth, and having done so, was surprised to see a small foreign body at the extremity of the root. When drawn out, it proved to be a small splinter of wood, about three lines in length, which had traversed the centre of the tooth, and had probably been introduced in picking the teeth. A probe was passed from the socket into the antrum, from which a few drops of thin purulent fluid escaped. The pain ceased almost entirely, and on the same evening the eye was sensible to light. Vision gradually improved, so that on the ninth day the patient could see as well with the left eye as with the right, after a blindness of thirteen months. On the eleventh day he left Wilna to return to his family."

As Mr. Job Collins points out, the discharge from the inner canthus points to the direct extension of inflammation upwards, and renders it far more probable that this was a case of blindness from that cause, and not from any reflex disturbance.

Numerous other cases might be quoted, but the following will suffice to give an idea of their general character.

A patient of Mr. Hancock's (*loc. cit.*) became suddenly blind; when examined the pupils were seen to be fixed and dilated: the entire absence of premonitory symptoms and of structural lesions having led to the conclusion that the disease was of reflex origin, the mouth was examined, and great crowding of the teeth discovered. Six teeth were removed, and on the same evening the patient, having been totally blind for upwards of a month, was able to distinguish light from darkness, and in the course of a week was entirely cured ; no other treatment, save two doses of aperient medicine, having been resorted to.

A similar condition of functional amaurosis has been known to follow the extraction of a tooth, the effect speedily passing off under the influence of sedative applications to the socket.

In the second case of amaurosis, of eight months' duration, with entire fixity of the pupil, and inability to distinguish light from darkness, a carious second upper molar tooth was found. After the extraction of the tooth, the sight gradually improved, and was entirely restored in a few days.

It is the opinion of Mr. Hancock that a purely functional disorder of the eye may, if allowed to continue unchecked, lead to a permanent structural lesion. Such attacks differ from the advent of true amaurosis in their sudden access, in not having been preceded by dimness of vision, muscæ volitantes, flashes of light, pain, and the like symptoms. Entire absence of local pain in the teeth seems to be the rule, and not the exception ; indeed, it often seems as though manifestations of local pain stood, in some measure, in a complementary relation to one another, so frequently is the disappearance in the one place coincident with the access in the other.

Teirlink [1] found that extreme photophobia, pain in the eye, dimness of sight, and contraction with immobility of the pupil, were dependent on a splinter of tooth stuck in the upper jaw, but he does not mention where it was.

Hay [1] also met with an instance of photophobia and pain in the eye, together with severe darting pains in the face, which were provoked by tapping or touching an incisor tooth. On the removal of the tooth these symptoms disappeared ; at the root was found an abscess.

Sir Thomas Watson ("Lectures on Physic," 4th edition) mentions a case in which blindness, confined to one eye, recurred three or four times, always being cured by the extraction of carious teeth.

Mr. Salter has seen an instance of change in the colour of the iris dependent apparently on prolonged neuralgia ; no other nutritional change had occurred.

[1] Wedl. "Pathologie der Zähne," p. 355.

De Witt found vision to return in an eye which had been totally blind for twelve years, after the removal of an amalgam filling, beneath which was pent up some decomposing pus. Pain returned at the place, and coincidently the sight again deteriorated; but after the extraction of the tooth the blindness wholly disappeared, though the patient could not distinguish what very small objects were.

Another patient suffered for fourteen years from congestion and lachrymation from one eye, and photophobia, these symptoms being aggravated by unsuitable diet; the symptoms began to amend and soon disappeared after the extraction of a carious tooth.

A patient under the care of Mr. Salter and Dr. Hyde Salter suffered from dimness of vision and aching pain in the eye, and likewise from facial paralysis, which rapidly became complete. This latter was clearly due to the portio dura being involved in plastic inflammatory products in the parotid region; due to a carious upper wisdom-tooth; the eye affection may, more probably, have been reflex, as it recurred afterwards when a lower tooth was in fault, and was accompanied by painful paralysis of the arm, which was unquestionably reflex.

Amaurosis may also be produced by carious teeth in a more direct manner; namely, by displacement of the ball of the eye by accumulation of pus; but these cases may be more appropriately mentioned in connection with diseases of the antrum.

One case of exophthalmos has been recorded (Mr. Power, *loc. cit.*), which appears to have had a dental origin; there was much pain, the eye was red, the tension + 1, and there was marked exophthalmos. The cornea was hazy, the retina injected, and a few hæmorrhagic spots near the macula; heart, lungs, and urine normal. Ten days later acute chemosis supervened, with much periorbital pain; and two carious teeth and a stump were removed, with the result that in three days there was marked improvement, the chemosis had disappeared, as had also the injection of the conjunctiva and the exophthalmos. Possibly the explanation of such a case as this may be found to be in an inhibitory action upon the vaso-motor system, set up by the irritation of the fifth nerve, leading to an engorgement of all the parts supplied.

Occasionally cases occur of a very puzzling nature: thus a few years ago a patient was seen by several ophthalmic and dental surgeons, who had almost lost the sight of one eye—there was some retinitis and great protrusion of the eyeball, but no suppuration occurred, and the mischief quieted down without any certainty as to the diagnosis being attained. One or two carious teeth were removed, but the patient had few teeth, some apparently never having been cut, and those that were present were exceedingly imperfect, stunted teeth, with soft brown enamel, so that it is possible that she may have had buried teeth in some wholly abnormal position.

Mr. Power thinks that it is not at all improbable that dental disease may be the starting-point of glaucoma, seeing that experiment has shown that irritation of the fifth nerve can alter the vascular tension of the eyeball, and that disturbance of tension is the first and most conspicuous phenomenon in glaucoma, of which disease pain in some of the branches of the fifth nerve is a very frequent precursor: on the other hand, Priestly Smith has investigated the tension in a large number of cases of toothache in young persons at the dental hospital, without finding any really definite alteration of tension.

Mr. Power sums up "that in all cases of threatening glaucoma, especially when this is associated with ciliary neurosis and obscure pain in the temples and maxillary orbital regions: in all cases of mydriasis and probably of myosis, originating without apparent causes: in all cases of sudden paralysis of either of the orbital muscles, or of loss of sensation in the absence of cerebral symptoms: in all cases of phlyctenular disease of the conjunctiva: in all cases of ulcers of the cornea resisting ordinary treatment: in all cases of sudden failure of the accommodation, especially in young children: and finally in all cases of exophthalmos, the condition of the teeth should at least be examined, and if faulty conditions present themselves, these should be at once rectified, and then one at least of the possible causes of each of these diseases will be removed."

Some years ago the writer himself experienced a severe supra-orbital neuralgia, accompanied with a visual disturbance like the quivering which one observes when looking over strongly-heated ground; this condition was coincident with great tenderness of some upper stumps, and ceased almost immediately with their extraction.

Keratitis punctata is in certain cases due to septic absorption, not infrequently originating from septic teeth.

Dr. Wendell Reber, in considering the relation of diseases of the eye and teeth ("Ophthalmology," vol. i., No. 1, Trans. Brit. Dental Journal, September, 1905), comes to the following conclusions :—

"The ophthalmologist should seek the assistance of the dental surgeon in all cases of unexplainable paralysis of the accommodation, dilatation of the pupil, palsy or spasm of the external ocular muscles, corneal ulcers, phlyctenular disease, lachrymal fistula, orbital cellulitis, abscess, caries, and periostitis, and in threatening glaucoma without apparent cause.

"The dental surgeon should refer to the ophthalmic surgeon patients that develop any ocular symptom whatever, and in particular those exhibiting altered pupils, or accommodation, lowered vision and painful eyeballs, and swollen lids, or orbital margins with prominence of the eyeball. The latter is particularly important, as pus in the orbit will almost invariably do some damage.

"From two to ten days is the time wherein infection from an alveolar wound is most likely to take place.

"The so-called reflex affections (traumatic hysteria) may occur at almost any time within six months after contraction.

"Eye strain in certain diseases of the eye may give rise to neuralgias reflected along the dental branches of the fifth nerve, and thus make it appear as though the teeth were the primary offending cause.

"The upper premolars and first permanent molar are the teeth which most frequently give rise to antral and orbital trouble."

TUMOURS OCCURRING IN THE MOUTH.

Of these, perhaps, the simplest is the so-called

Polypus or Fungus of the Gum.—It is not uncommon to find a cavity situated on the mesial or distal surface of a tooth filled up by a vascular mass, similar in colour and general appearance to the contiguous gums. It may be an outgrowth from the dental pulp (see p. 424); more commonly, however, it springs from the inter-dental gum, or, according to Dr. Magitot,[1] from the periosteum investing the neck of the tooth.

On a close examination it will be found that the tooth has decayed down to the level, or even below the edge of the gum, leaving a sharp, ragged margin, capable of acting as a source of irritation: that the gum has grown up from a flattened pedicle, and expanded out so as to fill up the cavity in the tooth; in other words, that a tumour has been produced by local irritation.

In structure it is a fibroma, and is similar to the tissues from which it springs. It is for the most part made up of fibrous tissue, with nuclei and fusiform cells; the surface is covered by greatly enlarged papillæ and a thin epithelium.

Pain does not occur unless the growth inflames and ulcerates, when the patient is unable to distinguish the pain so produced from that which arises from inflammation of the dental pulp.

If allowed to take its own course, the new growth usually rises to the level of the masticating surface of the adjoining teeth, and its further increase is restrained by the action of the opposing tooth. It will spring up again and again after simple excision; but if the decayed tooth be removed, or reduced to the level of the gum, any subsequent development of the mass is not only

[1] Dr. E. Magitot, "Mémoire sur les Tumeurs du Périoste Dentaire," p. 58 and Figs. 7, 7*a*.

checked, but that which has been already produced rapidly wastes away, and is lost.

In the treatment of cavities situated on the mesial or distal surfaces of teeth, it is frequently necessary to cut away the sides of one or more teeth down to the level of the gum, leaving a wedge-shaped interval. Into the space so produced the gum will sometimes advance, and is then liable to be injured by food, which, in the course of mastication, becomes forced into the separation between the teeth. The pain attendant upon this condition is usually attributed to the teeth which have been operated upon, and may very readily be mistaken for ordinary toothache. The absence of a cavity within which the new growth can find partial protection from pressure, appears to limit its growth; for in these wedge-shaped intervals we seldom find that it attains a size beyond that of a slight excrescence. This circumstance may be taken advantage of in our treatment of the disease.

Treatment.—Decayed teeth, when they afford a receptacle for polypus, are usually too deeply involved in disease to admit of successful treatment. It is better that they should be extracted, an operation which not only removes a useless organ, but cures at the same time the disease of the gum.

The extraction of the tooth often brings away the polypus, which is then (see Dr. Magitot, fig. *loc. cit.*) seen to be adherent to the neck of the tooth by a flattened pedicle. If for any special reason the preservation of the tooth is desirable, the tendency to recurrence of the growth must be kept down by escharotics.

Epulis.—Not very different from the growths just described is the more defined tumour known as simple or fibroid epulis. Tumours springing up from the margin of the gums, whatever may be their structural character, usually receive the designation epulis, and it must be borne in mind that another and quite distinct form of tumour, which is of far more serious nature, and is, in fact, a myeloid sarcoma, does not greatly differ in appearance at first from a simple epulis, and to it the name of myeloid epulis is often applied.

By common consent, however, the use of the term is becoming restricted to a particular form of tumour, which at first makes its appearance at the end of the gum, and very commonly at that portion which lies between two teeth, which, with the growth of the tumour, become gradually separated. The separation does not, however, afford sufficient space for the accommodation of the new structure which by slow degrees speads itself out either upon the labial or lingual surface of the gums, or upon both. The attachment, at first limited to the inter-dental portion of the gum, may not spread with the increasing size of the tumour, or the base may be gradually extended over the alveolar border. In other words, the epulis may be attached by a small and flattened pedicle, or by a broad base. The sub-mucous fibrous tissue, or perhaps the soft tissue contained in

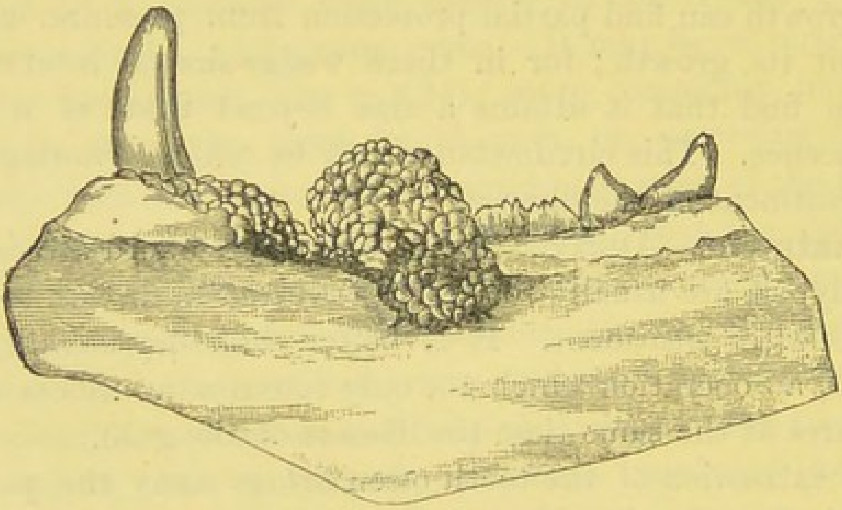


FIG. 280.—Jaw of a tiger, with a fibrous epulis springing from the alveolus. From Sutton's "Pathology."

the Haversian canals of the bone, is usually the site of the disease, which in its growth carries before it the superjacent mucous membrane. The tumours springing from the fibrous tissue are very generally themselves fibrous in character, and, lying close to the surface of the bone, very frequently contain osseous spicula. The new bone may be altogether detached from, or it may shoot out of the alveolar process, the surface of which, in either case, is usually abnormally rough. A simple fibroid epulis commonly does not exceed in vascularity the adjacent gum, and the density of the tumour usually corresponds with that of the latter structure.

Mr. Burghard (Trans. Odont. Soc., 1888) records three cases of exceedingly vascular forms of epulis which had little or no relation to the teeth ; none of them recurred after removal. He also records an unusual occurrence in the transformation of a fibroid epulis of several years' standing, which had never been removed, into a well-marked epithelioma; recurrence of an epulis, diagnosed as fibrous, in a sarcomatous form is, however, not very uncommon, though probably the sarcomatous character had existed from the first.

The preceding figure (from Sutton's "Introduction to General Pathology") shows well the situation of an epulis. As it is not a fatal disorder, such specimens are not often obtainable from the human subject.

When the new growth has attained a considerable size, secondary conditions are induced, which complicate, and to some extent alter, the character of the disease. Unrestrained by surgical treatment, the tumour, at first small, and productive of but little inconvenience, increases in size, generally encroaches upon the space assigned to the tongue, or upon the hard palate, and, covering over one or two of the teeth, impedes both mastication and articulation. The surface becomes injured either by the teeth of the opposing jaw, or by those whose crowns it has overrun. The injured part becomes the site of an ulcer, which emits a copious and fœtid discharge; and the patient, in the place of feeling inconvenience only, is subjected, if not to acute suffering, to great annoyance. The external characters of the ulcers sometimes closely resemble those assumed by malignant disease, and may present a further likeness in the occurrence of hæmorrhage; but the cases in which epulis passes into cancer rarely occur.[1]

Such, then, are the general characters of epulis. As regards the structure of these tumours, several minor varieties may be noted: first, those which are composed of fibrous tissue intermixed with cells; secondly, those which are mainly composed of the elastic fibrous tissue, the individual fibres of which, like those of yellow elastic tissue, are tolerably uniform in size, curl up when divided, and remain uninfluenced by the action of acetic acid; thirdly, those composed of myeloid cells, to which reference will be made later.

[1] A case in which epulis was supposed to have passed into epithelioma is recorded in the Pathological Society's Transactions, vol. xii. Mr. Adams removed the jaw, but the patient died from the recurrence of the disease in the skin.

In many cases it may be extremely difficult, if not impossible, to discover any satisfactory cause for the occurrence of epulis; but in others an examination of the tumours reveals a source of irritation to which the presence of the disease may with probable truth be assigned. In an epulis treated by the late Mr. De Morgan, the tumour contained an isolated piece of bone, which, on careful examination, was found to be embedded and entangled in, rather than adherent to, the fibrous tissue which composed the mass. After it had been dislodged from the tumour and submitted to microscopic examination, the following characters were clearly manifested :—the whole of the surface bore the marks of absorption, while the substance of the bone presented the structural characters of normally-developed tissue.

The presence of these characters, and the size of the fragment of bone, fully justified the assumption that it at one time formed a portion of the subjacent alveolus, and that its detachment had been effected by absorption; and further, that when so detached, it had proved a source of irritation, and thus led to the development of the epulis. In a case previously published, the stump of a tooth, the crown of which had been broken off five years before, was found in the centre of an epulis.

But true bone may be developed in the fibrous tissue of an epulis, just as bone may occur as a new development in various other situations; examples of this are given by Mr. Heath, who states that such epulides are generally now regarded as ossifying sarcomata.

Treatment.—Whatever may be the primary seat of an epulis, it is quite certain that it very generally involves the periosteum or the endosteum; indeed the balance of evidence is in favour of the view that, although it appears, when first developed, to be confined to the gum, it really springs from a deeper origin. Complete excision of the tumour is the only remedy upon which any dependence can be placed; and in order to effect its complete removal more or less of the bone at its base must be cut away. When it has grown up between two sound teeth, it may be necessary to extract one or both, in order to render the base of the tumour accessible.

As the growth is almost sure to recur if the bone at its base be not removed, it is exceedingly bad practice to cut off an epulis and apply nitrate of silver to the cut surface, or to remove it with a ligature. If the attachment to the bone appears superficial, the bone may be scraped away with a gouge or a chisel; but if, as is more commonly the case, its origin is deeper, the alveolus must be freely cut away with bone-forceps. Free removal of the alveolar border of the jaw does no appreciable harm in such cases; and it is far better to sacrifice a little more of a part which, in old age, nature would mainly remove, than to risk repeated recurrence of the disease. More

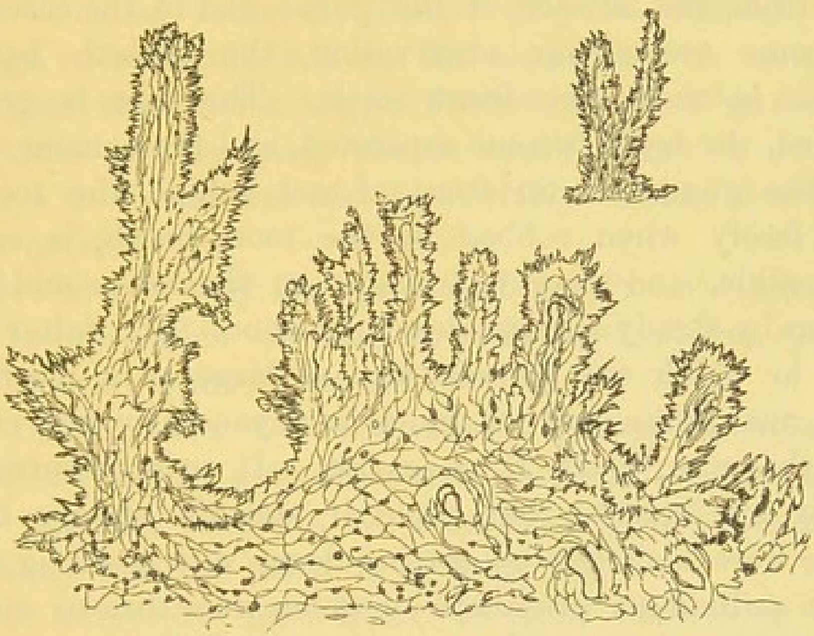


FIG. 281.—Section of a papilloma as large as a pea: from a specimen prepared by Mr. Charters White.

than this will never be required; even in the most formidable-looking cases of fibrous epulis, it is only the alveolar portion of the jaw which is involved.

Even the myeloid form, which is more prone to recur, may be successfully treated thus.

The hæmorrhage, which is rarely troublesome, may be checked by the use of the actual cautery.

Papillary Tumour of the Gum.—This is a rare disease described by Mr. Salter in Guy's Hospital Reports for 1866, in which local hypertrophy of the papillæ takes place to such an extent as to form a definite tumour; Heider and Wedl also (*op. cit.*, Taf. xiii., Figs. 118, 119) give figures of what they term "papillary proliferations," occurring in the vicinity of carious teeth, and Dr. Arkövy met with a case at the Dental Hospital. Mr. Mason (Monthly Review Dent. Surgery, 1873) describes a case in which the new growth had a white shreddy appearance, and an elastic feel. It consisted of an enormous hypertrophy of normal structure, and allowing for difference of situation, was analogous to a wart.

Vascular Tumours of the Gums.—The gums are sometimes the seat of tumours which, but for their close structural resemblance to nævus, might come under the head of epulis. The disease first shows itself in a bright red pimple, slightly raised from the surface of the gum; and in the cases which have come under our observation, the growth has been situated between the front teeth. The size is gradually increased, the teeth become separated, and the tumour extends along the gum, both in front of and behind the teeth. It bleeds freely when rubbed by the tooth-brush, is soft and compressible, and may be reduced to the colour and level of the gum by steady and gentle compression. Mr. Salter records a case in which the growth was as large as a marble, and which was productive of much annoyance by the constant hæmorrhage to which it gave rise. It twice recurred after removal by ligature, but when it and the spongy bone at its base were detached by cutting down with a strong scalpel, and the redundant granulations which were thrown out from time to time cauterised, a cure was effected.

Some cases which have come under the notice of the author have been successfully treated by the local application of powdered tannin to the surface of the tumour, but one case was met with that frequently recurred after destruction with nitric acid, sodium ethylate, and other caustics. It was never larger than half a pea, and ultimately ceased to recur.

More extensive and severe forms of vascular tumours are sometimes met with: thus Lannelongue, of Paris, met with an extensive cirsoid aneurism affecting the neck, face, and floor of mouth, which was caused to solidify by repeated injection with 10 per cent. solution of zinc chloride.

And Mr. Marmaduke Shield brought before the Odontological Society (Trans., 1895) a case of aneurism by anastomosis occurring in the upper jaw, which proved so troublesome, and even dangerous, by repeated hæmorrhage, that he was induced to resect a considerable portion of the jaw.

Sarcomatous Tumours.—These are composed of tissues of more or less embryonic type, in which the structure of completed tissues of the connective tissue group may be to some extent attained. They occur with some frequency in the mouth, and in the bones of the jaw, and may be divided into several groups, according to their structure. All are liable to recurrence after removal, but their degree of malignancy varies greatly: they appear to be spread by means of the blood-vessels and not by way of the lymphatics.

The so-called recurrent fibroid may be mentioned first, although in structure it is not the simplest. It resembles in histological character a simple fibroma, and it is probable that those cases of recurring fibrous epulis which on recurrence assume a more vascular and more richly cellular character are of this nature.

In recurrence they are apt to assume the form described as small spindle-celled sarcoma, in which the fibrous connective tissue element is much less pronounced.

Mr. Oakley Coles met with a small tumour attached to the side of the root of a tooth, which was examined by Professor Klein, and was found to be a spindle-celled sarcoma. This came away with the tooth on its extraction.

These forms are more liable to recur than those of more fibrous character, but are far less liable to cause secondary growths than the round-celled sarcomata, of which the small celled variety is the worst.

Myeloid Sarcoma.—This is a form of spindle-celled sarcoma in which giant "myeloid" cells are found: they occur in connection with bone, and are not uncommon in the mouth. Of this nature is the "myeloid epulis" already alluded to.

Mr. Hutchinson gives the following description of a tumour of this class:—"On examination, the epulis presented all the characters of myeloid growth in a most remarkable degree. Its section was very vascular, and showed hues varying from a deep red to buff, and a peculiar light-greenish tint of yellow (xanthoid of Lebert). Scattered in its structures were some detached masses of soft, spongy bone. Under the microscope were seen abundance of the large poly-nucleated bodies characteristic of these growths, many of them being very irregular in shape, and much branched."

The colour alterations are generally due to altered blood pigment, or to fatty degeneration.

They arise as malignant epulis, as tumours invading or originating in the antrum, or in any part of the substance of the jaw, and may attain to great size.

Free removal is the only treatment available, but recurrence frequently takes place, and secondary tumours may arise, especially in the lungs, so that they present a considerable degree of malignancy.

Osteo-sarcoma is another very malignant form, in which there is free formation of bony spicules. In this, as well as in the kindred osteoid-sarcoma, cells having the character of cartilage cells may be found, to which in great part the hardness of the tumour is due. A more purely cartilaginous tumour which is met with not uncommonly in the parotid gland is the chondroma; transitional forms between the pure chondroma and tumours which partake of the character of a sarcoma are met with, and calcification may occur in them.

Sarcomatous tumours are not uncommon, springing up in the antrum, the malar bone, or the pterygo-maxillary bone. They often present themselves as smooth swellings on the palate, and it is hence necessary to bear in mind that there are several innocent conditions of dental origin which may simulate them.

Cancerous Tumours. Epithelioma. — In essential character an epithelioma is an overgrowth of epithelium, partaking more or less of the character of the epithelium whence it was derived, invading subjacent tissues and becoming disseminated so as to produce secondary growths by way of the lymphatic system.

Thus squamous epithelioma is the one which is usually found on the lips, tongue and other parts of the mouth, such as the gum, sometimes apparently originating round the neck of a tooth, and both the squamous and columnar varieties occur in the mouth and jaws.

Mr. Christopher Heath (Trans. Odont. Soc., 1892) points out that in the antrum you have columnar epithelium, but in the lower jaw there is only squamous epithelium: nevertheless, both squamous and columnar epithelioma occur in the lower jaw. Of the former he says: "It is hypertrophy of the epithelium, with a tendency to heap up and burrow down in the deeper structures of the parts: and on the surface, wherever there is a squamous epithelioma, we have the characteristic heaping up of the edges, and the eversion of the edges, by which we recognise the disease."

One of the most characteristic histological characters of an epithelioma is the occurrence of nests of concentric flattened cells, but these are least conspicuous when the growth is rapid.

Epithelioma rapidly involves the neighbouring lymphatic glands, hence its early recognition and free removal is of the utmost importance.

The tendency of epithelioma is to rapidly invade the cavities about the upper jaw, so that when it has originated in the gum it soon enters the antrum; whilst of course it in some cases originates in the antrum, though this is less common.

It is insidious in its beginnings, the ulceration being often not very conspicuous nor angry-looking, and painless; but its early recognition, which will often fall to the lot of the dentist, is of the utmost importance, as nothing but very early removal can save the patient.

The mucous membrane of the cheek is liable to ulceration caused by the irritation of jagged decayed teeth; and it may become so indurated by constant irritation as to, in a measure, simulate epithelioma.

An ulcer of most suspicious appearance is apt to be produced when the edge of a plate cuts into the inflammatory swelling over the root of a dead tooth, or where from shrinkage of the alveoli an old plate cuts along all its edges and has continued to do so for a lengthened period.

And we have seen all the naked eye appearances of epithelioma simulated by the granulations over a partly-buried wisdom-tooth.

Although sores produced by a local injury such as this are generally very tender, whilst epitheliomatous ones are not, this distinction is lost when they are of old standing, for the surface of the sore seems after a time to become callous.

But actual epithelioma may result from the continuance of an irritation, though it will sometimes arise without any such apparent cause. A case some years ago under observation had originated in the edges of the socket of a dead tooth (a second upper molar), the roots of which had been filled and a crown built up upon it with the aid of screws in each of the three roots. Until after the extraction of the tooth there was not much to excite suspicion; there were some florid granulations about the neck, but not more than may often be seen in innocent places when teeth are loose. After the tooth had been removed, however, its whole socket was seen to present a granulating surface, which under soothing treatment showed no disposition to heal. A diagnosis of epithelioma having been made by Sir J. Paget and Mr. Heath, a vulcanite plate was made, covering the socket, which was packed with wool dipped in deliquesced chloride of zinc; this was left for twenty-four hours, and produced a considerable slough, with the result of getting a healthier surface; this was more than once repeated, but failed to do more than keep it in check, and the ulceration, quite painless and singularly clean in surface, slowly extended. Some few months after the disease was first noticed, Lord Lister removed the tuberosity and a portion of the soft and hard palate, and the disease has shown no sign of recurrence. In this case the disease certainly originated within the socket of a dead tooth, and the success that has attended its treatment is due to its early recognition, for it is very apt to have spread insidiously far beyond its apparent limits, even at the time of its first discovery. True carcinoma is rarely if ever met with in the mouth or jaws, though it may affect the œsophagus. Speaking generally the symptoms which would lead to a suspicion of tumour where it is not itself visible, are projection of the surface of the face, some degree of immobility of the jaw, irregularity of the surface of the palate, displacement of teeth and alveolar processes, obstruction of lachrymal duct, prominence of one eye, or obstruction of the nasal passages. But in one case met with by the author, in which a serious view was taken by several surgeons in consultation on account of asymmetry of the face and palate, an old nurse of the patient's declared that this asymmetry had existed from early childhood though unnoticed by the patient or his friends, and the sequel proved that she was right.

Other Tumours.—The commonest cause of swelling on the hard palate is abscess dependent on a lateral incisor tooth, though other teeth do occasionally give rise to swelling in this situation. Sometimes these abscesses are very chronic, painless and hard, and may be mistaken for some more serious condition.

In forming a diagnosis of a palatal tumour, it must not be

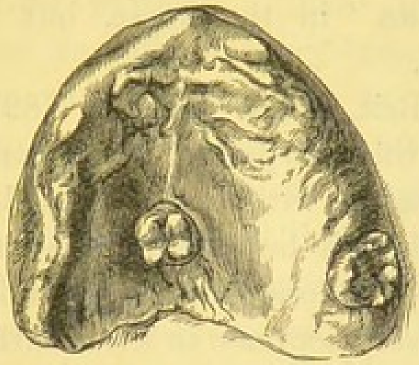


FIG. 282 —From a plaster model in the Museum of the Odontological Society.

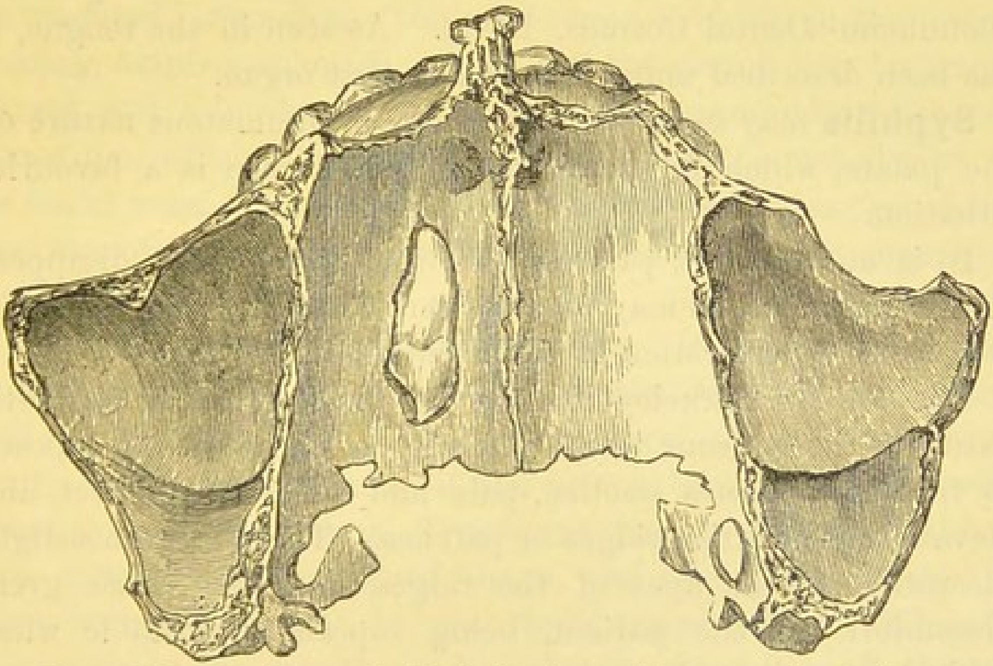


FIG. 283.—Canine embedded in the palate, seen from above. From Heath's "Injuries and Diseases of the Jaws."

forgotten that it may be due to a misplaced tooth, as is exemplified by the accompanying figures; in one a molar tooth has been erupted in the median line of the palate; and in the other the canine is shown lying horizontally along the palate, exposed by the removal of the bone above it.

The author has himself met with an unerupted tooth in the palate which gave rise to a hard, smooth swelling, the form of which was in no way suggestive of a tooth being buried beneath it.

Mr. Storer Bennett has shown (Trans. Odont. Soc., 1894) a case of soft swelling of the gum, not tender nor very vascular : indeed if it was wounded it hardly bled. It appeared to be similar to "**lampas**" in the horse, but it is of very rare occurrence in man.

Mr. Shattock (Brit. Med. Journal, 1895) also records a curious tumour of the soft palate, which consisted of cartilage and myxomatous tissue, with branching columns of cells, like those of a gland, though he attributes to them a connective tissue origin rather than one from the glands of the palate.

Tubercle is not very common in the mouth : it may, however, affect the lips, the alveolar borders, and even invade the bone. The tonsils and pharynx are perhaps rather more often affected, and it is a troublesome condition to treat in this position (Bonnheim Dental Cosmos, 1901). As seen in the tongue, it has been described under diseases of that organ.

Syphilis may cause an induration of gummatous nature on the palate, which for some reason not known is a favourite situation.

It is an indolent, painless swelling, which may disappear under treatment, or may break down, and involving the bone, may cause a perforation of the hard palate.

The late Mr. Berkeley Hill has pointed out that, in syphilitic patients, the mucous membrane of the cheek where exposed to friction becomes swollen, pale and sodden in aspect, and elevated into whitish ridges or patches. There is often a slight ulceration at the apex of the ridges, and they cause great discomfort to the patient, being especially irritable when rubbed by a jagged tooth.

These, if present, are an aid to diagnosis, but their absence is not conclusive as to freedom from syphilitic taint.

Gummata may also occur in the substance of the cheek, though they rarely do so, and they are common in the tongue.

Actinomycosis.—A rare disease has been observed in the jaws of a human subject (Mr. Shattock, Pathological Society Transactions, vol. 36), which is due to the growth of a fungus, the actinomycetes. It was formerly thought to be so rare that it had little practical importance, but it is more common in cattle, and appears to be communicable from them to man. But one observer, Mr. Kellock,[1] has met with no less than ten cases in the out-patient department of the Middlesex Hospital, and other cases which have been reported seem to indicate that the disease is becoming more common and needs to be kept in mind by the dental surgeon. The development of the fungus gives rise to an inflammatory lump, and these lumps coalescing give rise to a tumour, but as they increase they break down and suppurate, so that the whole mass is riddled with suppuration cavities. The swellings are accompanied with little pain or tenderness, and do not observe anatomical limitations, but speedily invade surrounding tissues; hence when occurring in a gland they do not, like tubercle, retain the shape of the gland and remain moveable. As if left to themselves, they soften and break at several points, they thereby differ from alveolar abscess, with which they may at first easily be confused. Sometimes the ray fungus is visible in the pus as shining, sulphur-coloured grains, but the grains may be transparent and colourless. On microscopic examination the ray formation, which is due to refraction of light, is not always to be found even when staining has afterwards demonstrated the presence of a streptothrix, or even when, subsequently, characteristic ray masses have been conspicuous. And the streptothrix is not always easily found after staining. It stains with Gram's method, and also, according to Mr. Astlett Baldwin, with eosin, but not with methylene blue or ordinary aniline dyes. More acute symptoms may arise if the person become infected with other pyogenic organisms. Treatment consists in letting out any pus, scraping away softened tissue, and giving large doses of potassium iodide (10—15 grs. three times a day). When it occurs about the mouth or face the prognosis is good, though treatment has to be carried on for a considerable time.

[1] "Actinomycosis," Trans. Odont. Soc. Dec., 1904.

ODONTOMES.

Irregularities in the form of individual teeth have already been noticed at a previous page; these irregular teeth, however, are linked, by insensible gradations, with those masses of dental tissues which bear no external resemblance to the form of teeth.

The name "odontomes" is applied to those masses of dental tissues which result from morbid conditions of the formative organ; these may consist in hypertrophies, local or general, or various degenerations. It is hardly possible to strictly define what is meant by an "odontome," in the usual acceptance of the term; for it is not usual so to designate, for example, the teeth with enamel-coated nodules, near their necks; and yet these excrescences differ only in degree from those which equal or exceed the whole tooth in size, and would, by most writers, be called "odontomes." Mr. Bland Sutton suggests as a definition, "Neoplasms composed of dental tissues, in varying proportions and different degrees of development, arising from tooth germs or from teeth still in progress of growth." Professor Broca has described these malformations, taking as the basis of his classification the periods of development at which they arise; and although something may be said against this sharply defined discrimination of the one form from the other,[1] yet it has obtained some currency and must be described here.

In order to understand the origin of these pathological products, it is necessary to clearly keep in view the normal process of tooth formation. At an early stage, a future tooth is represented by a mass of submucous tissue (meosoblastic),

[1] Prof. Wedl ("Pathologie der Zähne," p. 116) objects to Prof. Broca's classification, on the ground that it is not based on histological investigations, nor is it in exact accordance with the history of tooth development.

which has, as it were, risen up to meet the inflected process of epithelium (epiblastic), which forms the enamel organ.

Broca ("Traité des Tumeurs," 1869) classifies odontomes according to the period at which they arise, into four groups:

1. Those which arise before the development of the membrana eboris (*O. embryoplastiques*).

2. Those which arise shortly before the formation of the dentine cap (*O. odontoplastiques*).

3. Those which arise during the formation of the crown of the tooth (*O. coronaires*).

4. Those which arise during the formation of the root (*O. radiculaires*).

Whilst this classification was a step in advance of anything which existed before, it has proved to be not wholly satisfactory, so Mr. Bland Sutton, who has investigated, and with the aid of comparative pathology greatly elucidated them, classifies them thus:

a. Aberrations of the Enamel Organ.—1. Epithelial odontomes; 2. Calcified epithelial odontomes.

b. Aberrations of the Follicle.—1. Follicular cysts; 2. Fibrous odontomes; 3. Cementomata; 4. Compound follicular odontomes.

c. Aberrations of the Papilla.—1. Radicular odontomes; 2. (*a*) Dentomata, (*b*) Osteo-dentomata, (*c*) Cementomata.

d. Aberrations of the whole Tooth Germ. — Composite odontomes.

In the following pages Mr. Sutton's classification will be followed.

An odontome which goes on to completion becomes a calcified mass, composed of one or more of the dental tissues; but it was first pointed out by Broca that this need not necessarily be so, but that the overgrowth of the dental germ, or of parts of it, might take place and yet no calcification go on in it. This is fully confirmed by the examples which Mr. Sutton has found in lower animals, and it may be accepted with a high degree of probability that some soft tumours of the jaws have this origin.

(*a*) **Epithelial odontomes.**—Thus it is probable, inasmuch as calcified odontomes arising from an overgrowth of an enamel organ do occur (see page 725), that such a tumour might originate and be removed, or the bearer of it die before it calcified, or it may be that, having started on so aberrant a course, it might have no disposition to calcify.

Thus Professor Wedl (*op. cit.*, p. 275) relates that a case of sarcoma, occurring in a man aged thirty-five, may have had some connection with an enamel germ, inasmuch as in its fibrillated stroma were numerous cavities and tubes lined with epithelium, calling to mind an utricular gland, the terminal vesicles of which had become in places pinched off from the rest.

Mr. Eve (Trans. Odont. Soc., 1885) calls attention to this class of tumours, and inclines to the view that they may have their origin in tooth germs; it is interesting to note that he figures a process of vacuolation like a colloid degeneration

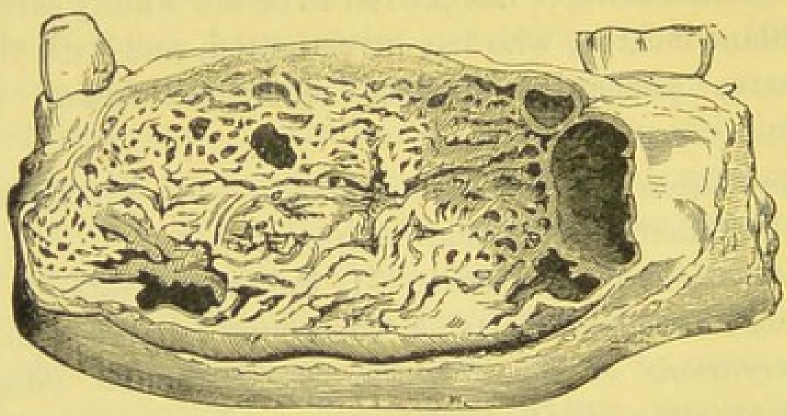


FIG. 284.—Epithelial odontome. After Bland Sutton. Trans. Odont. Soc.

going on in them, resulting in the formation from an epithelium of masses of stellate cells with their interspaces filled with colloid material, exactly like what we see in an enamel organ. And in the poison canal of a viperine tooth we may see the enamel cells, here become useless, undergoing this very degeneration.

To this form of odontome the name of multilocular cystic epithelial tumour has been given; it occurs in young persons, and does not recur after removal. Formerly they would have been described as cystic sarcomata. The appended figure, from Mr. Sutton's paper, shows the appearance of a tumour removed by Liston, and now preserved in the museum of University College Hospital; in it all teeth from the incisor to the molar were absent.

The writer has observed one example of an odontome which was for the most part made up of the products of calcification of an infinitely branched enamel organ, and Wedl ("Atlas zur Pathologie der Zähne," 1870) figures a specimen which may be referred to this group. Mr. Eve also describes a specimen of cystic growth, which had almost destroyed the right side of a lower jaw, which contained no tooth, but the cysts were lined with an abundant round-celled epithelium. This, he thinks, may have originated from the expansion of an early enamel organ.

(*b*) From these comparatively rare forms we pass to the aberrations of the follicle, a far more numerous and common class.

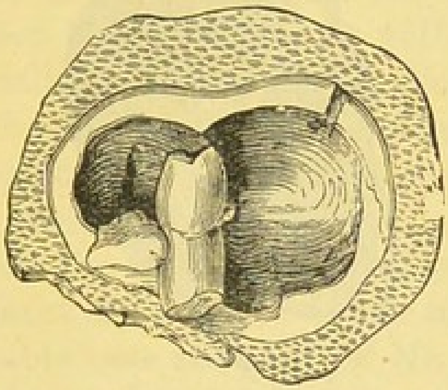


FIG. 285.—Follicular cyst (R.C.S. Museum). After Bland Sutton. Trans. Odont. Soc.

The **follicular odontomes** embrace all that class of tumours more usually known as dentigerous cysts.

As dermoid cysts, and parasitic fœtuses and ovarian cysts often contain teeth, the term dentigerous cyst comes to be loosely applied, and hence is open to objection: moreover follicular odontomes run by degrees into other and calcified forms of odontomes. The follicular cyst arises in connection with teeth retained in the jaws, generally bicuspids or molars: they cause great distension of the jaws, and have often been removed by operations of needless severity: they rarely occur with temporary teeth. A simple example of such a cyst is figured by Mr. Salter.

Teeth which lie buried in the jaw do not by any means invariably give rise to irritation. Numerous examples of teeth occupying abnormal situations are to be found in museums, with no signs of disease around them; and there are even instances of teeth inverted and embraced between the roots of other teeth, whose presence has never been suspected until the erupted tooth has been extracted in consequence of caries.

But in a certain number of cases these retained teeth cause to be developed around them a cyst with bony walls. An excellent example of this is here figured: the drawing is taken from a wax model of a portion of the lower jaw excised by M. Maisonneuve: at the bottom of the cyst is seen a canine tooth lying horizontally. In this case a saline fluid flowed

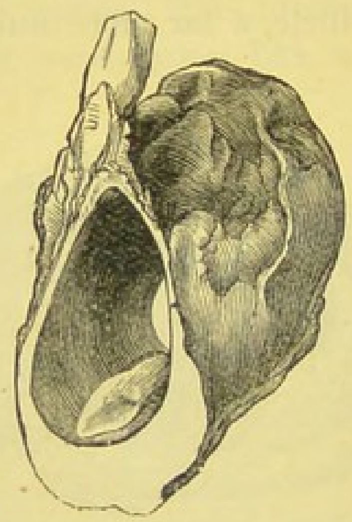


FIG. 286.—Cyst of the lower jaw, containing a canine tooth. M. Maisonneuve's case.

from an opening behind one of the front teeth, leading into the cyst.

In this case the patient's age (fifty-six) would add to the difficulty of diagnosis, as dentigerous cysts, in the majority of cases, come under the surgeon's notice at a much earlier age.

A considerable number of such cases have from time to time been put on record, and most of the museums of the different London hospitals contain portions of jaws which have been removed through a mistake in the diagnosis. The cysts in these cases have generally consisted of a thick soft membrane, outside which comes a bony shell, formed by the bone of the jaw expanded over the growth within it. This membrane in some instances becomes calcified, as is well exemplified in Fig. 291; or it may become infiltrated by earthy salts, without definite structural arrangements.

Some of these cyst walls when examined have been found to be lined with a distinct polyhedral epithelium, the origin of which is a little difficult to understand; from the inner surface shreds often hang loosely into the cavity, and have been supposed to be uncalcified portions of tooth-germs, as they sometimes bear small nodules of dentine and enamel.

The tooth very generally has its crown projecting into the cavity, while its root is buried in the cyst wall; sometimes, however, the whole tooth appears to lie free.

Mr. Heath met with a large cyst in the lower jaw, which when punctured was found to be quite empty, the fluid which it once had doubtless contained having been wholly absorbed. No tooth was discovered at the time of the operation, but after some little suppuration had occurred, one (a bicuspid), which had previously been buried in the cyst wall, came to light.

The cyst is usually filled with a clear glairy fluid, in the first instance; but not uncommonly it has become inflamed at some period, and its contents will then be pus, or perhaps a yellowish fluid loaded with cholesterine.

As a general rule, the cyst appears to give rise to a distinctly localised enlargement of the bone; but in some instances, as in the very remarkable case recorded by Mr. Fearn,[1] the whole jaw was expanded by a separation of its internal and external plates, extending from the ascending ramus on the one side, to a point beyond the symphysis on the other. The figure of this jaw here given is borrowed from Mr. Heath's "Diseases and Injuries of the Jaws," where a very comprehensive account of dentigerous cysts is to be found.

Dr. J. S. Marshall (Chicago Medical Journal, January, 1884) describes a dentigerous cyst in a boy aged sixteen, which had been noticed for two years. On being incised it was found to contain about four drams of fluid, and it had loosened and displaced the first and second permanent molars; well up towards the sigmoid notch the crown of the wisdom-tooth could be felt. On this being grasped it readily came away, having little or no root, and the condyle and back of the ramus were found to be loose and detached from the surrounding parts, being apparently necrosed.

The periosteum being comparatively uninjured, the ramus,

[1] British Medical Journal, August 27, 1864.

and what is more extraordinary, the articulation, were almost completely reformed, so that two years afterwards hardly any deformity or inconvenience remained.

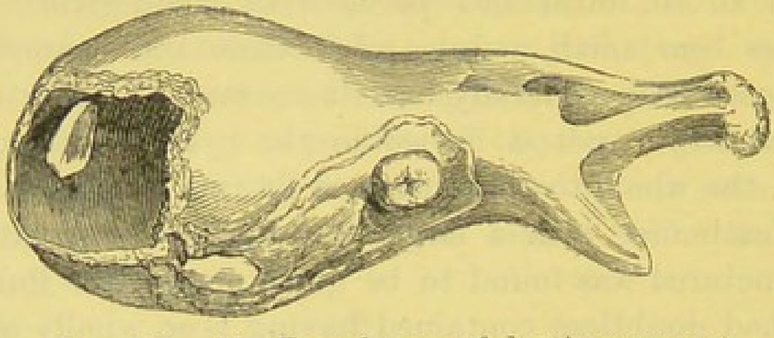


FIG. 287.—Mr. Fearn's case of dentigerous cyst.

Another case, in which the whole of one ramus was expanded, is given by Dr. Forget in the work before referred to. The

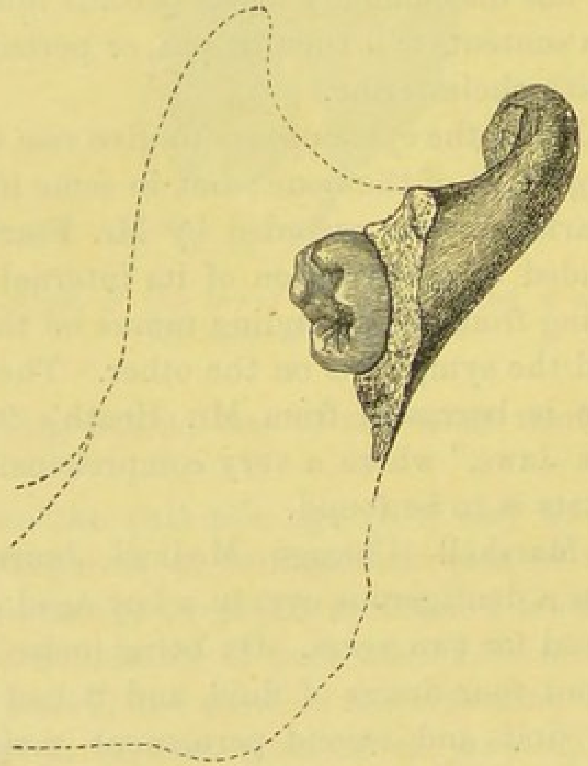


FIG. 288.—Dr. Marshall's case of dentigerous cyst.

tumour, which proved to be a cyst in which lay an inverted wisdom-tooth, had been slowly growing for ten years, and at the time of operation was larger than a hen's egg. In this case the half of the jaw was removed by M. Lisfranc, the patient recovering the operation well; though, of course, had the true nature of the case been recognised, this formidable procedure would have been unnecessary.

This inversion of a tooth is not uncommonly found in cases of dentigerous cyst; as is seen in the following case, related in the first edition of this work:—

A girl of sixteen, the daughter of a tradesman, gave the following history of her case:

"Nine months since a swelling appeared in the lower jaw, about the implanted portion of the second molar, which was supposed to be a gum-boil.

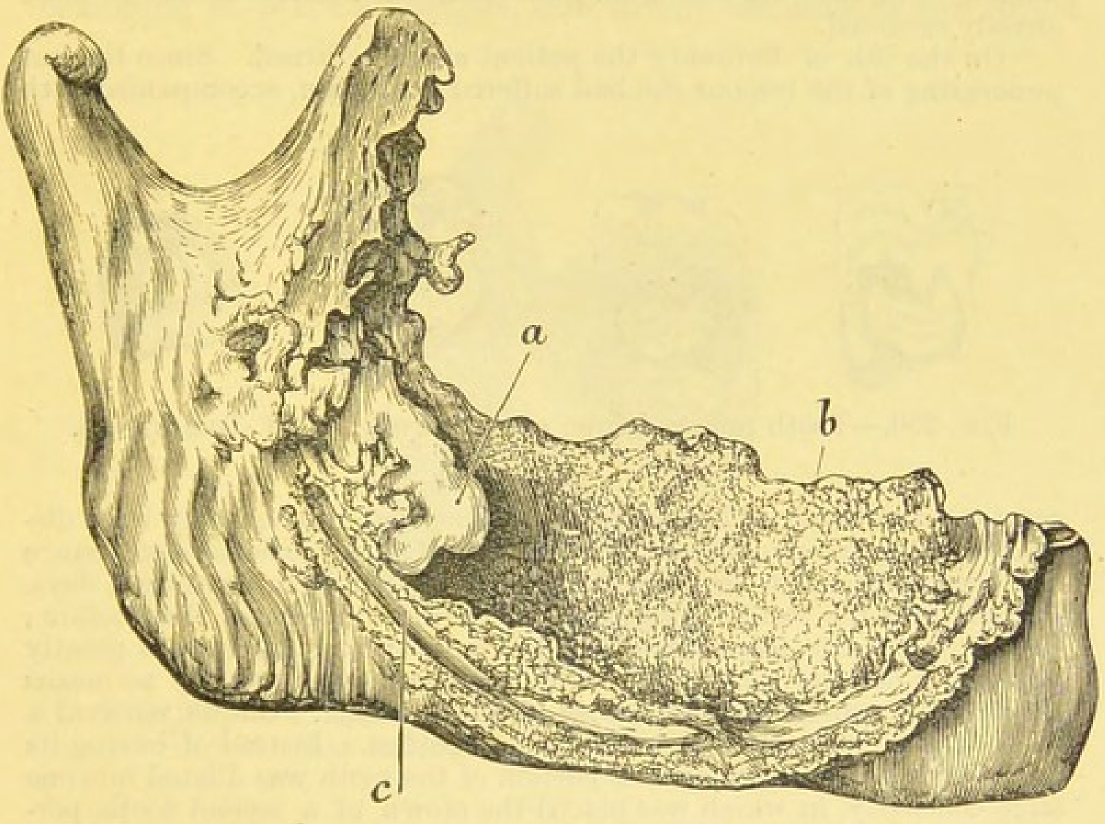


FIG. 289.—Right half of the lower jaw, expanded out by a dentigerous cyst. *a*, inverted wisdom-tooth; *b*, internal wall of the cyst; *c*, inferior dental canal. M. Lisfranc's case. We are indebted to the late Mr. Christopher Heath for the use of the woodcut.

"The pain was at first slight and intermittent; but as the size of the swelling gradually increased, the amount of discomfort became greater, though never amounting to acute pain. I saw her for the first time on December the 15th, 1856. There was a very considerable enlargement of the alveolar portion of the jaw around the second molar. The tooth, however, was perfectly sound, and although tender when pressed upon by the antagonistic teeth, yet it was not considered by the patient to be the seat of pain. The colour of the tooth was perfectly good, and its implantation firm—indeed, there was a total absence of any indication which would induce a belief that disease had arisen firstly in it and subsequently extended to the jaw.

"The swelling was not confined to the soft parts—the bone was obviously involved. At one point, however, fluctuation could be felt, and the examination did not appear to produce any considerable amount of pain. The absence of acute inflammatory symptoms, and the comparative freedom from tenderness, coupled with the large amount of local swelling, rendered the nature of the disease obscure. Mr. Arnott was kind enough to see the case, and he introduced a grooved needle; several drachms of a clear yellow fluid escaped, and the swelling of the soft parts to a certain extent subsided, leaving the outline of the enlargement of the bone comparatively distinct. The patient felt relieved by the operation from the sense of tension and weight, which had latterly become distressing. On the 26th of January the swelling had again returned, and with it dull aching pain: the involved tooth had in the interval become slightly loose, and was turned inwards towards the tongue. The swelling was again punctured, with results similar to those already recorded.

"On the 5th of February the patient again returned. Since the last puncturing of the tumour she had suffered great pain, accompanied with

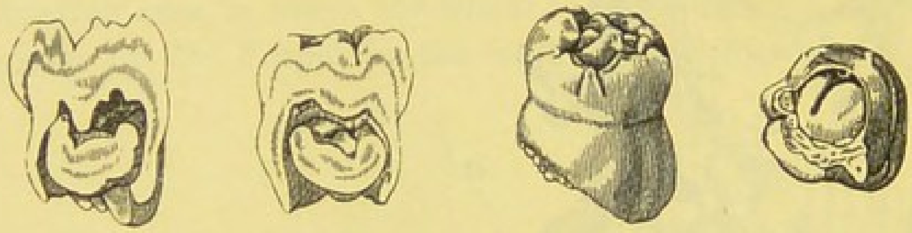


FIG. 290.—Tooth removed from above a cyst. Sir J. Tomes' case.

constant throbbing in the tumour, and pus had subsequently been discharged from the puncture. The amount of constitutional disturbance had been sufficient to confine the patient to her room for several days. Finding that the tooth had become much more displaced than before; that it was quite loose, and that the surrounding gums were greatly inflamed, I determined to remove the tooth, although it was by no means clear that it was the primary cause of the mischief. On its removal a most curious state of things was made manifest. Instead of having its normal two roots the implanted portion of the tooth was dilated into one large concavity, in which was placed the crown of a second tooth, perfectly invested with well-developed enamel, but having its masticating surface directed downwards towards the jaw. The two teeth appear to be united by dentine at one point, and to have one common pulp-cavity. The appearances presented by the united teeth are shown in the figures on this page.

"The pain from the operation quickly subsided, and within a fortnight all swelling and pain in the soft parts had disappeared; the enlargement in the bone had also sensibly diminished."

A case presenting somewhat similar general characters was treated at the Middlesex Hospital. In a female under thirty, the lower jaw had become enlarged and painful in the neighbourhood of the second molar, behind which was a fistulous opening. Through this opening a probe passed readily into a cavity in the substance of the bone, but no tooth could be felt. An opening was then made with a trephine, and the finger introduced, when a tooth covered in great part, if not entirely, by membrane was found lying upon the floor of the cavity. The tooth proved to be a perfectly sound wisdom-tooth.

When one of these dentigerous cysts is situated in the upper jaw, it is very common to find the antrum involved in the disease; a number of cases are quoted by Mr. Heath in which this has taken place: one remarkable case is quoted by him from Dupuytren, of a cyst developed between the plates of the palatine process of the upper jaw. There is a preparation belonging to Mr. Cartwright, now in the Museum of the Royal

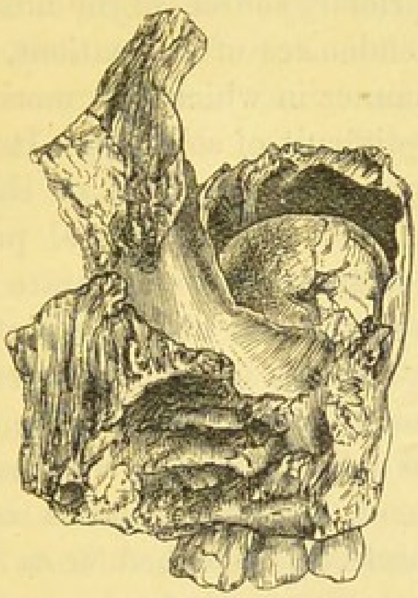


FIG. 291.—Dentigerous cyst which has invaded the antrum, and has subsequently become calcified.

College of Surgeons, in which a cyst of this kind occupies the antrum; the cyst wall has become calcified, so that it presents the remarkable appearance depicted in the figure of a very fragile bony shell, attached only at one point, and elsewhere free of the walls of the antrum. The cyst contains a supernumerary tooth.

But a yet more remarkable case (Baume's case) is cited by Mr. Heath, in which *both* antra were dilated to an enormous size by cysts, in the one of which was a canine, and in the other a molar tooth.

A very interesting case of dentigerous cyst in the antrum is reported by Mr. McCoy in the Lancet (1871). The patient was a negro, aged fourteen, and the tumour, which had been first noticed about two and a half years previously, was as large as an apricot. The cavity of the antrum was found to contain a small quantity of glairy fluid, but to be chiefly occupied by a gelatinous substance, apparently thickened mucous membrane. Projecting into the cavity was a perfectly sound canine tooth, which was imbedded in a distinct socket situated in the nasal process, on the inner angle of the orbital process of the maxillary bone ; it required some force to extract it. Previously to the operation it was noticed that the left upper canine tooth was missing from its natural place.

No reasonable doubt can be entertained that the teeth are, in these cases, the primary sources of the mischief, aided perhaps by constitutional tendencies of the patient. But the question as to the precise manner in which the morbid conditions were developed is more difficult of solution. It will be remembered that, when treating of the eruption of the temporary teeth, attention was directed to the occasional presence of vesicular enlargements over teeth about to penetrate the gums, the contents of which presented the characters of serous fluid ; and to the fact that, on incising such enlargements, the knife comes down on the enamel-coated crown of the coming tooth. In connection with this subject, allusion was made to the fact that, when the development of the enamel is completed, its outer surface becomes perfectly detached from the investing soft tissue, and that a small amount of transparent fluid not uncommonly collects in the interval so formed. Now I believe we may find in this an explanation of the manner in which cystic tumours containing buried teeth arise.

I conceive that, in the cases cited, fluid collected between the enamel and the tooth-capsule. As the cyst enlarges, the contiguous bone is removed to make room for it, fresh bone being concurrently deposited on the outside of the jaw. In the case of such a cyst lying in front of a tooth which is being cut, it is obliterated by the advancing tooth, or it bursts ; but when situated deeply in the jaw, a cystic tumour may be the result.

If the foregoing views be correct, it is not difficult to see how an encysted tumour may be produced by a hidden tooth ; in M. Maisonneuve's case a perfectly sound canine lay at the bottom of a cavity lined by membrane and filled by fluid.

Nasmyth's membrane is furnished by some part of the tooth-capsule, or of the enamel organ; if, then, the "cuticula dentis" is present on these teeth enclosed in cysts, some light would be thrown upon the question which of these views is correct.

But, so far as we know, no observations have been made on the presence or absence of Nasmyth's membrane on these abnormally-placed teeth; so that, so far as it is concerned, the question must remain in abeyance.

A case that lends some support to the above views was met with by Mr. Moon, at the Dental Hospital, in which a dense, elastic tumour, simulating a solid growth, occupied the place of one of the central incisors of a child. On incising it, it was found to contain clear fluid, and the crown of the missing incisor was exposed in the cavity: it was described by Mr. Moon as an example of a dentigerous cyst devoid of bony walls.

It must, however, be recollected that cysts lined with a very distinct fibrous membrane occur in other bones than the jaws, so that it is not at all necessary that the lining membrane of a dentigerous cyst should have been in any way derived from the tooth and its capsule. And Professor Wedl (*op. cit.*) suggests that it is quite as probable that a tooth growing in an abnormal direction should set up an irritation, resulting in the surrounding bone becoming abnormally developed into a cyst, as that the dental sac should itself degenerate into a cystic formation. Mr. Eve (Brit. Med. Journal, 1883) holds the opinion that the epithelial lining of such cysts may be due to an ingrowth from the epithelium of the gum.

The subsequent changes which may occur, such as calcification of the cyst wall, or the alteration of the contained fluids by inflammation and subsequent suppuration, do not require any special comment. But when once a buried tooth has become a source of severe irritation, it is seldom that the mischief ceases until the source of irritation has been removed; when this has been effected, the cure is usually rapid and complete.

Follicular cysts may suppurate and give rise to severe symptoms, though they rarely do so.

Diagnosis.—The recognition of dentigerous cysts, in the earlier stages of their growth, is exceedingly difficult, and they have in a number of cases been mistaken for solid growths. As a rule they grow very slowly—in one case the tumour having been noticed for ten years; and they are often painless, unless inflamed. The surface of the tumour is rounded, hard, and smooth; or it may be lobulated, from the existence of several cysts. The age of the patient, which *à priori* might have been expected to have afforded some clue, is not a reliable guide in diagnosis, as out of the cases mentioned

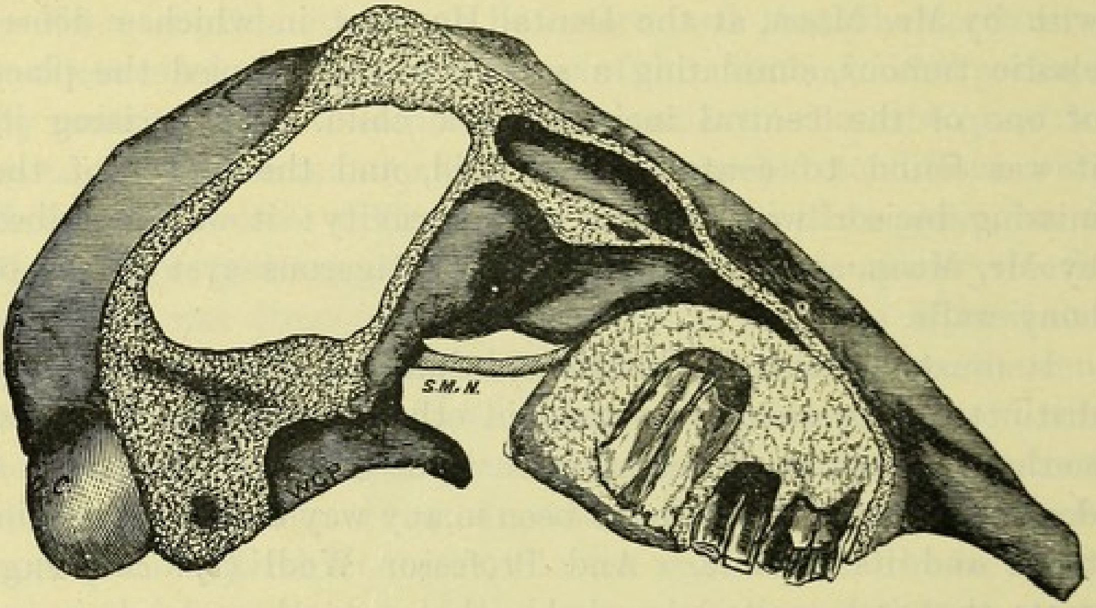


FIG. 292.—Mr. Sutton's specimen of odontome in the jaw of a goat.

by Mr. Heath, one patient had reached the age of sixty, whilst M. Maisonneuve's patient was fifty-six.

Nevertheless, the majority of the cases recorded have been in persons under thirty; and, taking into account the slow growth of these tumours, their first appearance would have been at a somewhat earlier age.

But a very important point to look for is the absence from its proper place of one or more teeth; or, as in Mr. Salter's case, the presence of a temporary tooth where the surrounding teeth belong to the permanent set. But, as has been noticed by Mr. Heath, the absence of particular teeth is in some instances a hereditary peculiarity; and the retention of a temporary tooth to an advanced age is not so rare an occurrence as to render its presence anything like an absolute proof that the tumour is due to a hidden permanent tooth. Nevertheless, any such irregularity in dentition will be very strong evidence in favour of the assumption that the enlargement of the jaw has for its cause the missing tooth. The presence of the regular number of teeth does not by any means preclude the possibility of the tumour being due to a tooth; for there are several instances of supernumerary teeth lying buried in cysts.

The tooth sac presents an outer firm wall and an inner looser layer of tissue, and is largely concerned in the formation of cementum. In ruminants it is very greatly developed, and in them the fibrous odontome is relatively common, being curiously enough generally existent symmetrically on both sides of the mouth.

Mr. Sutton found in a goat fibrous odontomes which are, both to the naked eye and to microscopical examination, clearly hypertrophies of this fibrous tooth sac; had they gone on to calcification they would have been "cementomata." In a Dasyure he found on each side of the upper jaw a fibrous tumour, into which the roots of a molar tooth projected; here and there a little irregular calcification had occurred, and in the centre of the tumour giant cells and embryonic connective tissue occurred, this latter apparently being in continuity with the tooth-pulp.

Broca, under the term odontomes embryoplastiques, grouped certain cases of fibrous tumour of the jaws, with or without calcification. In Mr. Sutton's paper (Trans. Odont. Soc., 1887) are quoted several examples occurring in the human subject; one that was removed at St. Thomas's, and catalogued as an osteo-fibrous tumour, was firmly attached to the canine, incisor, and first molar teeth. Mr. Heath has (probably) met with such a case in a young lady, from whom he removed a fibroma from the antrum, which was enucleated with the finger and did not recur (after fourteen years), although rich in cell-elements; and Broca and Letenneur have removed from children fibroid tumours connected with and entangling partly-developed teeth.

It, therefore, seems reasonable to suppose that some fibroid tumours of the jaws are "fibrous odontomes," or, in other words, cementomata, as yet not calcified.

In **cementomata** the bulk of the tumour is made up of cementum, often very distinctly laminated. As might be expected, they are commoner and larger in ungulata than in man, in whom the cementum is scanty in amount; in the horse they are sometimes enormous, as is seen in a following figure, in which at least three teeth germs were concerned (Fig. 295).

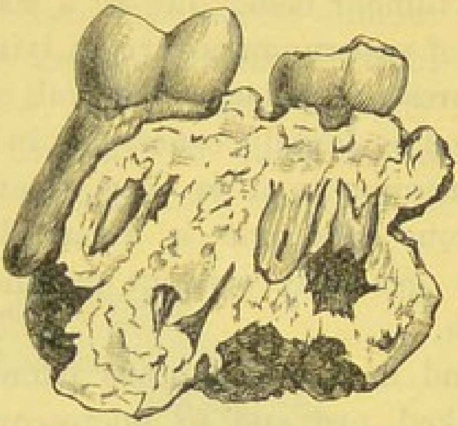


FIG. 293.—An odontome, probably a cementoma, removed by Mr. John Murray (see p. 583).[1]

Though pure cementomata are not common in man, Forget's case may be of this nature. Broca considered that it was an outgrowth of the dentinal pulp, though he did not find dentine in the mass, which was laminated and of bony structure. The

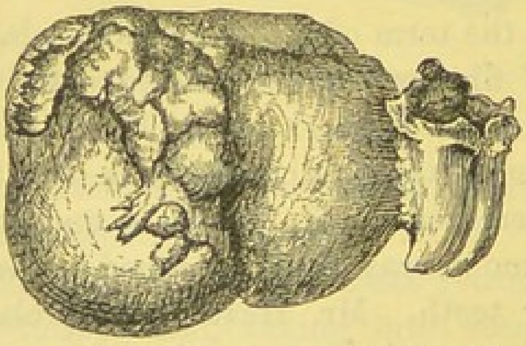


FIG. 294.—Forget's odontome. From Heath's "Injuries and Diseases of the Jaws."

whole mass came away in attempting to extract the decayed tooth which formed the anterior portion of the mass.

A remarkable specimen lent to the author for inspection by Dr. Barrett, of Buffalo, evidently belonged to the category of cementomata. A molar tooth, normal as regards its crown and two-thirds of the length of its roots, had the ends of the

[1] Trans. Odont. Soc., May, 1905.

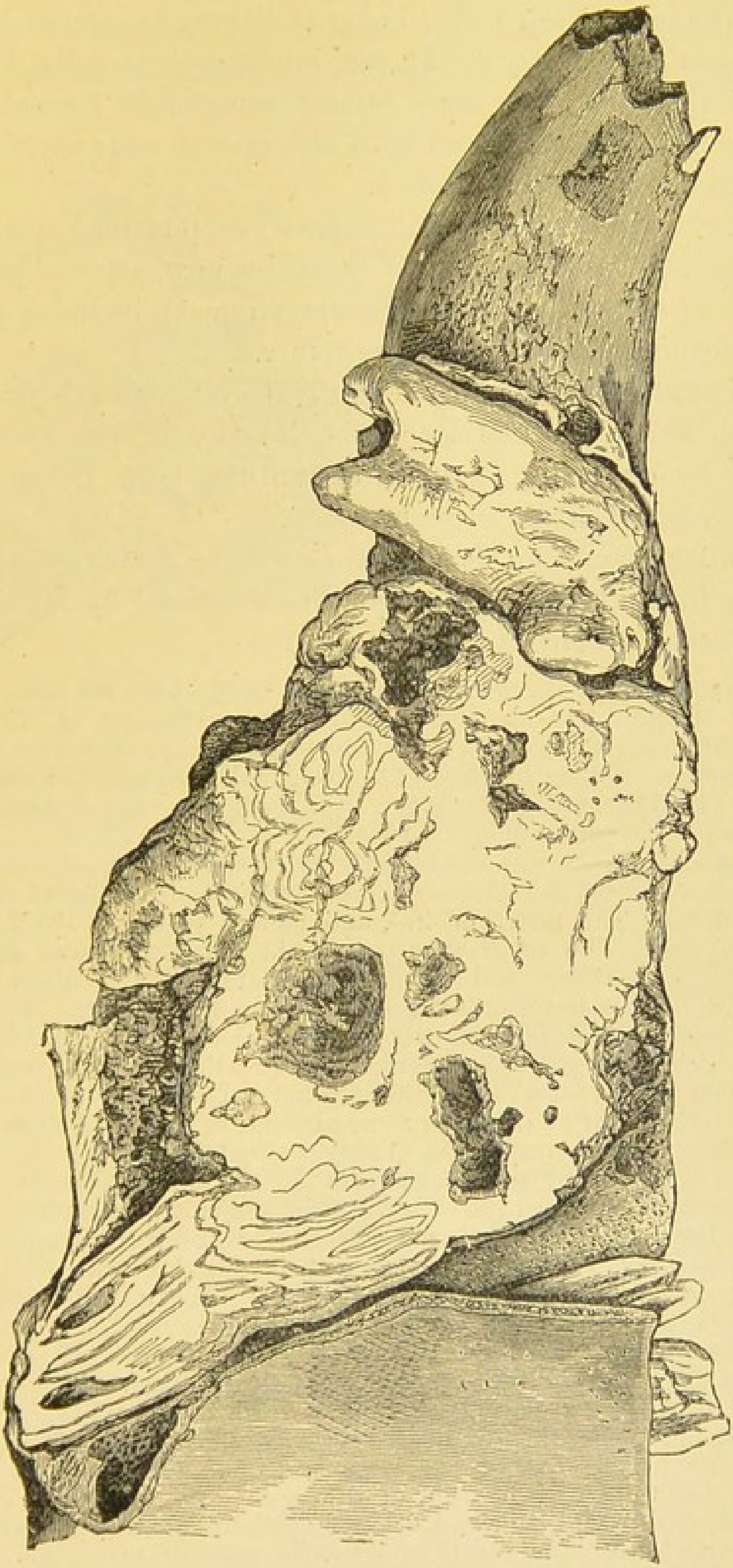


FIG. 295.—Front of the jaw of a horse, with odontome *in situ*. After Bland Sutton.

roots merged in a rounded, rough-surfaced mass, nearly as large as the tooth itself. Not being at liberty to interfere with the specimen, the writer could not investigate it fully, but it appeared that the roots were almost completely formed, and that they had been embraced by a soft growth near their ends, which had subsequently calcified.

In Mr. Sutton's earlier classification a group termed "anomalous odontomes" was included; these he now, especially after the study of a case in a thar (Himalayan goat), includes under the term compound follicular odontomes.

In the thar each antrum held a great cyst with a bony wall, lined with thick fibrous tissue; the interior of the cyst was occupied by denticles, pieces of cementum, bony tissue, etc., to the number of about three hundred.

A similar specimen of a compound follicular odontome occurring in the human subject is thus described by Mr. Bland Sutton (Trans. Odont. Soc., Feb., 1902):—

"In August, 1901, a girl, aged eleven, was placed under my care, in the Middlesex Hospital, for an obvious but painless tumour of the right maxilla. The only facts of note in the history of the patient were these: for two years a swelling of the right cheek had been noticed, but as it caused no pain little notice was given to it until the tumour became so large as to produce great disfigurement.

"On examination it was easily determined that the tumour occupied the right antrum and caused considerable bulging of the facial portion of the maxilla. The nasal, orbital, and palatal plates of the maxilla were unaffected. The teeth were correct in number, regular in their relation to each other, and normal in shape. Mr. William Hern examined the girl with me and was satisfied on these points. The fact that the tumour had been slowly growing for two years and was absolutely painless negatived any suspicion of malignancy, and supported us in the conviction, notwithstanding the normal character of the teeth, that the swelling had its origin in some aberration of dental elements.

"Operative interference being clearly indicated, I raised the muco-periosteum over the expanded facial plate of the maxilla, cracked away the thin bone and exposed the capsule of the tumour. On attempting to enucleate the mass, I found it was soft and broke up on manipulation. With a blunt scoop I extracted a mass of soft vascular tissue containing a large quantity of irregular pieces of bone. When the cavity was thoroughly evacuated a delicate osseous shell represented the expanded walls of the antrum. I drained this cavity with a narrow strip of gauze, and in ten days the child left for the convalescent home.

"From a careful count of the pieces of bone removed from the tumour, we found that they numbered over five hundred: each is formed of true bone, which exhibits the loose and open texture of the bone which forms the alveolar margin of the jaw.

"The tumour itself, I believe, arose in a tooth follicle, and the crowd of osseous particles are the result of sporadic ossification of the fibrous tissue of the follicle, and that this tumour is an example of what I have ventured to term a 'compound follicular odontome.'"

We have thus several stages exemplified : the fibrous odontome as exemplified in the goat ; the fully-ossified cementomata, the sporadically-ossified odontome, in which small denticles and

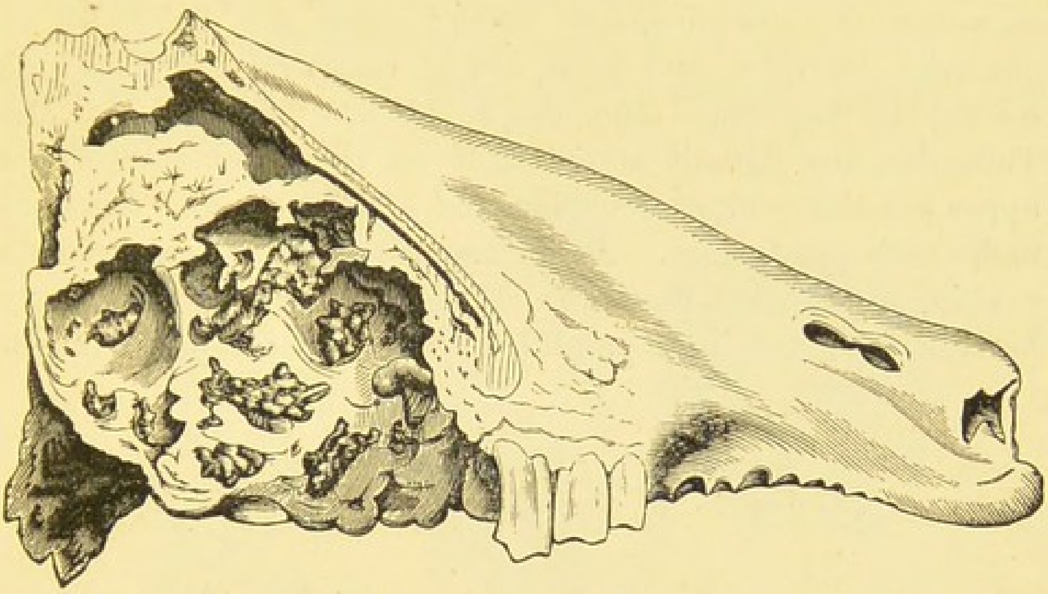


FIG. 296.—Right maxilla of a thar (*capra jenilaica*).

pieces of cementum exist in the fibrous tissue, as in the thar, in which the denticles did not certainly contain dentine, and also the cases hitherto called dentigerous cysts, and by

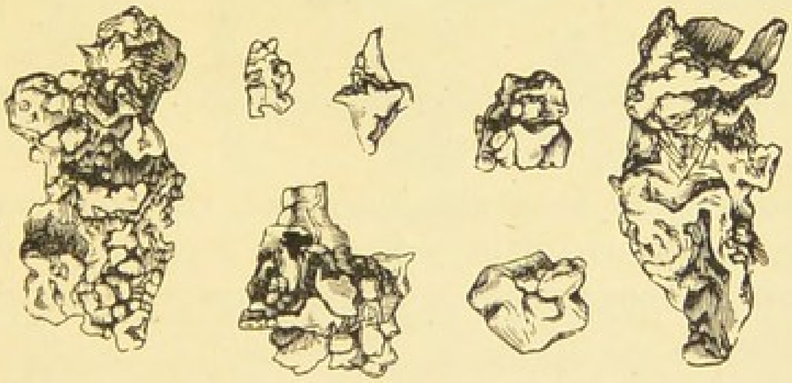


FIG. 297.—Seven denticles from the above cyst.

Mr. Bland Sutton termed compound follicular odontomes, which have been met with both in the incisor and molar regions.

In some cases an enormous number of teeth have been found in dentigerous cysts. A remarkable case of dentigerous cyst containing supernumerary teeth occurred in the practice of

Mr. Tellander, and was described in the Transactions of the Odontological Society for the year 1862, whence the accompanying illustration is borrowed. The teeth, the number of which was no less than twenty-eight, mostly present the usual character of supernumerary teeth; some are built up of adherent denticles, and some are of very irregular form, one having no less than nine cusps. When first seen by Mr. Tellander, the patient stated that on the right side of the upper jaw the canine, bicuspids, and first molar had failed to make their appearance. At the age of twelve, a hard, painless swelling appeared on that side of the jaw which subsequently became inflamed and painful. When first brought under

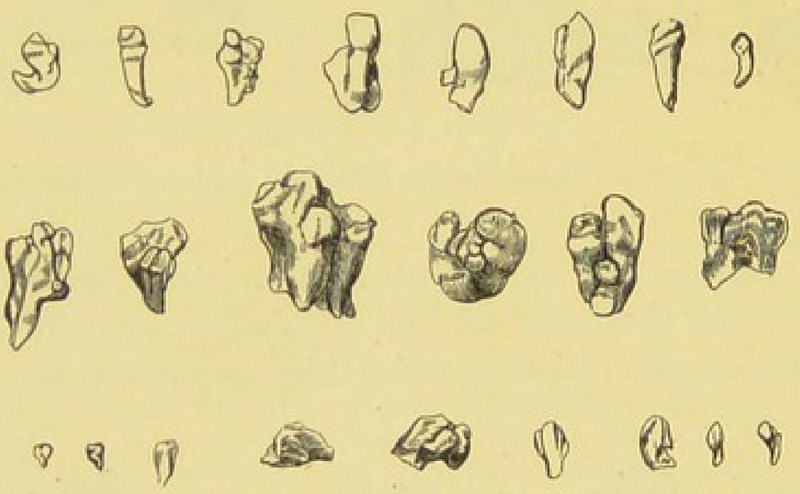


FIG. 298.—Contents of dentigerous cyst. Mr. Tellander's case.

observation there was enlargement of the bone and great swelling of the surrounding soft parts; a profuse discharge of pus oozed up round the root of a temporary molar which had been retained.

On proceeding to remove the supposed carious bone, it was found that there were a number of loose hard bodies enclosed in a shell of dead bone, and these proved to be the teeth here figured; but as their importance was not at first recognised, it is more than probable that some were lost.

After the lapse of six months, all swelling of the jaw had subsided, but a bicuspid tooth had made its appearance in the very place from which all the supernumerary teeth had been removed—a circumstance which is very extraordinary, seeing that it must have been in very close proximity with the cyst and its contents, and yet was unaffected.

But a still more remarkable case of a cyst containing supernumerary teeth occurred in India under the care of Mr. Mathias. The patient, aged twenty-five, was unable to close his mouth on account of the presence of a large tumour in the front of the upper jaw, which pressed the lip up against the

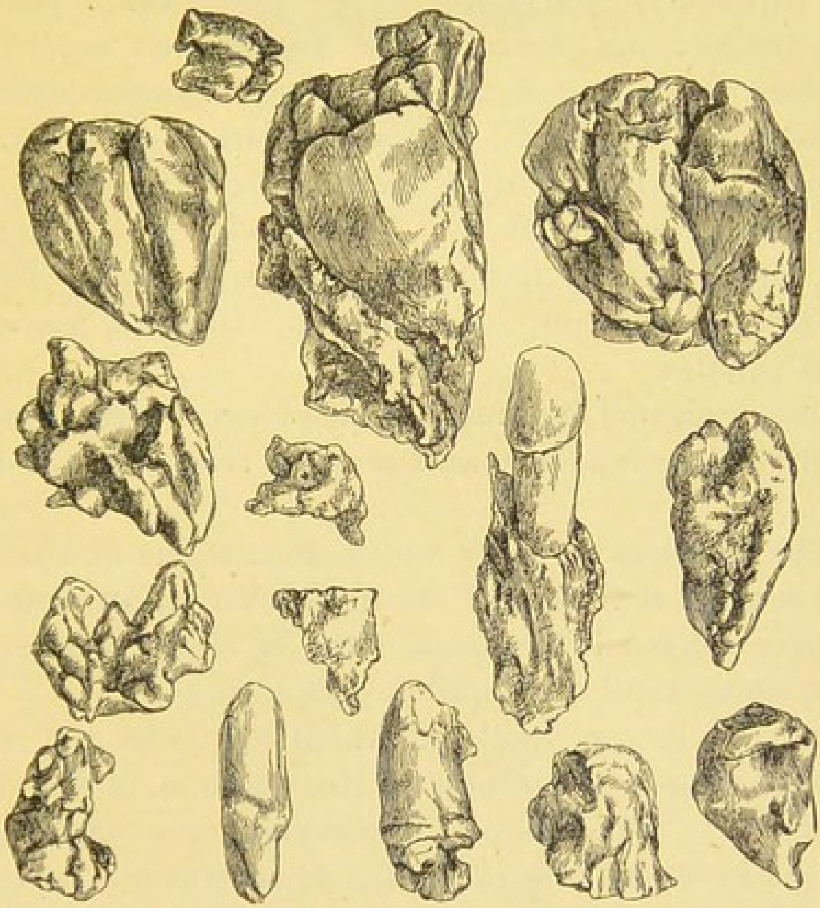


FIG. 299.—Contents of dentigerous cyst. Mr. Mathias's case.

nose. The surface of the tumour was eroded by ulcers, from which a profuse offensive discharge poured out. The man was much emaciated, and the appearance presented was that of malignant disease; but on passing a probe into the tumour it was found to strike on a hard loose body, which proved to be an agglomeration of ill-formed teeth. One after another the whole of the teeth figured on this page were removed; but as there are fractured surfaces which will not fit together, the inference is that some have been lost. The soft parts around rapidly returned to a healthy condition, and all deformity disappeared. The teeth absent from the mouth were the central and lateral incisors, the canines occupying their usual position.

The masses of tooth-substance removed are in the museum of the Odontological Society, and a more full account will be found in the Trans., vol. iii., p. 365.

To these must be added a remarkable case of Mr. Sims's, of Birmingham, described by Professors Windle and Humphreys (Jour. Anatomy, 1887). The deciduous and permanent lateral incisor and canines had never been erupted, and their place was occupied by a quiescent tumour with dense unyielding walls. This contained forty denticles, some caniniform, others multicuspidate. Mr. Heath records a similar case; and with the horse's odontome, figured on p. 737, there were a number of smaller masses scattered about, mostly, however, of cementum, though a few contain dentinal tubules.

The diagnosis and treatment of this form of cyst in no wise differs from those which contain a single relatively well-formed tooth.

(*c*) The simplest form in which aberrations of the dental papillæ occur is that termed the **radicular odontome**. The crown is completed in a normal form, or almost so, but when the root comes to be developed it goes astray.

By far the largest specimen which has been met with in the human subject is that now in the museum of the Odontological Society, from whose Transactions the accompanying figures are borrowed (*loc. cit.*). The mass, which is represented of its natural size, is seen to be attached to and to surround the root of an upper molar tooth.

Before a section had been carried through the crown and roots of the tooth, and the adjacent portions of the tumour, it was supposed to be an exostosis; Mr. Salter,[1] objecting to this view, designated it by the term "dilated hypertrophied tooth-fang;" and it was also suggested that it might be a calcified cyst. An examination of the section by the author renders each and all of these views as to its nature untenable. As is seen in the subjoined figure (Fig. 302), the roots of the

[1] Holmes's "Dictionary of Surgery" (*loc. cit.*).

tooth are not dilated nor hypertrophied, but are of rather small size: at some point, not seen in the section, there has sprung from the dentinal pulp an outgrowth, which has

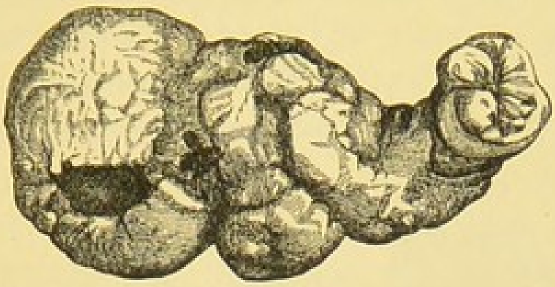


FIG. 300.

completely enveloped the roots, and grown out into a great lobulated mass.

The examination of the sections made along the lines *a b*, *b c*,

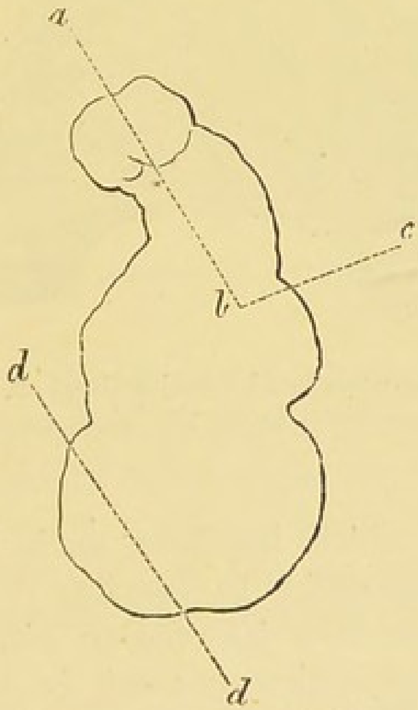


FIG. 301.—Diagram showing portion of the sections made.

and *d d*, revealed the following structures. At the top were the roots of the tooth, bedded in the mass; an investment of cementum of varying thickness completely encased the whole, following all the irregularities of its outline. Inside these layers of cementum came a shell of dentine, seen at the right-hand lower corner of the figure; the tubes in this layer of dentine radiated outwards, and were disposed with considerable regularity: the inner surface of this dentine shell was, however, far less regular in its outline than its outer surface, the interior being filled up with an ill-defined osseous structure. At the part marked *d d* the dentine shell was entirely absent.

In a somewhat similar specimen at the College of Surgeons

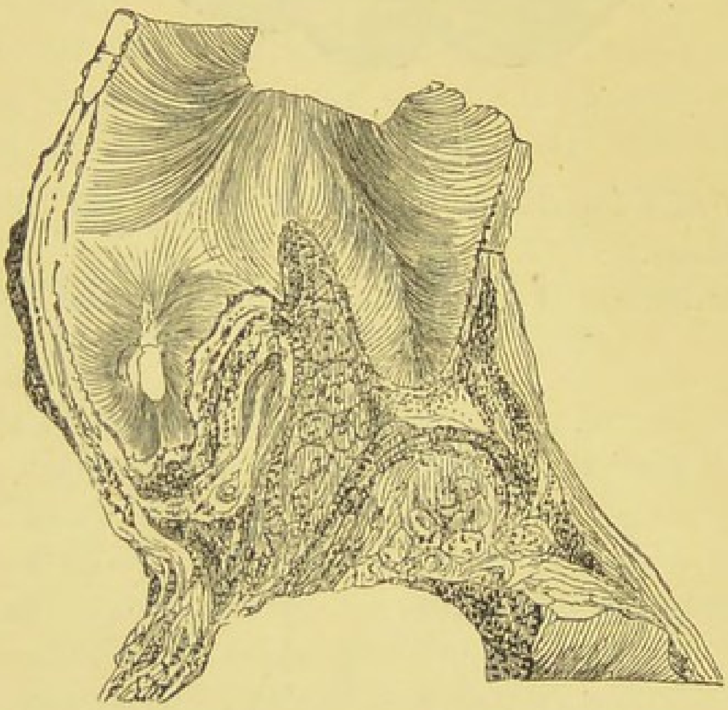


FIG. 302.—Section made along the line *a b*. The upper edge of the dentine shell is at the right-hand lower corner of the figure.

the only section which has been made is at a part of the mass nearly corresponding to the line *d d* in the specimen here described; so that its relation with the tooth-root is purely a matter of conjecture; and in the one figured by Heider and Wedl nothing of its relation to the roots is shown. For this and other reasons [1] the proposed name "hypertrophied dilated tooth-fang" seems inapplicable. The manner of origin of the tumour is tolerably clear: at a certain period in the development of the dentine pulp, an outgrowth takes place, which, though often connected by only a very small pedicle with the rest of the normal pulp

[1] See Odontological Society's Transactions, vol. iv., pp. 81 and 103.

(see description of an odontome in Transactions of Odontological Society, February, 1872), grows up around and embraces a considerable portion of the tooth or its roots. Being contained within the tooth capsule, it receives an investment of cementum on its surface, within which the pulp has become calcified into dentine or bony tissue. The incomplete calcification, or death of portions of the pulp, may lead to the existence of cavities in the interior; or it may become absolutely solid, as appears to be the case in the specimen in the museum of the College of Surgeons. The result of calcification of the outgrowth of the dentinal pulp is true dentine only so long as the odontoblast layer, or "membrana eboris," retains its integrity; so soon as this is lost, the remainder of the pulp becomes converted into an irregular osseous structure. Thus in the specimen

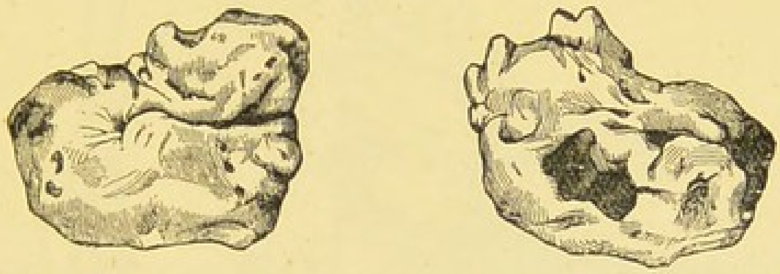


FIG. 303.—Radicular odontomes. From Bland Sutton.

here figured, as also in that described by Mr. Salter, there is a mere thin shell of true dentine, the interior of which is filled up by the products of calcification subsequently to the production of true dentine: whilst at the lowest point of the first-named specimen (along the line *d d*) no true dentine was found, but only an irregular bony structure, enclosed in thick laminated cementum.

Radicular dentomata are common in animals, especially in those with teeth of persistent growth. Mr. Sutton figures many examples from marmots, porcupines, agoutis, horses, elephants, etc.

When in a radicular odontome cementum predominates greatly, it is classed as a radicular cementoma: an example is figured by Professors Windle and Humphreys and copied by Mr. Sutton, which is here appended (Fig. 303). It occurred in a man æt. 25, and set up such profuse suppuration and pain that his life was at one time despaired of. Another example from a horse is also figured (Fig. 304): here the tooth pulp had evidently expanded, but the calcification which took place is cemental in character.

Mr. Moon has recorded a case in a female æt. 38: the swelling was of eight years' duration, with partial closure of the jaws: at times the swelling was immense, extending

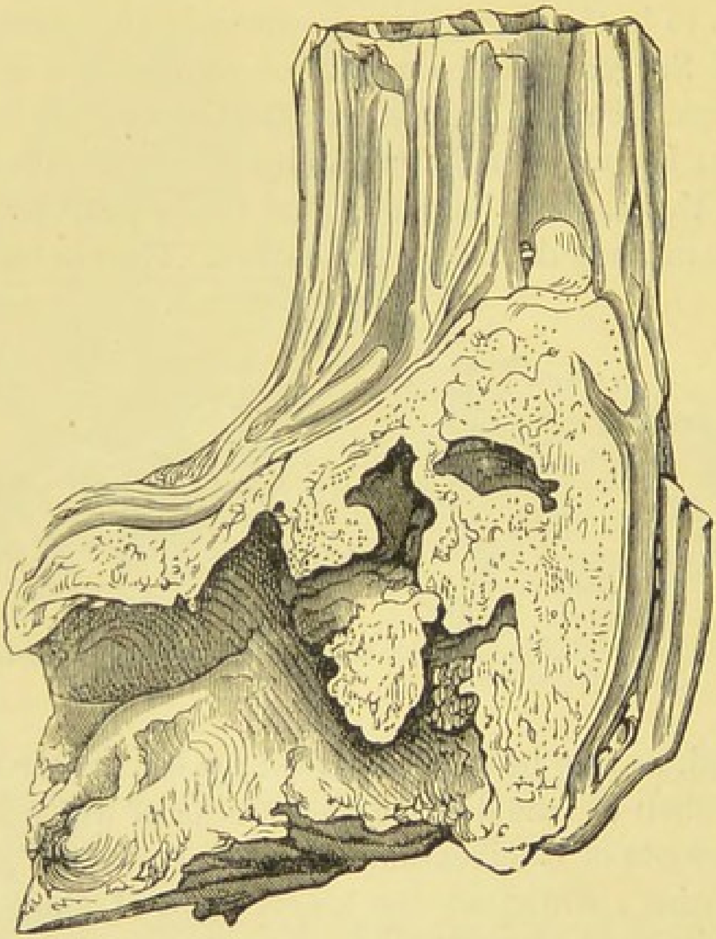


FIG. 304.—Radicular cementoma affecting molar of a horse. After Bland Sutton.

upwards so as to pass behind the tuberosity of the upper jaw.

A bony mass was found to lie behind the lower wisdom-tooth, to which it was attached: after removal it was found to belong to the class of radicular odontomes.

When the tissue formed resembles bone they are termed radicular osteo-dentomata. No odontomes of this character have been met with in the human subject, but a good many specimens have been met with in animals, some of those in the elephant being of great size.

Passing on to the next class, the "odontomes coronaires" of Broca, we no longer have a shapeless mass in which little or no resemblance to a tooth can be traced. As these originate after

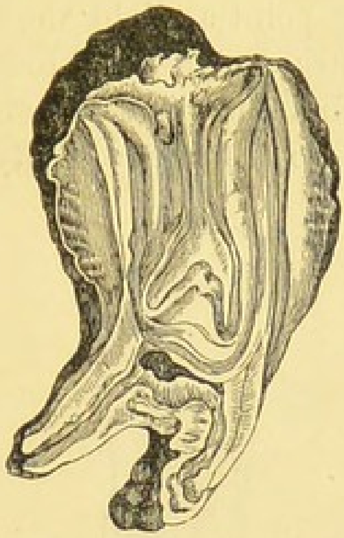


FIG. 305.—Natural size. From Heider and Wedl's "Atlas zur Pathologie der Zähne."

the commencement of calcification, at a time when there is a cap of dentine over the pulp, this crown is always to be found bearing a tolerably close resemblance to that of a normal tooth, however much the aspect of the whole mass may be altered by

FIG. 306.—Small odontome, from the incisor region.

subsequent outgrowths of the pulp. This form of odontome is far more common than that last described, and is exemplified by the specimen here figured (Fig. 306), which is taken from Sir John Tomes' collection. Here the outgrowth is limited to the anterior surface of the tooth.

A similar specimen has been figured by Mr. Salter, in his article in Holmes's "Dictionary of Surgery," in which there has been a localised hypertrophy of the formative pulp. In some instances the defective tooth is not the subject of any very obvious deformity, though it is usually somewhat irregular in shape and enlarged at some point. The enamel investing the crown may be, and often is, perfectly well-developed; but we shall find at some point a slight depression, in the centre of which is a small dark spot. If the tooth be divided through its long axis we shall find that the dark centre of the depression is in fact the choked-up orifice of a cavity situated within the

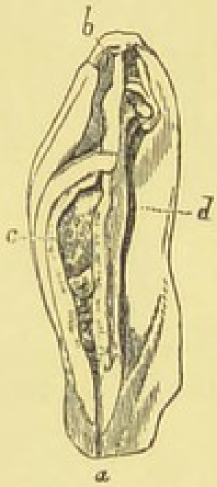


FIG. 307.—Shows a section of an upper tooth in which a cavity, *c*, is formed external to the pulp-cavity, *d*. It is lined with a thin layer of somewhat imperfectly-developed enamel, and communicates with the surface of the tooth at *a*.

substance of the tooth, external, however, and perfectly unconnected with the pulp-cavity. If the section be a fortunate one, we shall be able to trace the enamel as it is continued from the exterior of the tooth through the orifice into the cavity, the surface of which is lined more or less completely with this tissue.

But besides these cavities, which are in reality outside the tooth, we shall also very generally discover, on microscopic examination, that there are other cavities, which are continuous with the main pulp-cavity, and these by the direction of the dentinal tubes radiating from them will generally serve to explain the manner in which the abnormality has originated.

Deep fissures are in some cases formed upon the lingual surfaces of the incisors, near their bases, leaving a basal ridge. Now, if we imagine one of these ridges, sufficiently thick to contain in its centre a process of the pulp-cavity, to rise up still higher and approximate itself at the top to the surface of the tooth, the orifice leading to the space between it and the back of the tooth would become contracted, and we should have a condition of things not very dissimilar to that presented by the specimens here described.

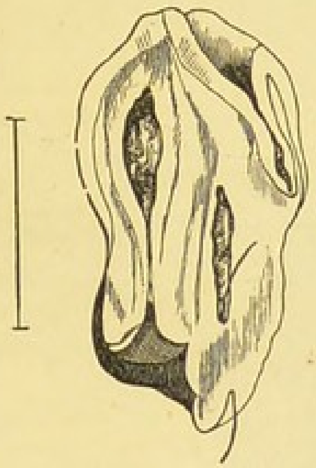


FIG. 308.—Mr. Margetson's specimen.

A tooth presenting this sort of deformity was presented to the Odontological Society by Mr. Margetson: the above figure is borrowed from the Transactions of the Society.

Sometimes, however, the malformation commences after the crown of the tooth has been completed, and whilst the roots are in process of formation. These "odontomes radiculaires" are rare, only a few cases having been recorded, though Mr. Sutton has found them to be comparatively common in lower animals. Of these one is in the museum of the College of Surgeons,[1] one is recorded by Dr. Forget,[2] and another by Heider and Wedl[3] in their "Atlas;" a fourth was presented

[1] Specimen 1022, Pathological Series. Guy's Hospital Reports, series iii., vol. xiv., and Art. "Diseases of the Teeth," by S. J. Salter, in Holmes's "Dictionary of Surgery," 2nd edition.

[2] "Des Anomalies dentaires et de leur Influence sur la Production des Maladies des Os maxillaires." Par A. Forget. Paris, 1860. Plate ii., Figs. 1 and 2.

[3] "Atlas zur Pathologie der Zähne," von Prof. Heider und Prof. C. Wedl. Leipzig, 1868. Taf. ii., Figs. 28 and 29.

to the Odontological Society by Mr. Hare, of Limerick, and described and figured in the Transactions of the Society,[1] in whose museum the specimen now is.

In these cases the growth is due to a hypertrophy of the formative tooth pulp arising after the development of the tooth is nearly complete; hence in those two cases which have been thoroughly examined, the tooth and its roots were found but little altered, although the latter lay imbedded in the mass which had grown around them.

This is the case in the specimen here figured from a slight sketch made some years ago in Boston: on the right-hand side

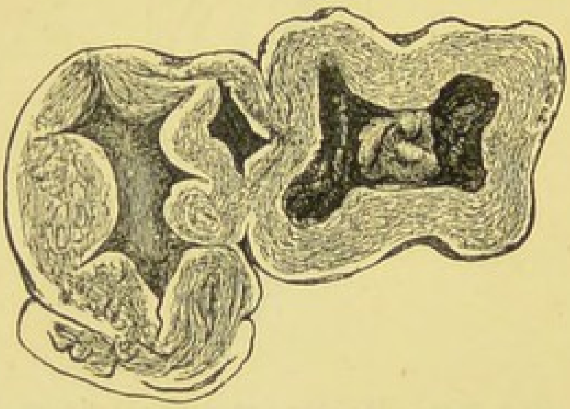


FIG. 309.—Section of an odontome in the Boston Medical Museum.

is the comparatively normal tooth, seen in section, and on the left is the new outgrowth, which is of very irregular form.

(*d*) The last group to be considered are the **composite odontomes.** In these all parts of the tooth germ have gone astray in their development, and to this group the majority of those met with in man are to be referred. They constitute the odontomes of Broca's second class (odontomes odontoplastiques); at the date of their origin the dentine germ is covered by a layer of odontoblasts, more or less completed, but dentine has not yet been formed. Consequently, when the bulb has become the seat of an irregular outgrowth, a mass is produced containing dentine from the calcification of the odontoblasts, and perhaps also enamel, the enamel organ having

[1] Transactions of the Odontological Society, vol. iii., p 335, J. Tomes: and 2nd series, vol. iv., p. 81, Charles S. Tomes.

followed, as it tends to do, the wanderings of the dentine germ; but as no part of a tooth had as yet been formed, the mass may be a confused heap of dental tissues, not bearing the most remote external resemblance to a tooth.

It will be well to note, before proceeding further, that the product of the calcification of a dentine pulp is by no means always true dentine: so long as the layer of odontoblasts coats its surface, true dentine is produced; but this layer

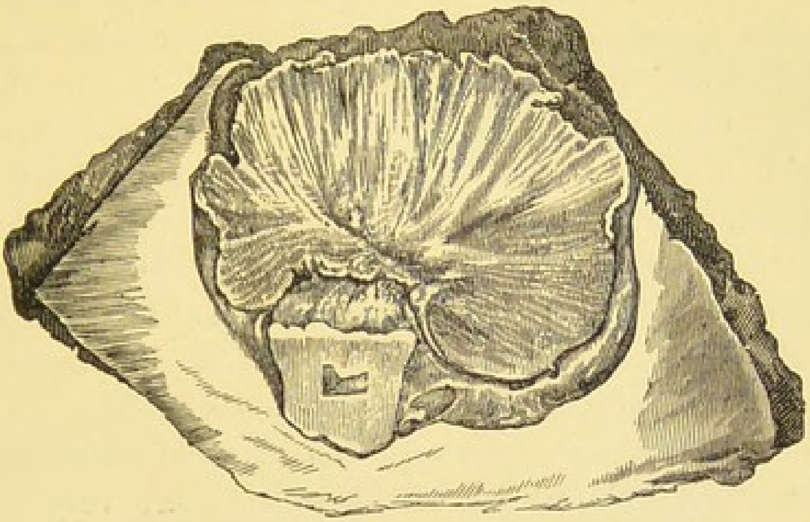


FIG. 310.—Shows the appearance presented by a vertical section through a portion of the lower jaw, in which was enclosed an irregular mass of dental tissues representing the second permanent molar, beneath which the wisdom-tooth was confined. The prominence at the lower part of the figure shows the angle, and the part to the left a portion of the ascending ramus of the jaw.

is easily displaced and destroyed, and, once destroyed, is probably never formed afresh. Any calcification which may take place after the destruction of the odontoblasts will assume the form of secondary dentine, or of confused bone-like tissue, but no more true dentine can be formed. The foregoing description may serve to explain the manner in which the mass here figured arose.

In this case the second molar of the lower jaw was represented by an irregularly flattened mass, composed of enamel, dentine, and a bony tissue thrown together without any apparent regularity. The wisdom-tooth was held down beneath this most extraordinary mass. The nature of the case not having been rightly understood, a portion of the jaw including it was removed, the figure showing the appearance presented by the excised portion after a longitudinal section had been made through it. The mass when removed from its receptacle in the bone, presented no resemblance to a tooth. From its surface little beads of enamel here and there projected, whilst the woodcut fairly represents the naked-eye appearance of the section through its middle. The radiate appearance is due to the alternation of the structures which compose it: these are mainly dentine and a bone-like tissue, which in some places occupies a position relatively to the dentine which would lead to the inference that it is cementum, whilst in others it is obviously the result of the calcification of portions of the dentine pulp which had lost their layer of odontoblasts, and had, therefore, ceased to produce true dentine by their calcification. There is no single definite pulp-cavity, but the dentinal tubes radiate from numerous small canals, and become lost in the confused irregular structures which abound around them. In places the dentinal tubes radiate with considerable regularity from these central canals, whilst in others they are very confused and irregular in their course.

Prior to the operation there was considerable enlargement of the jaw behind the first permanent molar, where a hard; brown-looking body was seen projecting slightly above the level of the gum. This was in fact the upper surface of this aberrant tooth, which, from its position relatively to the first and third molars, is shown to be the representative of the second molar: a few nodules of enamel were scattered over this exposed surface. The patient had suffered considerable pain in the situation of the enlargement: and the case having been regarded as one of disease of the bone, which was likely to proceed from bad to worse, the portion of the jaw figured was excised by Sir W. Fergusson.

Dr. Forget records a somewhat similar case: the mass in this instance occupied the whole space between the first bicuspid and the ascending ramus of the jaw, and was by him regarded as the representative of the second and third molars of that side, the crown of one molar and the second bicuspid having been found held down beneath it. For the use of this figure, which is copied from Dr. Forget's memoir, "Des Anomalies dentaires et de leur influence sur les Maladies des Os maxillaires," we are indebted to the kindness of Mr. Christopher Heath.

The patient in whom this odontome occurred was aged twenty, but disease of the jaw had first been remarked at the age of five years. Behind the first bicuspid no teeth were to be seen, but the jaw, as far back as the ramus, was the seat of a smooth, unyielding tumour. This was removed by a

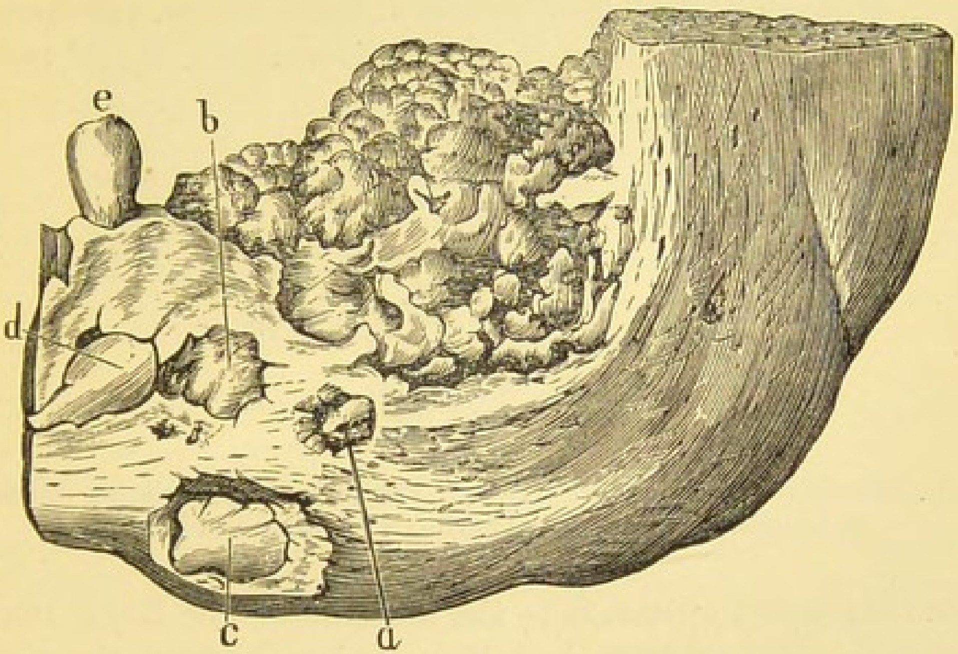


FIG. 311.—*e*, First bicuspid ; *d*, second bicuspid ; *c*, first molar ; *a* and *b*, portions of the mass which protrude through the bone.

vertical saw cut in front of the bicuspid, and a horizontal cut at the level of the inferior dental foramen. After removal the jaw was found to be expanded over an uneven, tuberculated oval mass, of the size of an egg. Beneath it at one spot (*c*) was found the crown of a molar tooth, whilst between it and the bone was a thick, more or less fibrous membrane. On microscopic examination it was found to be mainly composed of dentine, the surface of which was in places covered with enamel, this latter dipping down into the crevices, at the bottom of which cementum was found.

In this case resection of nearly half the jaw was practised, but in a case related by Mr. W. A. Harrison, before the

Odontological Society,[1] a mass occupying the whole space between the incisor and molar teeth came away spontaneously, leaving a groove large enough to receive the last joint of the thumb; this speedily filled up by granulation.

A similar case, in which the mass lying above the wisdom-tooth was removed by operation, is quoted by Wedl,[2] and figures taken from models of jaws are given showing the rapid contraction and filling up of the cavity left.

A large composite odontome, occupying the left side of the mandible from the incisor to the second molar tooth, was removed from a boy aged fourteen years by Mr. Brothers, of Cape Town, who presented the tumour and a model of the

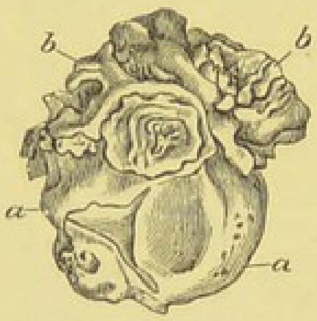


FIG. 312.—From Heider and Wedl's "Atlas zur Pathologie der Zähne." *a*, Smooth enamel-coated surfaces; *b*, nodules of enamel.

mandible before operation to the museum of the Royal Dental Hospital. The swelling had been noticeable from the age of six months. This case was described by Mr. Morton Smale in the Trans. Odont. Soc., January, 1903.

Mr. Vincent Cotterell (Trans. Odont. Soc., November, 1900) removed a composite odontome occupying the molar region of the mandible on the left side from a young lady aged twenty-one. The presence of a swelling had been under observation for twelve years.

The odontome represented in the accompanying figure is convex on its upper, and concave on its lower surface; it was placed like a cap over a lower molar tooth, the impressions left by the cusps of which may be traced on its inner surface.

The upper surface, represented in Fig. 312, is partly

[1] Prof. C. Wedl, "Pathologie der Zähne," 1807, p. 125.
[2] British Journal of Dental Science, 1862.

smooth, and partly studded with enamel nodules, like those met with in Sir W. Fergusson's case. It was made up of irregular tracts of dentine, amongst which folds of enamel dipped down; no well-marked cementum was found.

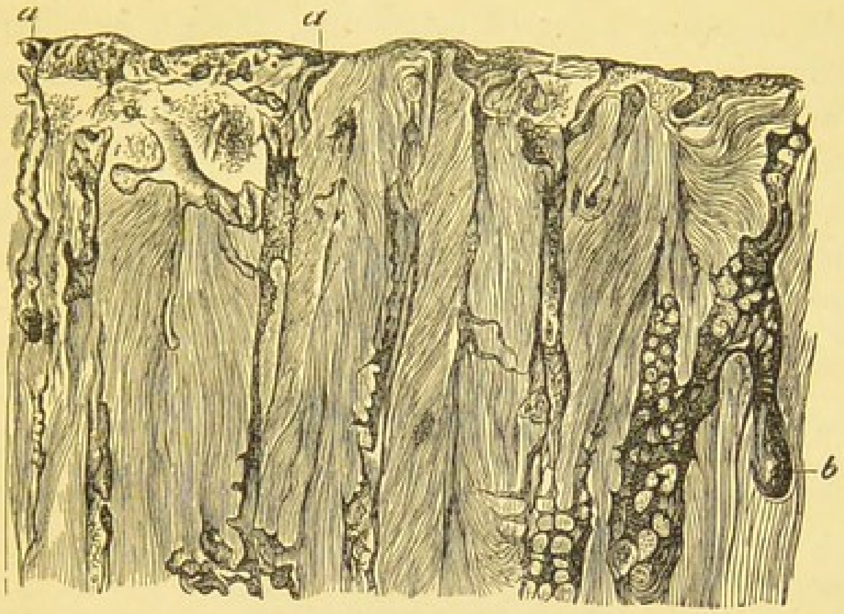


FIG. 313.—From an odontome. From Heider and Wedl's "Atlas."

The section represented in Fig. 313 was made from a very similar odontome, and will serve to exemplify the usual structural characteristics of these growths. It is traversed

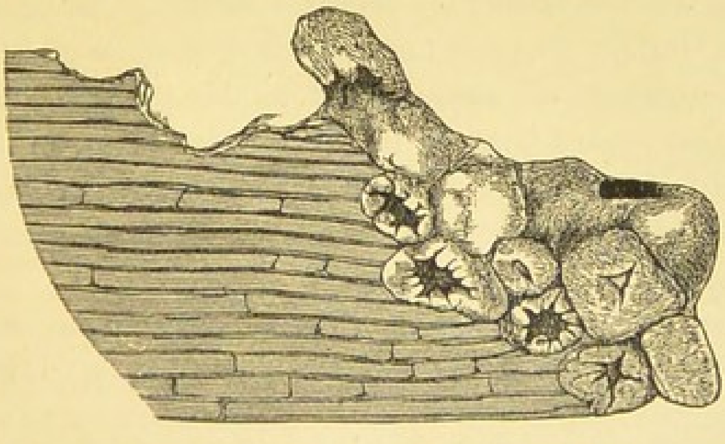


FIG. 314.—Section of an odontome.

by parallel vascular tracts (a), which here and there dilate into pouches, or branch out into several divisions; from these vascular tracts the dentinal tubes radiate with considerable regularity.

Globular masses are in places very abundant, and at the peripheries of the several systems of dentinal tubes irregular spaces abound. In some parts enamel is continued far down into clefts and fissures, so that on section it is seen lining cylindrical spaces, as is seen at the point *b*. There is no distinct investing layer of cementum, though here and there the clefts are occupied by lacunæ with numerous canaliculi.

In microscopic examinations of odontomes, it is very common to find those marks of alternations of absorption and deposition which we commonly regard as evidences of inflammation: the accompanying figure of calcified osteoclasts bedded in excavations of dentine shows this character.

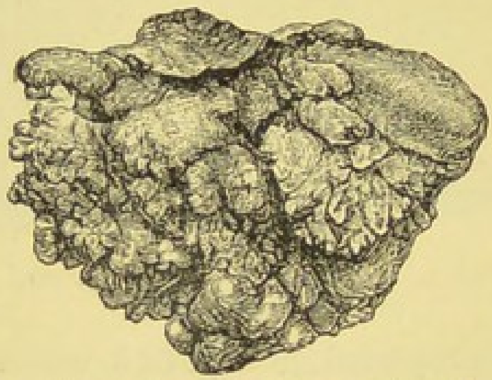


FIG. 315.—Composite odontome. Mr. Heath's case.

As will be inferred from the recital of the above cases, there is a danger of operations of needless severity being performed through a failure to recognise the true nature of the disease. Indeed, a surgeon so experienced as Mr. Christopher Heath has put upon record that he had a narrow escape of doing this himself, but the operation having been postponed for a time, the nature of the disease became evident during an operation undertaken for supposed necrosis.

The case is so instructive that it may be quoted in full (Heath's "Injuries and Diseases of the Jaws," 3rd edition, p. 221):—

"Miss C., aged eighteen, the daughter of a dental surgeon, was brought to me in July, 1881, with a considerable swelling of the right side of the lower jaw, some of which was evidently inflammatory, and partly the result of previous treatment; but there was, I thought, sufficient evidence of expansion of the jaw to warrant the opinion that a tumour was present, and I therefore recommended the removal of a portion of the jaw. Suppuration was then present, and with the finger a rough surface of apparently exposed bone could be felt, but this I regarded as the result of inflammatory action excited by the injudicious irritation of a periosteal growth, since partial necrosis of a jaw involved by cartilaginous or malignant growths, which have been irritated by exploratory measures, is in my experience by no means uncommon. The patient had the advantage of the opinion of Sir James Paget, who was not perfectly satisfied as to the existence of a tumour, and expressed a hope that the case might prove to be one of necrosis. Under these circumstances the operation was postponed.

"On my return to town in September I found the patient improved in health, and the swelling diminished by the subsidence of the inflammation, but a considerable enlargement of the lower jaw still present, with a sinus opening externally.

"From the mouth a white mass was visible, which, appearing among granulations, looked like necrosis, and I agreed that an attempt should be made to remove this, although I could not think it accounted for the expansion of the jaw. On September the 8th, with the assistance of Dr. Snow, the patient was put under chloroform, and I proceeded to examine the mouth with my finger. I soon found that the white mass was not bone but tooth, and thus was unable to make out its outline. I was unable to make any impression with chisel or gouge, but at last with an elevator succeeded in lifting out of its bed a mass of dental structures forming the odontome shown in Fig. 315.

"The mass measured $1\frac{1}{2}$ inches antero-posteriorly, 1 inch transversely, and $1\frac{1}{4}$ inches from above downwards. It weighed 315 grains.

"A section of the odontome has been made, and it has been submitted to Mr. Charles Tomes, who has kindly furnished the following report :—

"The whole surface of the odontome is nodulated and roughened by stalactitic excrescences, and there is at no point any form recalling the character of a tooth crown.

"The surface of a section presents a complicated marbled pattern due to the admixture of several dental tissues, and it bears a general resemblance to that form of dentine known as 'plici-dentine,' or 'labyrintho-dentine.' On the whole the mass is of tolerably uniform structure throughout, though there is an area of somewhat simpler structure in its upper and central portion, from which folds of dentine appear to radiate. So far as it goes, this would seem to point to the whole mass being the product of a single tooth germ, rather than that of several fused together, a matter which was left in some doubt by the absence of an accurate history of the case.

"The excrescences of the surface, as well as the greater part of the interior, are made up of folds of dentine, in which dentinal tubes are very abundant, and which surround flattened remnants of pulp chambers ; between and intimately blended with this comparatively well-formed dentine, is a more coarsely calcified material, containing numerous lacunæ, and permeated by vascular channels—in fact, osteo-dentine.

"Enamel is present upon some of the nodules of the surface, but it does not by any means form a complete investment ; where present it dips in folds, following the convolutions of the dentine, and it is to be met with in the very centre of the mass, though not very abundantly. It is nowhere well formed, being brownish and opaque.

"This odontome is the product of the formative dentine pulp of a tooth (or teeth), which has, in place of remaining simple, budded out innumerable processes on all sides, and finally has calcified ; its enamel pulp has in parts followed the complexities of its surface, and in parts failed to do so, or, at all events, has failed to perpetuate itself by calcification."

These irregularities in the form and size of the dentinal pulp may, as development goes on, give place to a more normal process, so that we occasionally find that at the bottom of a warty-looking irregular mass are tolerably normal roots. Such teeth have been described as "warty teeth" by Mr. Salter, but it seems objectionable to multiply names, and they have, therefore, here been included under the same heading as those in which the abnormal development continues till the last.

The tendency towards the assumption of the normal form in the roots is well illustrated by a preceding figure (Fig. 305). The crown is perfectly colossal, though it retains in a measure the typical form of four cusps; the investment of enamel is imperfect, but the cement is continued from the roots over the crown, on the sides and top of which it attains to a great thickness.

From what has been already said, it will be gathered that the several varieties of odontome run somewhat into one another; nevertheless the classification here adopted seems to be tolerably satisfactory.

It will be seen that the correct **diagnosis of odontomes** is a matter of no small importance, since an error will probably lead to an unnecessarily severe operation; as has, indeed, already happened in several cases. To distinguish those encysted fibrous tumours which Professor Broca claims as odontomes, from ordinary fibrous tumours of the jaw before the actual operation, is perhaps hardly possible; but the distinct limitation of such a tumour, joined with the absence of one or more teeth, might lead to a suspicion of its circumscribed nature, and an incision over it would serve to show whether it was encysted, or widely fused with surrounding structures, without much interfering with the operation, should the latter be found to be the case.

The absence of one or more teeth from their proper places is a character which has constantly existed in the cases hitherto recorded; though it is, of course, conceivable that the pulp of a supernumerary tooth might take on this morbid development. And this has actually been observed in animals, in whom supernumerary teeth are comparatively rare. But wherever in cases of enlargement of the jaw, teeth are found to have never made their appearance, there is a very strong probability that the missing tooth is at the bottom of the mischief; and if this fact be steadily kept in mind, many severe operations may be avoided, and the tooth tumour removed with but slight destruction of the bone. A skiagram should be taken of any suspected case.

Contrary to what might have been expected, these odontomes remain for a considerable time without giving rise to any inconvenience; they may even take up their position with

FIG. 316.—From an ovarian cyst. Specimen in Boston Medical Museum.

the other teeth and perform their share of mastication, as is well exemplified by an enormous odontome attached to the molar of a horse, which is in the Museum of the Odontological Society, and was described in the Transactions for February, 1872. Sooner or later, however, they generally set up inflammation in the surrounding parts, and profuse and prolonged suppuration ensues, leading to the inference that the bone is diseased. Of course the immediate removal of the mass is the only available treatment; and in most cases this can easily be effected through the mouth, without making any external incision, portions of the bone overlying it being removed with a Hey's saw, or by bone-nippers and a gouge.

The removal of the mass will be followed by subsidence of all the symptoms, and the large cavity left in the bone will very speedily contract and fill up, leaving no permanent gap behind.

The classification of odontomes is difficult, as the varieties overlap one another.

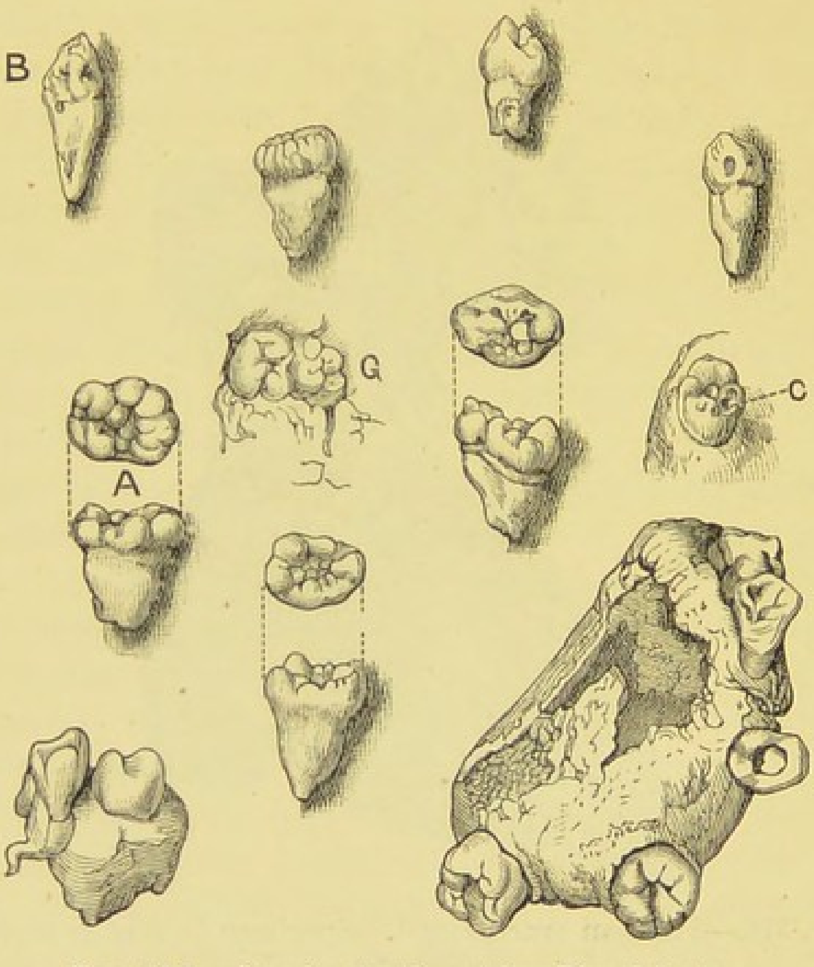


FIG. 317.—Ovarian teeth. After Bland Sutton.

It is to be regretted that these sheets were already in the press so that it has not been possible to make use of the unique collection of odontomes borrowed from all available sources exhibited at the British Dental Association's meeting in May, 1906. It is intended to issue an illustrated catalogue, which will be of the greatest interest. In the preliminary catalogue issued at the meeting, Mr. Bland Sutton's wide definition of an odontome as being "a tumour composed of dental tissues in varying proportions and different degrees of development, arising from teeth germs, or teeth still in the process of growth," was accepted.

Tumours containing confused masses of tooth-structure have been met with elsewhere than in the jaws.

Ovarian cysts are sometimes met with which contain, amongst other structures, teeth, sometimes implanted in a species of jaw (Fig. 317); another good example of this, here figured, is in the Museum at Boston, Mass. (Fig. 316).

Cysts are also found in the mouth and neighbouring parts other than the jaws: for example, these dermoid cysts have been met with in the substance of the tongue, and in the large majority of recorded cases have not been detected till the period of full adult life.

Confused masses of dental tissues have been met with about the petrous portion of the temporal bone in horses, and in one instance, the body of the sphenoid was found to be the seat of a tumour containing dentine; but as is pointed out by Mr. Sutton, these are to be regarded as dermoid cysts and not as true dentigerous cysts. This author, analysing the conditions present where dermoid cysts arise, points out that they occur in the situation of obsolete canals, once of functional importance in lower animal forms; where malformations exist in the way of locking in or adventitious mixture of parts derived from the epiblast, hypoblast, and mesoblast; and that these adventitious elements and dilated canals play the part of tumour germs.

Another form of cyst occurs in the jaws to which the name of Dental Cyst, as opposite to that of Dentigerous Cyst or composite follicular odontome, is given.

Mr. J. G. Turner has most carefully investigated the nature, origin and development of **dental cysts.** In a paper on this subject read at the annual general meeting of the Brit. Dent. Assoc., 1898, he writes :—

"Two theories are held as to the origin of dental cysts, which may be referred to as the epithelial or epiblastic inflammatory theory, and the connective tissue or mesoblastic inflammatory theory, and cases are held to occur supporting them both. According to both theories the starting point is an inflammation, septic and connected with a dead tooth, which on the first theory starts into active growth epithelial remnants eventuating in a cyst; on the second theory, mesoblastic or connective tissue elements are started into activity, and by their growth form an actively expanding cyst, "The results of pathological examination of cyst walls are very greatly in favour of the epithelial origin.

"According to *the mesoblastic theory*, either a granuloma breaks down in the centre while still growing at the periphery, or a chronic abscess causes pus formation, but continues to secrete a less cellular fluid, which by pressure pushes aside and expands neighbouring structures of bone. Out of 27 specimens examined, only one could be explained on the mesoblastic theory, and this case might be interpreted by either theory. All the remaining instances exemplified an epithelial origin.

"It is a matter of constant experience in the histology of the mouth to meet with *epithelial* masses amid mesoblastic surroundings.

"These remnants have their origin in a prolongation of the enamel-forming organ of the tooth, which precedes and determines the formation and shape of the dentine of the root, and is known as the epithelial sheath of Hertwig.

"Following the death of a tooth, the chronic inflammatory process set up by the continuous absorption of minute quantities of septic products induces, or is accompanied by, active growth of these remnants.

"By continued growth of these masses and cylinders, with branching of the cylinders, there is formed either a solid epithelial mass or an epithelial reticulum enclosing islands of mesoblastic origin. The epithelial cells of this reticulum immediately surrounding the meso-blastic alveoli are small, closely set, and evidently in active growth, while towards the centre the cells are large, stellate, and in process of disintegration, and the same is true of the cells at the periphery and centre of the solid masses.

"Though such reticula or masses may be found in the chronically thickened alveolar dental ligament, their presence is more constant in the small growths attached to dead roots, known as root tumours, in many of which they are the chief element, and to which they appear to give shape and definition. Such are truly epithelial root-tumours.

"These **epithelial root-tumours** are of common occurrence; they may be attached to any part of the root in the neighbourhood of the apex, and where of any size have determined for themselves the formation of a connective tissue capsule. Naked-eye section often demonstrates a cleft in the centre, the result, as shown by the microscope, of the breaking down of the cells before alluded to. This is the first hint of cyst formation.

"As the result of continued growth at the periphery and degeneration in the centre, a small cavity is eventually formed—a definite small cyst lined with epithelium and containing a pultaceous mass, looking like inspissated pus.

"At some period the contents liquefy, while the continued growth of the epithelium results in the formation of a clinically recognisable cyst.

"On opening such a cyst, a viscid, translucent, mucus-like fluid, holding crystals of cholesterine in suspension, escapes.

"The fluid contains abundant cholesterine, but no fats or fatty acids. Of proteids, it contains serum albumen and serum globulin, the latter being in exceptionally large proportion. A nucleo-albumen is present in small amount, but no mucin or any true mucoid. There is no reducing body, and none is produced by boiling with acids. Thus there is an absence of fats, mucus, and colloid.

"Such then is the pathological evolution of an epiblastic dental cyst. I have not been able to trace an analogous mesoblastic process.

"As met with clinically a typical dental cyst is a smooth, evenly contoured tumour; painless and non-inflammatory; of progressive and somewhat rapid growth; presenting to the feel (1) a hard or tense swelling; (2) a feeling of giving at the most prominent part; (3) parchment crackling; (4) a fluctuating central area, the most prominent part of the tumour, surrounded by thinned bone; (5) fluctuation all over with an edge of bone to be felt at the periphery—according to the stage of growth.

"It is the commonest tumour of the jaws, and the commonest cyst of bone.

"It occurs in either jaw, and is always connected with a dead tooth of the permanent series. It occurs at any age at which permanent teeth are present, and its growth is progressive.'

Mr. J. G. Turner also draws attention to an epithelial cyst met with in the gums—a gingeval cyst—which has an analogous history to dental cysts. They probably originate in the glands of Serres, which, when subjected to chronic irritation, enlarge, break down in the centre and form epithelial cysts.

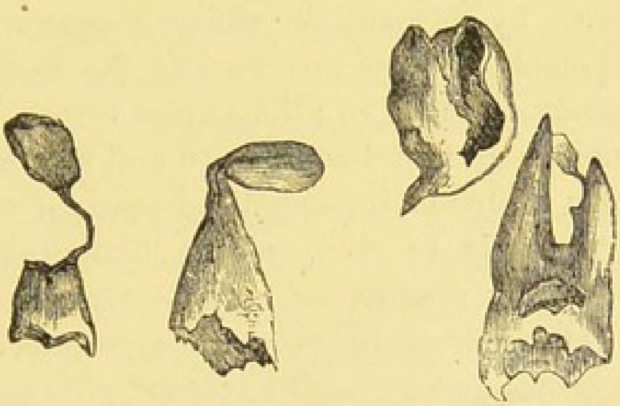


FIG. 318.—Cysts attached to the roots of permanent teeth. From Heath, "Injuries and Diseases of the Jaws."

Cysts of small size are tolerably frequently met with attached to the roots of extracted teeth; in the first instance the morbid process is probably identical with that resulting in the formation of alveolar abscess, but the process being less acute, a serous cyst takes the place of a rapidly suppurating sac. As such cysts increase in size they produce absorption of the bony structures around them, and may in this way come to occupy the cavity of the antrum. Mr. Heath quotes a case of Fischer's in which he was able, by post-mortem examination, to clearly trace that a cyst occupying the whole antrum had no connection whatever with the walls of that cavity, but was attached solely to the apex of the roots of a molar tooth, from the periosteum of which it sprang.

Mr. Coleman [1] drew attention to a tooth, to the side of the

[1] Transactions of the Odontological Society, 1862.

root of which a cyst containing cholesterine was attached, in addition to an alveolar abscess situated at the apex of the root. These cysts connected with the roots of teeth occasionally form swellings in the angle between the alveolar borders of the jaw and the reflected mucous membrane of the cheek, and when opened are commonly found to contain a fluid loaded with cholesterine: a case of this kind occurred at the Middlesex Hospital, under the care of the late Mr. Moore, which had apparently originated in this way; the cyst refilled several times after it had been punctured, but after being freely slit open from end to end, it filled up with granulations, and no further trouble was experienced from it.

M. Magitot ("Mem. sur les Kystes des Machoires") relates a case met with by Verneuil in which a cyst as large as an orange was opened, and on introducing the finger the roots of a tooth entirely denuded of all soft parts were felt: after its removal its roots were found roughened and eroded.

It seems very probable that cystic disease of the lower jaw may not infrequently be due, in the first instance, to the irritation set up by stumps or carious teeth: the following case, which lately occurred in the writer's practice, will serve to illustrate this point, as well as the general characters of cystic enlargement of the jaw.

The patient, a lady aged thirty-five, stated that two years previously she had had a severe inflammatory attack, involving the stumps of one of the molars in the lower jaw; at that time her face was excessively swollen for some days, after which the inflammation gradually passed off; but she distinctly states that the enlargement around the affected tooth never disappeared. When first seen by me, the second bicuspid and the three molars of the right side were all decayed down to the level of the gum, and the stumps were somewhat displaced inwards. From the stump of the second bicuspid to that of the second molar, the groove between the cheek and the bone was entirely obliterated by a rounded tumour, but the internal alveolar plate was only very slightly bulged inwards. On pressing firmly with the finger on the front or the back part of the tumour, a peculiar crackling sensation was felt, but a bridge of firm bone crossed its central portion which did not yield in the least to pressure. The stumps of the teeth were all loose, and the patient stated that a glairy fluid had at times oozed from around one of them. The face was considerably disfigured by the enlargement; but the skin was perfectly movable over the tumour, as was also the mucous membrane in the mouth. No enlarged glands were to be felt in its neighbourhood; and the tumour was quite painless, save that the patient complained of a sense of fulness and tension.

The patient was placed under an anæsthetic, and the stumps extracted, a slight flow of clear fluid from the sockets following their removal; an incision was made midway between the cheek and the jaw along the whole length of the cyst, which was cut into by bone-forceps, and a portion of the firm bar of bone which arched over its middle cut out. On passing the finger into the cavity, its walls felt as though made up of small fragments like a broken egg-shell, and by pressure on the outside it could be made to partially collapse.

The cavity was stuffed with carbolised lint, which was removed on the third day.

Three months afterwards all enlargement had disappeared, and no trace could be felt even of the strong bony bar which had bridged over the tumour; several small pieces of bone had come away in the meantime, but no fragment of any considerable size had separated.

In the development of cysts within the lower jaw, it is the outer plate which commonly becomes bulged by the tumour, which, if left to itself for a sufficiently long time, effects the complete absorption of the bone investing it, so that fluctuation may be readily detected through its membranous walls.

A fuller account of cystic disease of the lower jaw will be found in Mr. Heath's admirable work, to which the reader is referred for cases and information which hardly fall within the scope of the present book.

A case is recorded by Mr. Coote of cystic tumour of the lower jaw, which was referred to the irritation of tooth-stumps, and was treated by the extraction of the stumps—the patient's age (seventy-five) and condition precluding any more radical operation. But the patient's death occurred before sufficient time had ensued to show what result would have been attained.

When the disease is in connection with the roots of carious teeth, it has been proposed, and successfully practised in some cases, simply to remove the tooth, enlarge the alveolus, and through it stuff the cavity with lint.

As such cysts frequently fill up again, it is desirable to remove most of the cyst-wall, or to freely curette it: in some cases a successful result has been attained by stuffing the cavity with lint soaked in a caustic, such as solution of chromic acid. This destroys the cyst-wall and sometimes induces some exfoliation of bone, but effects a complete cure. In a few cases we have endeavoured to preserve an important tooth which has given rise to a cyst, but the ultimate result has usually been that the tooth has had to be removed after the cyst had refilled several times.

AFFECTIONS OF THE TONGUE.

ALTHOUGH it would be inconsistent with the purpose of the present work to enter at any considerable length into the subject of diseases affecting the tongue, it is very desirable that the dental surgeon should be familiar with the characters of ulcerations occurring there, seeing that some are, whilst others are not, dependent on the irritation of ragged and diseased teeth.

A very slight roughness of natural or artificial teeth will suffice to cause a superficial ulcer in a person predisposed to such ulcerations, which are very common amongst the dyspeptic: they come and go rapidly, are shallow and sensitive, have very bright red edges, there is no enlargement of glands under the jaw, and a touch with nitrate of silver generally suffices for their cure.

But ulcers of far more formidable appearance may be produced by ragged teeth; ulcers with an exceedingly foul, shreddy surface, pouring out an offensive discharge, and sometimes extending deeply into the substance of the tongue.

Although not surrounded with the hard base characteristic of epithelioma or syphilitic ulcers, the surrounding tissue will be in some degree hardened by infiltration with inflammatory exudations; and more rarely, an ulcer dependent simply on a ragged tooth may closely simulate epithelioma, by having sharply-defined, hardened edges, and a firm, comparatively clean surface.

The inflammatory action may extend to the whole floor of the mouth, causing great œdema and difficulty in swallowing or in speaking. The diagnosis of these ulcers is generally easy; their rapid formation, their irregular form, foul surface, and absence of a definite indurated base, serve to distinguish them from more serious diseases; and the existence of a roughened tooth will confirm the conclusion arrived at; though it must always be remembered that a local source of irritation may, and often does, determine the position of such diseases as epithelioma or syphilitic ulceration.

The ulcers met with are (i.) Apthous ulcers, generally multiple.

(ii.) Ulcer the result of local irritation, and

(iii.) Dyspeptic ulcer, just described.

(iv.) Syphilitic ulcer, or ulcerated gummata.

(v.) Tubercular ulcer.

(vi.) Epithelioma.

A syphilitic tongue is generally puckered and fissured, and the fissures may be the seats of slight ulceration, while in such a mouth mucous patches may be very often found on the inside of the cheeks.

A patient suffering from the slighter forms of syphilitic ulceration may apply to the dentist to have sharp corners filed away from one or more of his teeth, attributing to this cause the discomfort which he feels. On examining the tongue you may often fail to see anything the matter; on a closer examination, the organ is seen to be slightly fissured, and the surfaces of the fissures to be red; or there may be slight excoriations, sensitive to the touch, but not bleeding unless roughly handled; or flat, leathery mucous patches; or, again, there may be flat, defined ulcerations. The marked character of those slight superficial ulcerations due to syphilis, is the absence of surrounding inflammation, and the presence of sensitiveness far greater than their appearance would lead the observer to expect.

Deep syphilitic ulcerations specially affect the dorsum of the tongue far back; their occurrence is preceded by an indurated lump (gumma) proceeding to ulceration in the course of three weeks or a month.

When it ulcerates, portions of the induration appear to slough away, so that the edges, themselves more or less indurated, overhang the cavity: the form of the ulcer is irregular, and its edges smooth. It secretes a scanty discharge, hardly to be called pus, and has a sloughy aspect.

The free administration of iodide of potassium will speedily cure most syphilitic ulcerations, unless the patient be very cachectic: large doses of sarsaparilla often act very beneficially in such cases.

So amenable to the influence of iodide of potassium and of mercury are gummata and syphilitic ulcerations of the tongue, that the effects of treatment become a valuable aid in diagnosis.

Tubercular ulcer, first well described by Sir James Paget, is somewhat rare.

It has a thin ragged edge, often much undermined, and a sloughy floor; there is but little induration, and ulcers in the fauces often co-exist with it.

The edge is irregular and tortuous, the base of the ulcer yellowish or greyish, with oftentimes yellow spots, the ulcers being generally on the tip or the sides of the tongue.

These tuberculous ulcerations present a marked resemblance, in their course and appearance, to such deposits proceeding to suppuration and ulceration elsewhere in the body, and it is said that tubercle bacilli may always be found in scrapings from the surface.

Epithelioma affecting the tongue is a disease far from rare: the induration, which in the case of the syphilitic form ends in the destruction of the indurated mass, in the case of epithelioma is marked by constant extension beyond its original limits.

The base of the ulcer is greyish, or sometimes red; the discharge is very scanty, and the growth of the patch is attended with considerable pain.

The edges are hard, generally everted, and lobed; they are often of a peculiar red, polished appearance, and are sometimes fissured or nodulated. When the disease has lasted long, the submaxillary lymphatic glands become enlarged, but the period at which a correct diagnosis is of vital importance is earlier than this.

Epithelioma is most likely to be confounded with syphilitic ulceration; several of the characters by which it differs have already been pointed out, but there are some few other points which enter into the formation of the diagnosis, a matter sometimes of no small difficulty.

Epithelioma is more often on the edges of the tongue than on its dorsum; is often remarkably flat and regular in form, and is seldom found in young persons: the contrary is true of syphilitic ulcer.

Scrapings from the surface may reveal nests of cells, but their absence must not be taken as conclusive.

Epithelioma usually commences as ulceration in a crack, or a wart, or in a patch of **Leucoplakia**.

This affection, sometimes called ichthyosis linguæ, consists of white, slightly thickened and hardened patches. Mr. Hulke and Mr. Henry Morris lay great stress upon its being a very frequent antecedent of cancer, so that it becomes imperative to keep a careful watch upon any tongue so affected, and to exercise extra care lest it be exposed to any irritation.

It has been suggested that leucoplakia may possibly sometimes have been caused by the contact of the tongue with an amalgam filling, but this supposition rests upon an exceedingly dubious basis.

It bears various names, such as psoriasis linguæ, zona, leucoma, leucokeratosis, smoker's patches, etc., and several views as to its nature are entertained. Thus some still hold that it is a skin disease (zona) which happens to be manifested in the mouth, others that it is a chronic superficial glossitis (Butlin). It is very rare in women, and in men it occurs from the age of 40 to 60, being occasionally met with in non-smokers. Some have supposed it due to the irritation of volatile oils of tobacco derived from old and dirty pipes, but we have seen it in cigar smokers who never used a pipe. Out of 148 cases, 101 were moderate smokers, 2 smoked excessively, and 47 smoked not at all (Marshall, Journ. Amer. Med. Association, 1899).

In these same 148 cases, syphilis alone existed in 36, syphilis together with smoking in 64, smoking alone in 37, and neither syphilis nor smoking in 11 cases. Hence in the majority of cases syphilis and smoking co-existed as possible causes, but it appears to be rare in the absence of both.

It appears to exist in two forms, and patches are often present also on the palate, cheeks, and gums.

In the form which Marshall thinks especially due to syphilis there are greyish-white curdy surfaces, very much like the result of an application of argentic nitrate—they are slightly raised, give off a thin, contagious secretion, and tend to be painful and to ulcerate. In the other form the patches are flat, not raised, and are of a shiny, bluish-white appearance. There is no secretion, no pain, and no tendency to ulceration.

As regards its relation to subsequent epithelioma some doubt still exists. Marshall found that out of 80 cases of epithelioma only 16 had been known to be preceded by leucoplakia, but it is certain that after years of apparent quiescence it may become the site of epithelioma. As regards diagnosis it may be confounded with ordinary syphilitic plaques or with commencing epithelioma, but a three or four weeks' course of potassium iodide will usually clear up syphilitic deposits. It is but little amenable to treatment—caustics should of course be scrupulously avoided, and the parts swabbed with balsam of Peru, or with a resorcin ointment (6 grs. to ℥j), which sometimes causes some reaction and subsequent shrivelling of the spots. This may be followed by alkaline or boracic washes.

It is not, however, going too far to say that any abnormal condition of the tongue, lasting for a material time, is to be looked upon as a source of possible danger, and in a patient over the age of forty, no consideration of saving teeth should tempt the dentist to expose an unhealthy tongue to any constant irritation.

The fact that a tongue is obviously syphilitic is anything but a safeguard, as epithelioma frequently arises in the furrows of a syphilitic tongue.

Mr. Eve met with a case of glossitis with the usual white patches, which appeared to be due to micro-organisms in a very foul mouth. There was no syphilitic history, and a cure followed upon removal of stumps, and the production of a cleanly condition by use of antiseptics.

INDEX.

*

THE END.

BRADBURY, AGNEW, & CO. LD., PRINTERS, LONDON AND TONBRIDGE.

℞ Glyc. Thymol Co ℥viii

Sig ʒi ex. aq.