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AND PATHOLOGY

DENTAL SURGERY AND PATHOLOGY

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BY

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DENTAL SURGEON TO CHARING CROSS HOSPITAL AND
THE ROYAL DENTAL HOSPITAL

Being the Third Edition of

DISEASES AND INJURIES OF THE TEETH

BY

MORTON SMALE AND J. F. COLYER

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PREFACE

In this work an attempt has been made to bring the study of Dental Pathology in line with the current knowledge of General Pathology, and to identify the causes underlying diseases of the teeth with those underlying disease in general.

During recent years it has been shown that many pathological processes are to be regarded in the light of the natural reaction of the tissues to injury—*i.e.*, injury in its broadest sense, arising from trauma, physical causes and toxins. This conception of disease is exercising a profound influence on the methods of treatment adopted by the physician and surgeon and has in a variety of ways affected the practice of dentistry.

Of the various forms of injury, that produced by bacterial toxins is by far the commonest, and the mouth in unhealthy conditions is one of the most prolific sources of bacterial toxins and, consequently, of disease. The great importance of maintaining a healthy condition of the mouth is therefore obvious, and should be constantly borne in mind by the dental practitioner, who must carefully avoid any operations which may directly or indirectly lead to pathological processes in the mouth. The treatment which he adopts should be based on a thorough knowledge of the etiology and pathology of the condition which he is called upon to deal with, and he should be alive to the fact that the most elaborate technique is not necessarily the best treatment.

I am conscious that some subjects have been very fully considered, while others which appear of equal importance have received less attention. The subjects which have been dealt with in detail are those in which there has of recent years been a marked increase in knowledge, and also those in regard to which experience gained from teaching has led me to believe that the student is lacking in the knowledge of basic principles.

Here and there a disease has been considered in its relation

to the lower animals. The study of comparative dental pathology will often throw considerable light upon dental conditions in man, and this is well exemplified in the study of periodontal disease in horses and other animals.

A chapter on Tumours of the Jaw has been introduced, as the subject is one with which the dental practitioner should, I think, be intimately acquainted. This subject, moreover, is not very fully treated in the text-books usually read by dental students. Many of the illustrations in this chapter have been drawn for me by my friend Mr. Hopewell-Smith, and the excellent results produced testify to his skill and patience, for which I tender to him my best thanks. I also desire to express my indebtedness to my colleague Mr. H. S. Clogg, Assistant Surgeon to Charing Cross Hospital, who has assisted in the preparation of this chapter. He revised the text and gave me many valuable suggestions. He also greatly aided me in dealing with the chapters on the Diagnosis of Swellings about the Jaws, Interference with the Movements of the Temporo-mandibular Articulation and Common Ulcers of the Tongue.

Throughout the book I have frequently used the actual words of the authors I have consulted, and the excerpts have been indicated by quotation marks. In many places I have purposely refrained from giving the source of the quotation in order not to distract the attention of the reader, and I trust that this general acknowledgment of the assistance I have thus obtained will suffice.

A list of the papers which have been found useful in the preparation of this work has been added to most of the chapters, in the hope that they may prove helpful to anyone desiring to make a special study of the particular subjects.

I am greatly indebted to many of my colleagues and friends for much valuable assistance. Mr. Kenneth Goadby has entirely rewritten his chapter on the Bacteriology of the Mouth, and he has supplied the notes on the bacteriology of the various dental diseases.

I acknowledge my thanks to Mr. J. Thornton Carter for writing the section on the Eruption of the Teeth ; to Mr. G. F. Still for revising the part dealing with Pathological Dentition ; to

Dr. Pare for information on the Technique of Local Anæsthesia; to Dr. Malcolm Hepburn for kindly looking through the sections dealing with Reflex Conditions of the Eye arising from Dental Irritation; to Dr. Jobson Horne for that part dealing with Affections of the Ear; to Mr. Andrew Kelly for revising the part dealing with the Chemistry of the various Filling Materials, and to Messrs. G. Northcroft, J. Higson, and J. J. Ellison, for much kind assistance.

A large number of new Illustrations have been included in this edition, and many of these have been produced from photographs prepared by Mr. G. Payne.

For the loan of blocks I am indebted to the Council of the Royal Society of Medicine, the Publishing Committee of the *Journal of the British Dental Association*, Messrs. C. Ash, Sons and Co., the Dental Manufacturing Co., Messrs. S. S. White and Co., Messrs. Henry Kimpton and Co., Messrs. Rebman, Messrs. Churchill and Sons, Messrs. P. Blakiston and Sons, and Messrs. Smith, Elder.

Lastly, I have to thank Mr. Henry Bale for his unfailing courtesy and kindness, and to acknowledge the ready and willing assistance which I have always received from Messrs. Longmans, Green and Co., the publishers of the work.

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London,
July 30, 1910.

CONTENTS

CHAPTER V

CHAPTER VI

CHAPTER VII

CHAPTER VIII

CHAPTER IX

CHAPTER X

CHAPTER XI

CHAPTER XII

CHAPTER XIII

CHAPTER XIV

CHAPTER XV

CHAPTER XVI

CHAPTER XVII

CHAPTER XVIII

CHAPTER XIX

CHAPTER XX

CHAPTER XXI

CHAPTER XXII

CHAPTER XXVII

CHAPTER XXVIII

CHAPTER XXIX

CHAPTER XXX

CHAPTER XXXI

CHAPTER XXXII

CHAPTER XXXIII

CHAPTER XXXIV

CHAPTER XXXV

DENTAL SURGERY AND PATHOLOGY

CHAPTER I

Normal Dentition

The Anatomy of Dentition—The Process of Eruption—The Eruption of the Deciduous Teeth—The Absorption of the Deciduous Teeth—The Eruption of the Permanent Teeth

(A) THE ANATOMY OF DENTITION

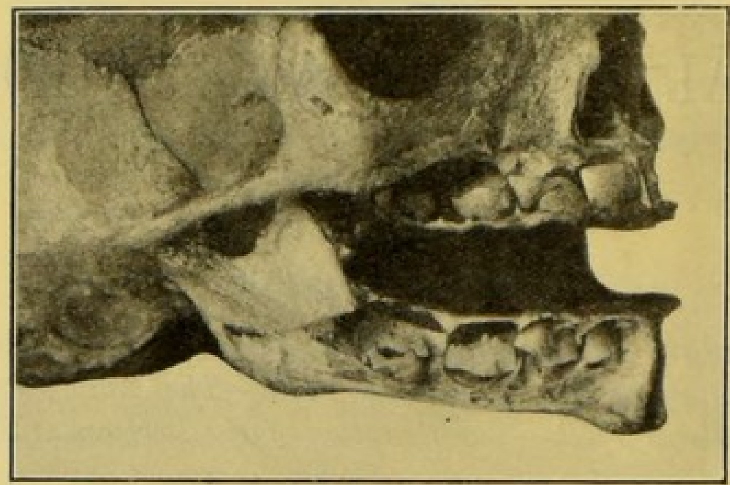
In the human subject the earliest manifestations of teeth are the enamel organs for the deciduous teeth, which appear during the seventh week of fœtal life, followed during the ninth week by the dentine bulbs. At the twentieth week calcification commences with the central and lateral incisors, and at the twenty-fourth week the canines and deciduous molars begin to show signs of calcification.

At birth, calcification of these teeth has advanced to the stage shown in fig. 1, and has also commenced in one of the anterior cusps of the first mandibular permanent molar.

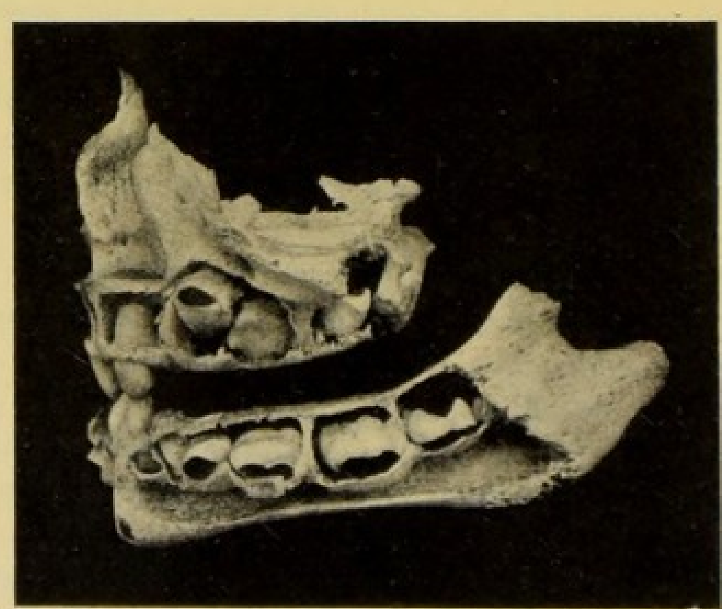
At the age of eight months, the growth of the deciduous incisors and canines has progressed to the stages shown in fig. 2. The roots of the first molar are commencing to form and the crown of the second molar is almost complete. In the permanent teeth, calcification has commenced in the incisors and the canines and is well advanced in the cusps of the first molars.

At the age of twelve months (fig. 3), the root of the deciduous canine has commenced to form, growth in the first deciduous molar has progressed beyond the division of the roots, and in the second molar almost up to the division. The deciduous incisors

are fully erupted, and eruption of the first molars has commenced. In the permanent teeth, about half of the crown of the first molar is formed, the upper third of the crown of the central incisor, about one-fifth of the lateral, and the tip of the canine.

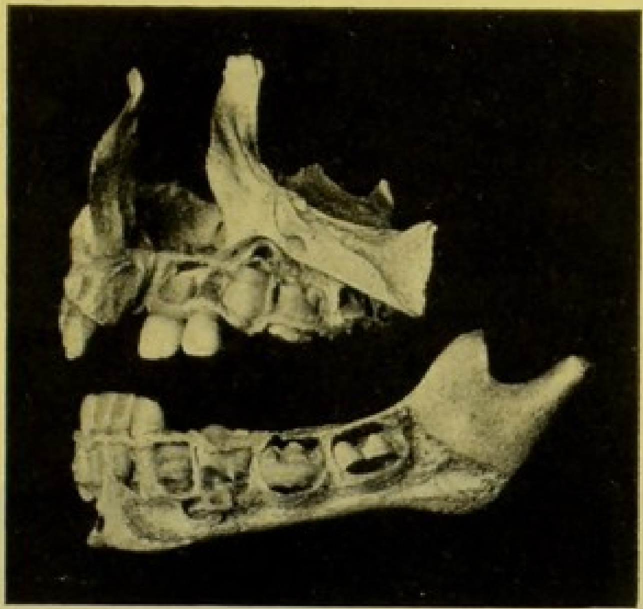


Birth.
FIG. 1.

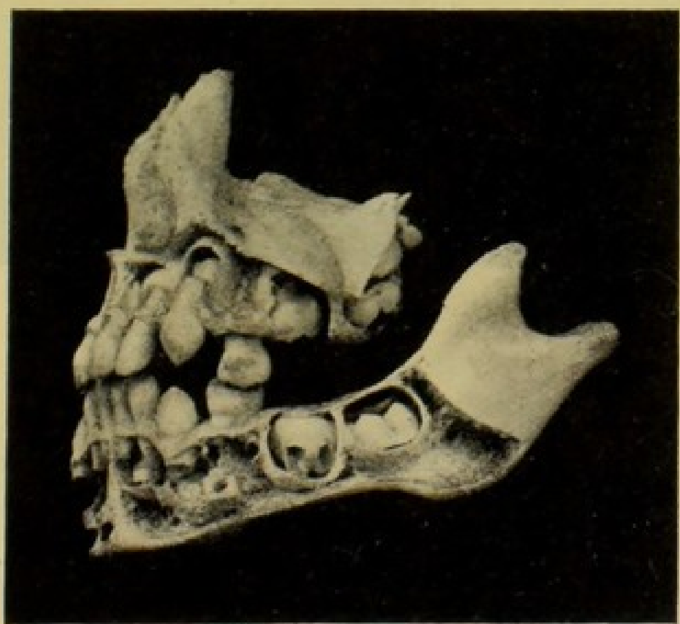


Eight months.
FIG. 2.

Fig. 4 shows the jaws of a child aged *fourteen months.* The first molars are in place, and the canines are partially erupted.



Twelve months.
FIG. 3.



Fourteen months.
FIG. 4.

At the age of eighteen months, the roots of the central and lateral incisors of the deciduous set are almost complete; about two-thirds of the roots of the canines, practically the whole of the roots of the first molars, and about half the roots of the second molars are calcified. In the permanent series, calcification has advanced, as shown below :—

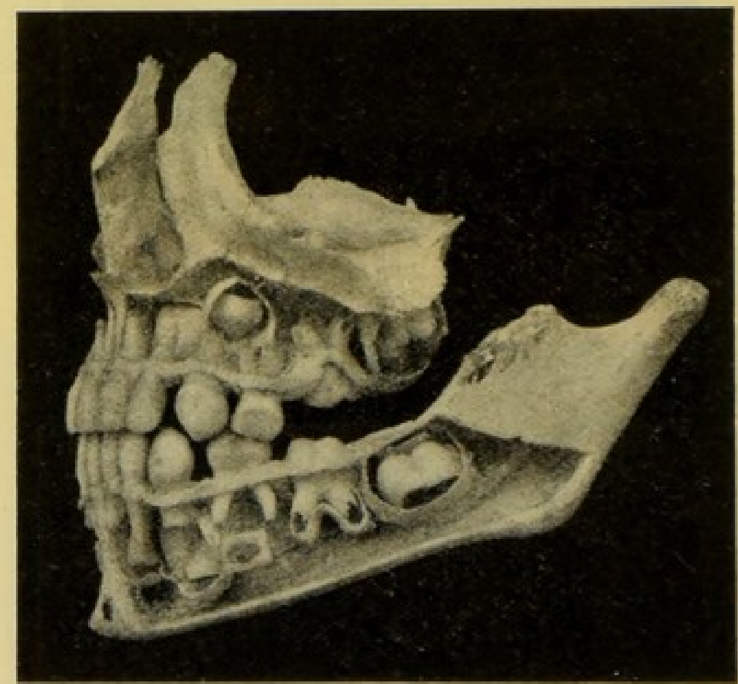
The central incisors about $\frac{3}{4}$ths of the crown.

The lateral incisors (maxillary) about $\frac{1}{4}$th of the crown.

The lateral incisors (mandibular) $\frac{2}{3}$rds of the crown.

The canines about $\frac{1}{2}$ of the crown.

The first molars a little over $\frac{3}{4}$ths of the crown.



Two years.
FIG. 5.

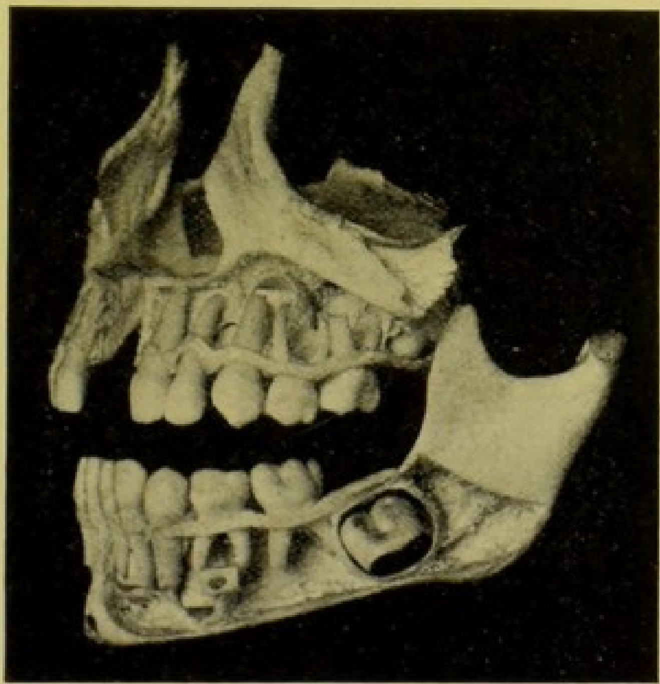
At two years of age (fig. 5), the formation of the deciduous teeth is complete, with the exception of the terminal portions of the canines and second molars. In the permanent series, the crown of the first molar is fully formed, and calcification has advanced in the incisors and canines, but the crowns are not complete.

At three years of age (fig. 6), the deciduous dentition is com-

plete and fully erupted. Of the permanent teeth, the crowns of the first molars, the incisors, and canines are fully formed. Calcification has commenced in the first mandibular premolar, and is beginning in the corresponding maxillary tooth.

At four years of age calcification has commenced in the second premolars and in the second permanent molars.

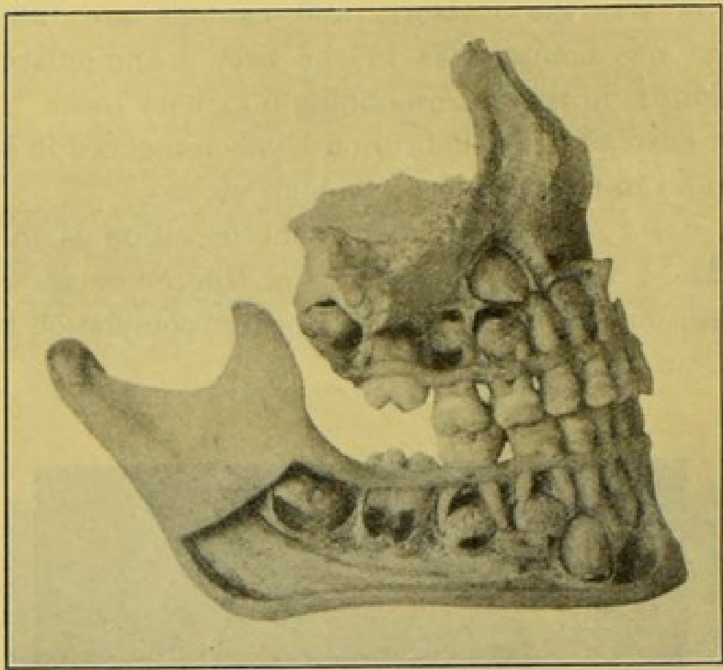
At six years of age the permanent dentition is in the state shown in figs. 7 and 8. The crowns of the premolars are not yet fully formed, but the calcification is nearer completion in the first premolar than in the second.



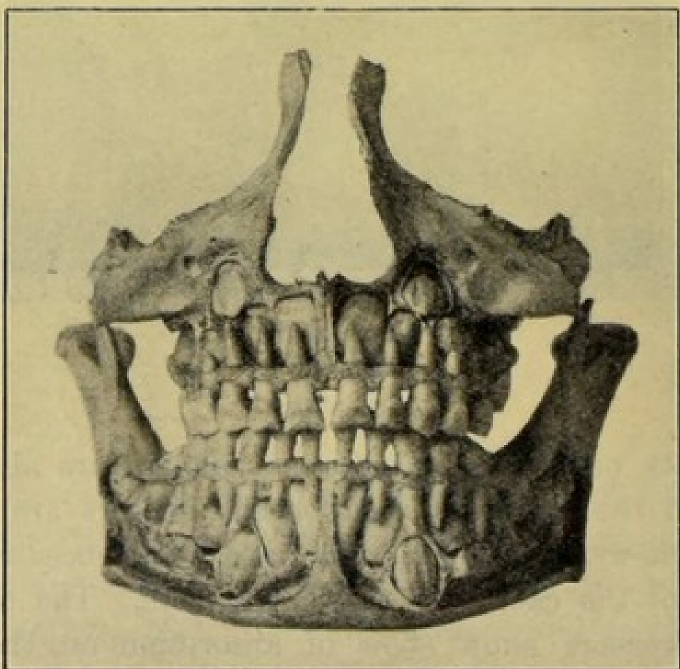
Three years.
FIG. 6.

The roots of the first permanent molars are also partially formed, and the crowns of the second molars are about half formed. The roots of the incisors have commenced to form, but the crown of the canine is barely complete. The roots of the deciduous incisors show signs of absorption on the posterior aspects.

Attention is drawn to the position of the permanent teeth in relation to the deciduous dentition. In the maxilla, the per-



Six years.
FIG. 7.



Six years.
FIG. 8.

manent central and lateral incisors lie behind the corresponding deciduous teeth. The permanent teeth incline outwards to a greater degree than the deciduous teeth, and consequently the permanent teeth when erupted form a larger circle. The premolars are embraced by the roots of the deciduous molars and their crowns are directed inwards, the second a little more than the first. The canine above and external to the arch of the incisors and premolars is directed slightly outwards. The lateral incisor lies close to the premolar, and the first permanent molar,

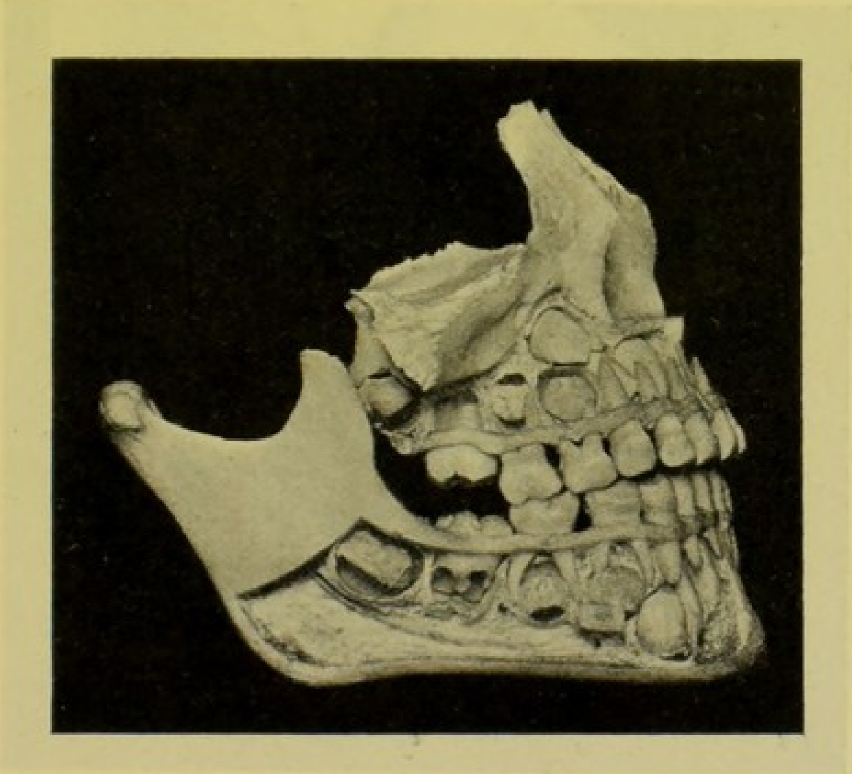


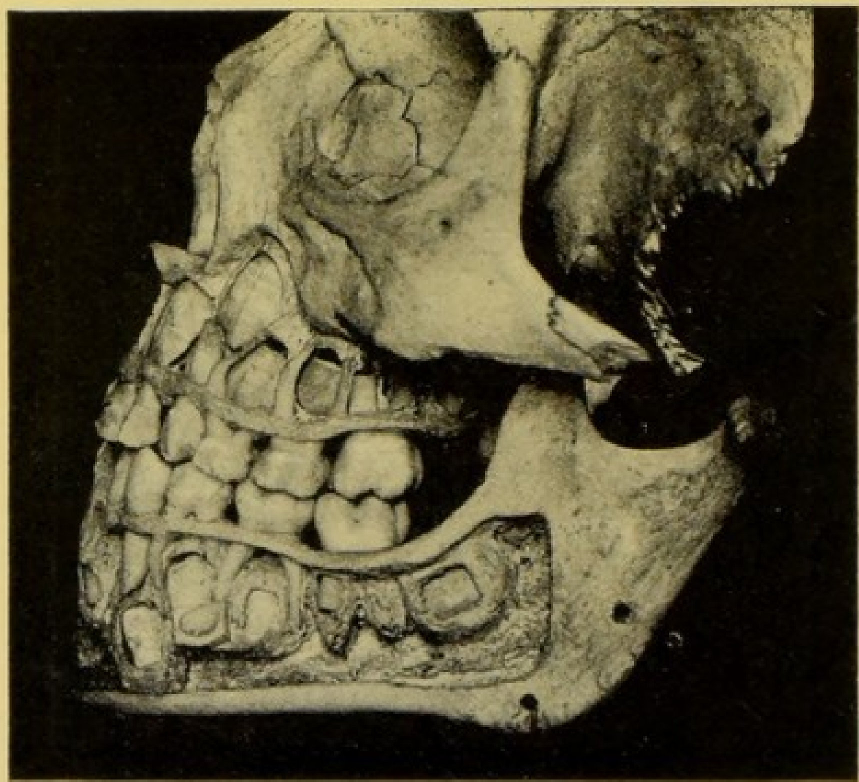
FIG. 9.

which is in the process of eruption, has the occluding surface directed outwards and backwards to a slight extent. The second permanent molar is situated high up in the tuberosity of the bone with the occluding surface directed downwards, outwards and well backwards.

In the mandible, the lateral incisors are in a plane posterior to the centrals and the canines are placed near the lower border of the bone and lie in a plane anterior to the lateral incisors, with a slight tilt towards the median line. The premolars are embraced by the roots of the deciduous molars and their crowns

are directed inwards. The first permanent molars are directed upwards and forwards, and the second molar is under the base of the coronoid process with the occluding surface directed upwards, forwards, and slightly inwards.

In fig. 9 is shown the normal occlusion of the deciduous molars. The mandibular first molar is covered in its posterior two-thirds by the corresponding upper tooth, and the second mandibular molar is covered in its anterior third by the maxillary



Seven years.
FIG. 10.

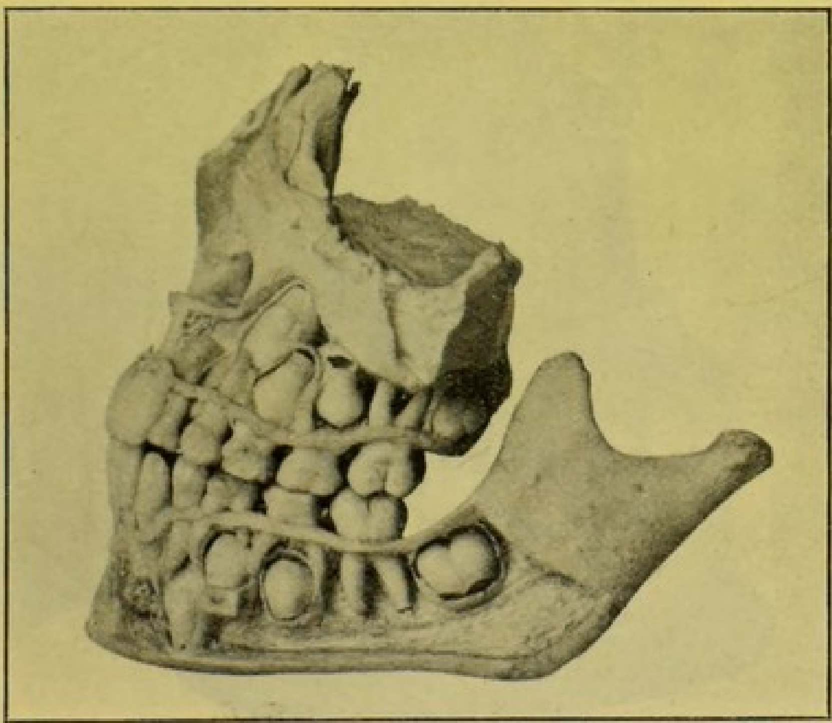
first molar and in its posterior two-thirds by the maxillary second molar. The posterior borders of the second molars are not flush, the bulb on the upper tooth projecting beyond the lower. It is this bulb which limits the forward movement of the maxillary first permanent molar and brings about correct occlusion.

In the specimen shown in fig. 10, of a child aged about *seven years*, the first permanent molars have erupted into correct occlusion. In this specimen, the lower central incisors are partially erupted.

In the skull of a child *nine years* of age, shown in fig. 11, the four central incisors, maxillary and mandibular, are in place and the roots are nearly completed. In the remaining teeth the condition is as shown below :—

Canines. About half of the root is formed. The lower canine is a little less advanced than the upper.

First premolars. About one-quarter of the root is formed.



Nine years.
FIG. 11.

Second premolars. The formation of the root has commenced.

First molars. Roots nearly formed.

Second molars. The formation of the roots has commenced.

Calcification of the maxillary third molar would seem to commence at about ten years of age, and of the mandibular third molar somewhat later.

At the age of twelve years, the incisors and usually the premolars are fully formed ; the root of the canine is nearing completion ; the second molar has the roots about two-thirds formed, and the crown of the third molar is calcified.

Calcification of the second molars is complete about the

sixteenth year, and of the third molars between the eighteenth and twentieth years. With the eruption of the third molars, the second dentition is complete and should present the occlusion shown in fig. 12.

The foregoing specimens may be regarded as affording an approximate indication of the degree of calcification which we may expect to find at the periods specified. Development and

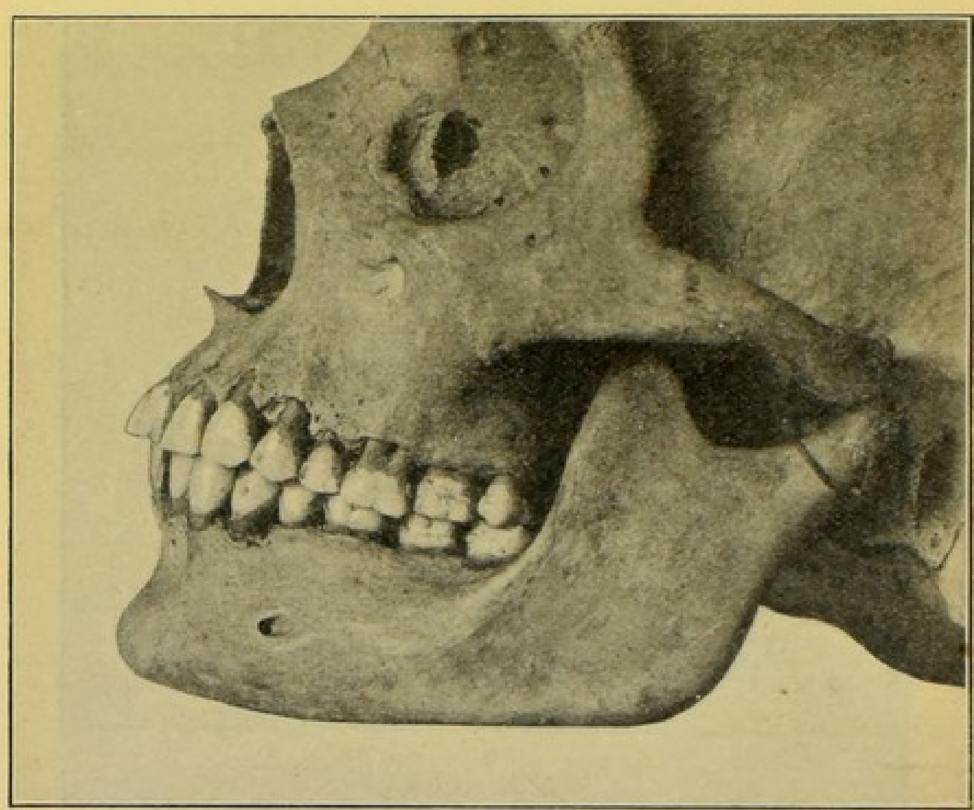


Fig. 12.

calcification of the teeth probably vary widely within the normal, and our knowledge of the relationship which tooth and jaw development bears to growth in general is still very scanty.

The diagrams shown in figs. 13 and 14 illustrate the amount of calcification of the deciduous and permanent teeth at various age periods.[1]

[1] The material for these diagrams has been obtained from an examination of the skulls in the Odontological collection of the Royal College of Surgeons, and from Symington and Rankin's "Atlas of Skiagrams."

In the process of dentition the periods of greatest activity are during the early years of childhood. This fact cannot be too strongly impressed upon parents by those responsible for the medical care of children.

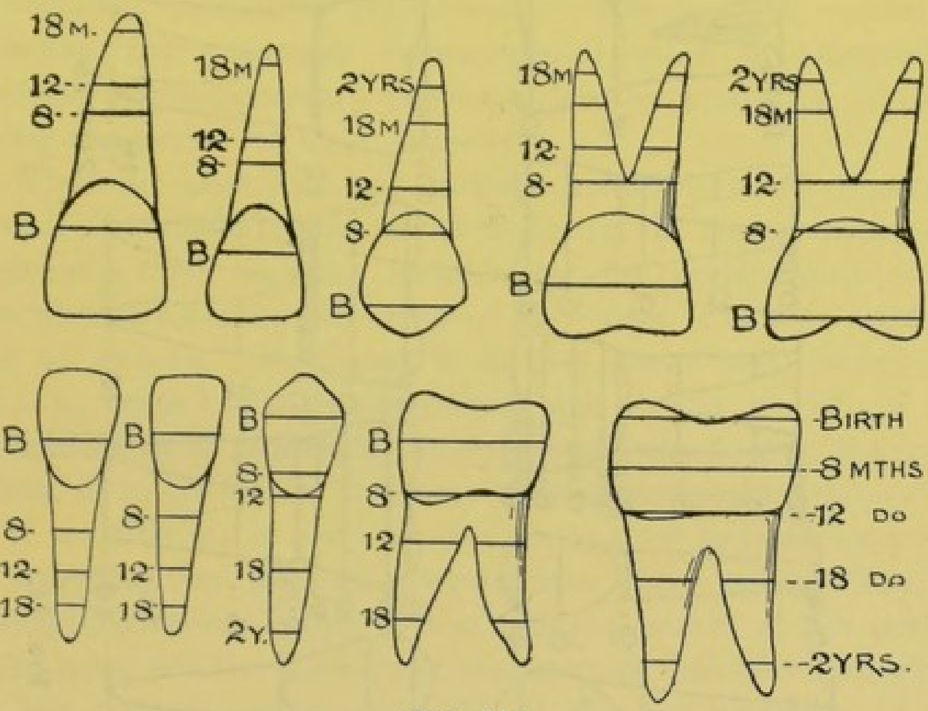


Fig. 13.[1]

(B) THE PROCESS OF ERUPTION[1]

A tooth lies deeply imbedded in the tissues of the jaws during a considerable portion of its developmental period. As the time approaches when it will be required to perform its natural functions, a movement to the surface commences, and continues until the tooth emerges from the gum and assumes its proper position in the dental arch.

The precise manner in which the movement of the teeth in man is brought about presents a problem which has not yet been fully elucidated. It seems probable, however, that the mechanism which produces this movement in man is, in the main, identical physiologically with the mechanism which produces tooth movement in the lower orders of animals, and

[1] For this section I am indebted to Mr. J. Thornton Carter.

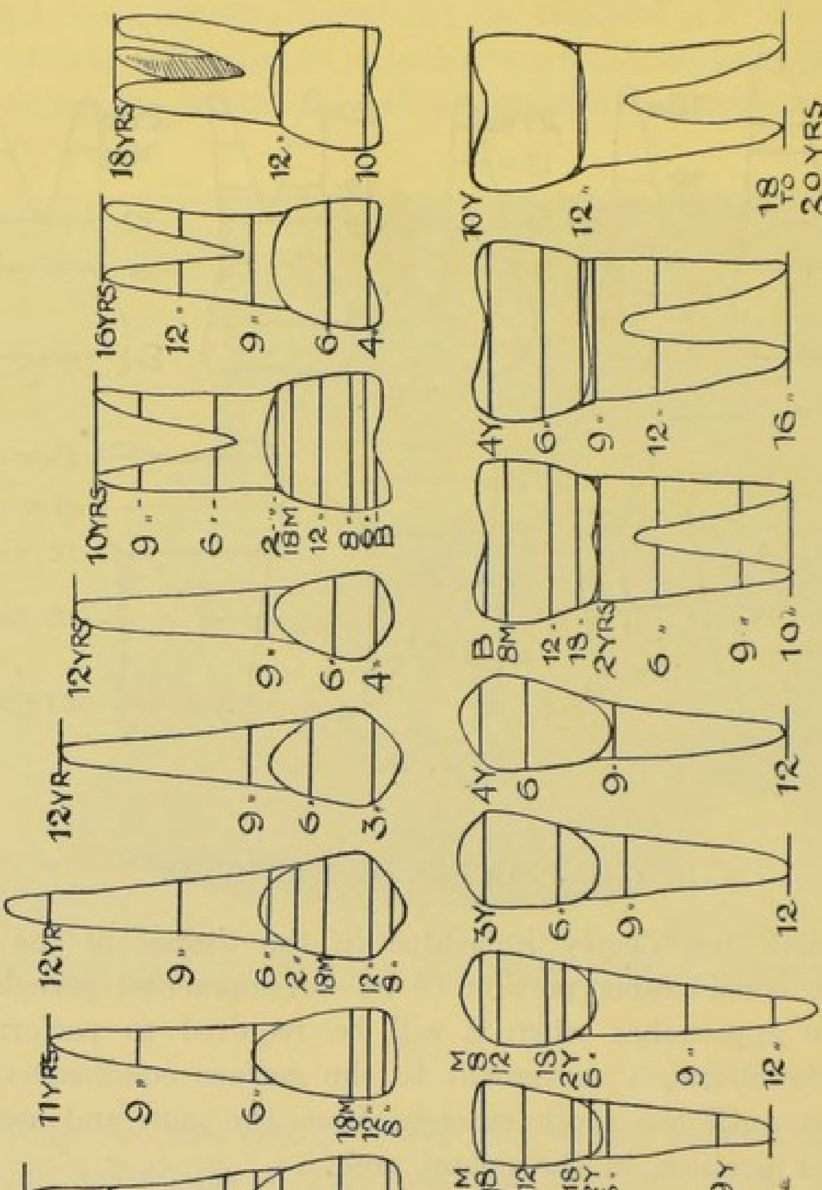


FIG. 14.

that by studying the process of eruption in the lower animals information will be obtained which will enable us to understand the process in man.

A tooth is essentially a dermal appendage, and any attachment which it may obtain with adjacent bony structures must be regarded as purely adventitious. The complex conditions attending the prolonged developmental stage of mammalian dentition are a necessary provision for the protection of teeth during the period of their formation.

When an organ in any sensate creature moves from the position in which it was situated during its development, and occupies a fresh position suitable for the performance of its natural functions, the physiological movement is always attributable to growth. But what is it that grows and causes the tooth to erupt? Is the movement due to the growth of the tooth itself, or to growth in the soft tissues constituting the tooth follicle, or to growth in the bony tissues surrounding the tooth?

If an attempt is made to find an answer to these questions by studying the jaws of mammalians only, great difficulties present themselves owing to the complex nature of the growth of the jaws, and the consequent obscurity of the operation, which are the natural accompaniments of the specialization of the parts and of the organs connected with those parts.

For the purpose of studying tooth movement the teeth of fishes probably present the least difficulty. In most fishes teeth are produced in an endless succession of series. Each series has only a short functional existence, and is replaced by rapidly developed successors. The mechanism of eruption is here constantly in operation unobscured.

Take, for example, the case of the dogfish. In the dogfish, as in all cartilaginous fish, the teeth are attached to the fibrous and mucous membranes which cover the maxillary and mandibular cartilages, and are not implanted in alveolar cavities, nor confluent with the substance of the jaws even where the external crust is ossified. The numerous teeth, in successive series, are constantly moving slowly upwards and over the border of the jaw. When each series reaches the outer margin of the jaw it is cast off, while new teeth, in equal proportion to those lost, are being developed in the mesoblastic tissues deep in the jaw.

This regular upward procession of the teeth is plainly observable, and it only remains to ascertain precisely in what manner the movement is brought about.

It is clear that there must be a change in the position of the fibrous membrane to which the denticles are attached corresponding to the tooth movement, and, on examining the osteocartilaginous jaws, the fibres of the sliding membrane, and the bases of the successional tooth germs, it will be seen that this change of position is due to absorption and deposition of bone at the margin of the jaw operating on the membrane.

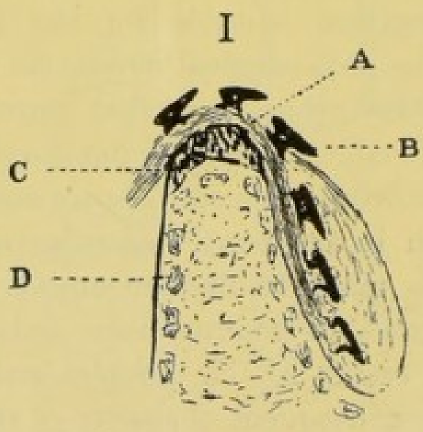


FIG. 15.—Section through jaw of dogfish. A, sliding membrane; B, tooth; C, bony crust; D, cartilaginous jaw.

The amount of ossification in and about the jaws of cartilaginous fishes is very slight, and extends but a very little way into the cartilage. At the margin of the jaw, however, at or about that part where the bases of the erupted functional teeth rest on the jaw, there is a considerable thickening of osseous tissue forming a crust of coarse and rapidly developed bone interspersed among the deeper fibres of the sliding membrane (fig. 15). This crust of bone, which is of a transitory nature, being constantly absorbed and deposited, is instrumental in causing the progressive movement of the sliding membrane. It is only at this part of the jaw that there is any intimate attachment of the sliding membrane to the tissues lying beneath, as may easily be observed by stripping the tooth-bearing membrane from the jaws.

The ossification at the margin of the jaw—which gives

stability to the teeth during their short functional life, and protects the margin of the cartilage and the rapidly proliferating cells of its surface—affords the first phylogenetic evidence of an alveolar process in higher vertebrates.

When a functional tooth is shed, absorption of the underlying bone takes place, and also absorption of the fibrous membrane at its outcrop. As a natural sequence to the absorption of the underlying bone and fibrous membrane, there is a rapid proliferation of cells at the margin of the cartilage, with formation of bony tissue over the same area. The newly-formed bony tissue operates on the fibres of the sliding

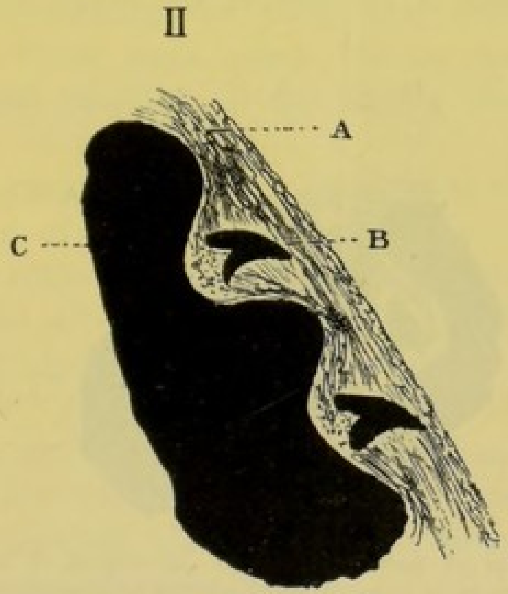


FIG. 16.—Diagram of jaw, showing septa between the individual teeth. The base of the dentine papilla is continuous with the oral muco-periosteum. A, muco-periosteum of jaw ; B, tooth ; C, bone of jaw.

membrane, which is poor in cellular elements and ill-adapted for active growth, and causes the membrane to move upwards and bear with it the next successional tooth. Concomitantly, there is renewed proliferation of the epithelial cells at the base of the tooth-band to give origin to the enamel organ of a new member for the series.

This comparatively unobscured process of eruption in the dogfish probably furnishes us with the key to the process by which teeth are erupted in man. Throughout the animal

kingdom connection of the teeth with the deeper fibres of the muco-periosteum of the gums seems to be an essential factor in the process of eruption. As teeth become more specialized and less numerous, and require a longer formative period during which the creature uses its jaws to some extent, the growth of the alveolar plates forms a groove, and transverse septa form crypts, in order to provide the necessary protection. These changes necessitate an upward prolongation from the base of the dentine papilla to form a sac of connective tissue continuous with the deeper layers of the oral muco-periosteum (fig. 16).

Wherever a tooth is developed in a bony crypt removed from the surface, a foramen will invariably be found leading from the tooth-bearing surface of the jaw to the crypt, and transmitting

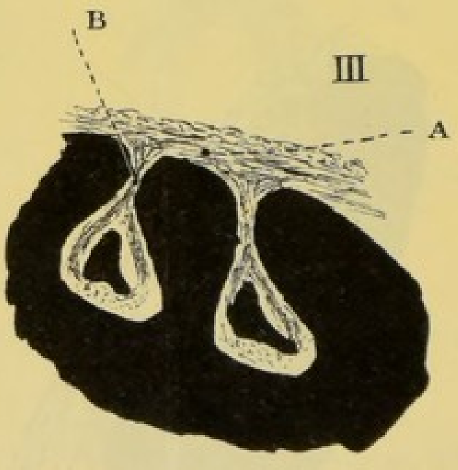


Fig. 17.—Diagram of jaw with teeth developed in bony crypts. The base of the dentine papilla is continued upwards around the tooth and communicates with the oral muco-periosteum by means of the "gubernaculum." A, muco-periosteum of jaw; B, gubernaculum.

a bundle of fibrous tissue continuous on the one side with the fibres of the periosteum, and on the other with those of the tooth sac (fig. 17). This bundle of fibrous tissue is known as the *gubernaculum*, but it must be clearly understood that its fibres exercise no traction in themselves and are merely sessile. The function of the gubernaculum is to afford connection between the developing tooth and the membrane of the gums.

In fibrous tissues poor in cellular elements (the tooth sac and gubernaculum are composed of such tissues), there is little adaptation for active and rapid growth. When, therefore, in

in the parts surrounding the tooth sac there is great activity owing to cellular proliferation, the passive tooth organs, which are supported by fibrous tissues, necessarily undergo a change of position, the direction and extent of the movement of the tooth sac being dependent on the degree of growth in the surrounding parts.

Thus we may conclude that in man the cause of eruption, or at least an active factor in producing eruption, is to be found in the disproportionate growth occurring in the tissues forming the tooth and the tissues surrounding the tooth.

The rapid growth of the osseous tissues surrounding the tooth carries upwards the more slowly growing fibrous connective tissues composing the tooth sac, so that as regards the movement of the teeth these fibrous connective tissues perform the same function as the sliding membrane in the dogfish.

A tissue or organ continues to grow up to the limit afforded by the resistance of the neighbouring tissues or organs. The lessening of this resistance through absorption causes a resumption of growth and cell-division, and these processes are continued until the normal equilibrium is re-established. The use of the term "resistance" must not be taken in its literal mechanical sense. Growth, with its associated phenomena, leads to compensatory changes in the neighbouring tissues; these changes are not a direct mechanical effect of its disturbance, but a highly complex physiological response to it.

(C) THE ERUPTION OF THE DECIDUOUS TEETH

The normal signs of approaching eruption are an increased flow of saliva, and a tendency on the part of the child to bite at any tangible object. A healthy child will often cut its teeth without the slightest trouble, but more often the gums are a little tumid, tense, and shining over the erupting tooth, the local condition being accompanied by slight irritability, restlessness, and a rise of temperature.

The order and date of eruption vary considerably within normal limits. For example, Dr. A. T. Spanton (*British Medical Journal*, June 3, 1907, p. 1362) examined 200 healthy breast-fed

children of normal parents to ascertain which tooth of the deciduous set was the first to appear. The summary of his investigations is given below:—

First tooth or teeth to appear through the gum	100 Boys and 100 Girls taken together: Number of instances of this eruption	100 Boys and 100 Girls taken together: Frequency of this eruption	100 Boys alone: Number of instances of this eruption	100 Boys alone: Frequency of this eruption	100 Girls alone: Number of instances of this eruption	100 Girls alone: Frequency of this eruption
		%		%		%
Right lower central incisor ..	71	35·5	39	39	32	32
Left lower central incisor	71	35·5	32	32	39	39
Both lower central incisors together	29	14·5	14	14	15	15
Right upper central incisor ..	12	6	10	10	2	2
Both upper central incisors together	11	5·5	5	5	6	6
Left upper central incisor.. ..	6	3	0	0	6	6
	Average age in days when first tooth erupts =237		Average age in days when first tooth erupts =252		Average age in days when first tooth erupts =221	

These figures show that girls begin to teeth earlier than boys, there being an average difference of thirty-one days between the sexes in this respect.

Reliable statistics as to the order and time of eruption of the deciduous teeth are not available. The following dates, however, may be taken as approximately correct:—

Mandibular central incisors, fifth to eighth month.

Maxillary central and lateral incisors, seventh to tenth month.

Mandibular lateral incisor, tenth to twelfth month.

First molars, twelfth to fourteenth month.

Canines, fourteenth to twentieth month.

Second molars, twentieth to thirtieth month.

The teeth erupt as a rule in pairs or groups, and between the eruption of each group there is an interval varying from two to five months, the interval becoming greater between the later groups.

Eruption of teeth before birth is extremely rare. When this occurs the teeth are usually imperfectly developed and loosely attached to the muco-periosteum, but occasionally they are well formed and attached to normal alveoli.

(D) THE ABSORPTION OF THE DECIDUOUS TEETH

Several theories have been advanced to explain the displacement and eventual removal of the roots of the deciduous teeth. The most commonly accepted theories are:—

(*a*) That it is caused by the pressure of the crown of the permanent tooth on the root of its deciduous predecessor.

(*b*) That it is due to the presence of an absorbent organ consisting of a mass of large multi-nucleated cells.

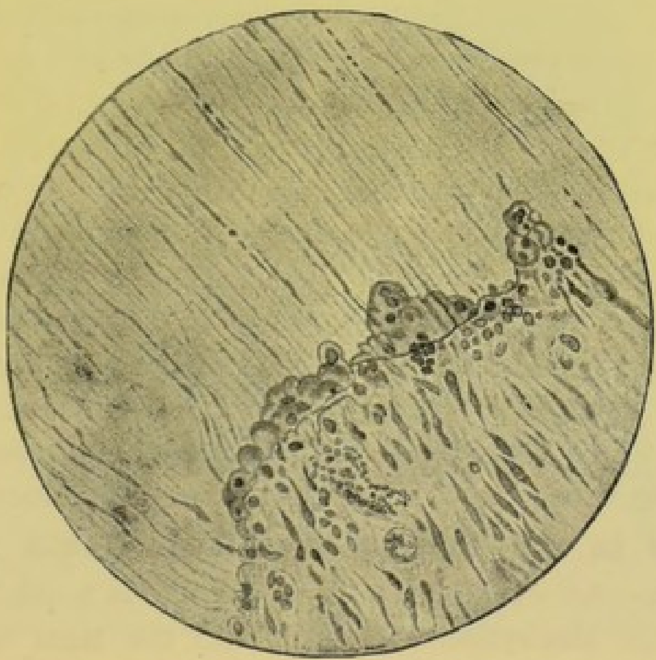


FIG. 18.[1]

As regards the latter theory, if a deciduous tooth which has undergone absorption be examined, the root will appear excavated in a cup-shaped manner, the loss of tissue being at or near the apex, and in fortunate specimens a soft vascular substance—the so-called **absorbent organ**—will be found in contact with the tooth. A section of such a tooth examined microscopically will show, at the part attacked by absorption, well-marked Howship's

[1] From a drawing by Mr. J. Howard Mummery.

lacunæ, and if the section has been prepared by a method in which hard and soft tissues can be cut together, it will be seen that the soft vascular part is composed of a mass of cells, those nearest to the dentine being multi-nucleated and fitting into the cup-shaped excavations in the dentine. Fig. 18 is a drawing of the absorbent cells in contact with the dentine. It will thus be seen that the so-called absorbent organ is only a mass of cells, some of which act as osteoclasts. In absorption of the permanent teeth, a typical example is the pressure of the mandibular third molar upon the posterior root of the second mandibular molar. A section through the absorbed portion will show exactly the same condition as may be observed in an absorbed deciduous tooth. In specimens of rarefying periodontitis, Howship's lacunæ filled with the characteristic giant cells can be seen. The disappearance of the tooth tissue of the deciduous tooth undoubtedly depends upon the presence of these multi-nucleated or osteoclastic cells. How they perform their work is not quite clear. Some writers have advanced the theory that the cells send out amœbiform processes; others that they secrete an acid and thus dissolve the tooth substance, the remaining organic substance being removed by phagocytic action. What determines the presence of the so-called absorbent organ is as yet unknown. Whether it is due to the presence of and pressure from the permanent teeth, or to some other agency, is a problem which still awaits solution. In deciduous teeth containing septic pulps, the process of absorption seems to take place slowly, and in some instances not at all.

Changes in the Pulp of Deciduous Teeth undergoing Absorption.—An examination of a deciduous tooth which is in the process of absorption will show that the large nerve trunks have been destroyed and that the pulp is fibrous and vacuolated. It will also be seen that at the terminal margin of the pulp there is a well-marked layer of fibrous tissue (see fig. 19).

(E) THE ERUPTION OF THE PERMANENT TEETH

With the permanent teeth, as with their predecessors, there is considerable variation as regards both the order and the time of eruption.

The late Mr. S. Cartwright published[1] a detailed account of

[1] *British Journal of Dental Science*, May, 1857.

over 3,000 cases he had examined and a perusal of the figures recorded clearly indicates not only that there is a considerable variation in the ages at which the various teeth erupt, but also that the order of eruption varies. An examination of about

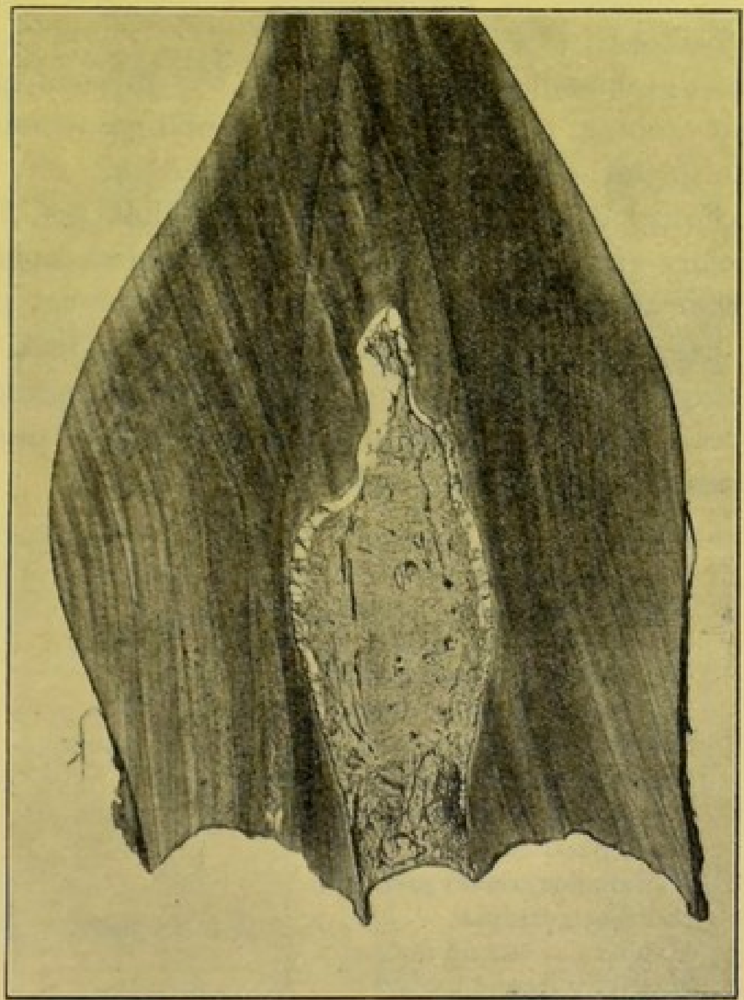


FIG. 19.

7,000 persons was made by Dr. Dietlin,[1] and his records also show similar variations.

Dr. C. Röse has compiled statistics comprising particulars of over 40,000 children of both sexes.[2] He finds :—

[1] *Oesterreich-Ungarische Vierteljahrsschrift für Zahnheilkunde.* (Translated in Ash's *Quarterly Circular*, Sept., 1895, p. 353, and Dec., 1895, p. 484.)
[2] *Deutsche Monatsschrift für Zahnheilkunde*, August, 1909.

(*a*) That the time of eruption varies widely, the limits of variation being smallest in the first permanent molars, and largest in the canines and premolars.

(*b*) That in the female sex the teeth erupt on an average four and one-half months earlier than in the male sex. The difference is smallest in the eruption of the first permanent molars, and largest in the canines.

(*c*) That the time of eruption varies in the different races.

(*d*) That eruption occurs earlier in the children of the leisured classes than in the children of the working classes.

From clinical experience it would seem that the first permanent molars and the incisors erupt in somewhat rapid succession, and that their eruption is followed by a distinct period of rest often extending over two years. After this rest, another period of eruption occurs, and the premolars, canines and second molars appear. The approximate order and date of eruption of the permanent teeth are shown below.

Mandibular first molars Maxillary first molars Mandibular central incisors Maxillary central incisors Mandibular lateral incisors Maxillary lateral incisors	6 to 8 years.
Maxillary first premolars ...	10 to 11 years.
Mandibular first premolars Maxillary second premolars Mandibular canines	11 to 12 years.
Mandibular second premolars Maxillary canines Mandibular second molars Maxillary second molars	12 to 13 years.
Third molars	20 to 25 years.

The time of eruption of the third molars depends, to a great extent, upon the amount of space in the arch. With all the teeth present the figures given in the above table probably represent the average age of appearance. The early removal of second molars will accelerate the appearance of the third molars which may erupt as early as the fifteenth year, and early removal of the first molars may produce the same effect.

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CHAPTER II

Pathological Dentition

Disorders associated with the Process of Teething—Retarded Eruption—Partial Eruption—Impeded Eruption—Pathological Changes in Retained Teeth.

(A) DISORDERS ASSOCIATED WITH THE PROCESS OF TEETHING

(1) General

CERTAIN general disorders frequently occur about the time of teething, and considerable diversity of opinion exists as to exact relationship between these disorders and the teeth. There can be little doubt that formerly illnesses at this period were too readily regarded as a natural sequence to the process of dentition, while there now seems to be a tendency to ignore altogether the possibility that dentition and general disorders are related to each other as cause and effect.

In endeavouring to arrive at the actual facts of the case it is well to remember that weakly children, and more especially those that have been hand-fed, are prone to general disturbances, and that it is probable that local trouble in the mouth would tend to aggravate such conditions. Again, general disturbance occurring during teething is often wholly traceable to other causes; for example, gastro-intestinal troubles to defective feeding, convulsions to a similar cause, and respiratory affections and otitis media to the presence of adenoids. But, taking these facts into consideration, there still seem to be instances in practice where the general disturbance is coincident with dentition, and there is no known cause other than dentition with which to associate it.

[1] In compiling this section I have been greatly assisted by Dr. G. F. Still's work on "Common Disorders and Diseases of Childhood."

There is naturally extreme difficulty in placing dentition in causal relationship with such disorders, because we have to rely mainly on clinical observation ; but it seems only reasonable to assume that such a relationship does exist when the occurrence of a disorder not only coincides with dentition but has a special tendency to coincide repeatedly with the eruption of successive teeth.

In referring to this question, Dr. Still expresses the opinion that there is too great a tendency to assume that as dentition is a physiological process it is, therefore, incapable of causing disturbance of health. He points out that pregnancy is also a physiological process, and no one would deny that pregnancy may disturb the health in many ways. Dr. Still states that, with increasing experience, he is inclined to enlarge rather than to restrict his conception of the *rôle* which dentition plays in the production of disturbances of various kinds in infancy.

Clinical observation clearly establishes the fact that irritation often exists in the mouth during the period of eruption. In most cases the irritation is due to direct pressure of the tooth upon the superincumbent tissue. Dr. White, however, points out that the aperture at the end of the growing tooth is large, and undue resistance of the gum tissue would lead to pressure on the nerve trunks entering the pulp. Dr. White supports his view by clinical evidence afforded by cases in which there are no local signs of inflammation and in which constitutional disturbance disappears on lancing the gum.

The following general disorders may, in Dr. Still's opinion, *be traceable to dentition :—*

(*a*) Loss of appetite.

(*b*) Sleeplessness.

(*c*) Instability of the nervous system. Infants troubled with coming teeth often show a tendency to convulsive twitchings, upward rolling of the eyes, slight strabismus, although not losing consciousness. In children of neuropathic heredity, or, through rickets, predisposed to infantile convulsions or epilepsy, dentition appears to be distinctly a time of peril. Dr. Still has seen attacks of *petit mal* which were much aggravated by dentition and ceased when the last tooth was cut.

(*d*) Rise of temperature. This may occur without the presence of an inflamed condition of the gums, and is probably in

most cases purely reflex and analogous to not uncommon cases in which neurotic children will show a rise of temperature with any excitement, such as a visit to a pantomime; the rise of temperature with the worry of an erupting tooth is thus part of the induced instability of the nervous system.

(*e*) Attacks of vomiting sometimes occur, with little or no disturbance of the bowels, just before the appearance of a tooth.

(*f*) Bronchitis and diarrhœa. Although children are prone to these conditions, there are cases, nevertheless, which seem to be distinctly nervous and traceable to reflex influence from the teeth. That such a condition could exist is quite conceivable when we remember that the bronchial catarrh of the asthmatic child and the lienteric diarrhœa (the nervous diarrhœa of Trousseau) are admittedly dependent upon nervous influence, often quite remote from the organs affected.

(*g*) Violent screaming attacks without apparent cause, independent of any digestive disorder and not obviously due to any pain, are sometimes associated with dentition. This condition is, however, uncommon.

(*h*) "A rare disorder which is closely related to dentition is *spasmus nutans*, or head-nodding with nystagmus. This disorder is so distinctly coincident with dentition in its onset and cessation, and is so definitely aggravated by the eruption of a fresh tooth, that there would seem to be a causal relationship between the two."

Treatment.—The treatment of these conditions lies within the province of the general practitioner, but the dental surgeon may be consulted with a view to lancing the gums. This operation, if considered necessary, should be performed as follows: "A curved bistoury should be used, and, in order to prevent injury to surrounding parts, a strip of lint should be wrapped round the knife so that only ½ in. is exposed. The technique of the operation is quite simple. The child should be placed on a pillow on the lap of the nurse who should be seated on a chair opposite the operator and with her back towards the source of light which should come preferably from a north window. The operator should seat himself facing the nurse, with the end of the pillow supporting the child's head in his lap. He then can command the territory of operation, and, by holding the child's head,

guard against any sudden movement. The hands and the body of the child are to be firmly held by the assistant. The lancet is then passed through the overlying tissue until it is felt to come into contact with the enamel surface, and the tissue divided sufficiently to allow the tooth to erupt without resistance" (Kirk).

The best method is to make two semi-lunar incisions which meet at their extremities, and remove the intervening portion of gum with a pair of tenaculum forceps. Objection is raised to the use of the lancet when the tooth is still some distance from the surface, on the ground that the cicatricial tissue offers a greater bar to the progress of the tooth. This objection is untenable, as cicatricial tissue is of a lower degree of organization than normal fibrous tissue and therefore more easily disintegrated by pressure.

(2) Local

Simple Stomatitis.—The stomatitis is usually limited to the neighbourhood of the erupting tooth, and is characterized by intense redness and swelling, the mouth at the same time being hot, the child fractious, restless, and in evident pain. The temperature may reach 104° or 105° F.; but it should be remembered that pyrexia in children readily supervenes upon slight causes.

Ulcerative Stomatitis.—In these cases the gums become hot, swollen, and painful, and these symptoms are especially marked over a certain tooth. Ulceration supervenes, and may extend to the gum around any other tooth already erupted. The ulcers thus formed have a sloughy appearance, the breath is fœtid and hot, the flow of saliva is increased, and the child rejects its food. In addition, there is marked pyrexia, and at times gastro-intestinal disturbance. Ulcerative stomatitis is due to local infection, and may often be traced to dirty feeding bottles or neglect of oral hygiene. It is interesting to note that as greater care in such matters is exercised in dealing with oral hygiene, the local disturbances associated with dentition decrease.

Treatment.—Treatment of the local condition consists in giving strict attention to the hygiene of the mouth and the application to the gums of hydrogen peroxide; a brisk purge should also be given. In cases where the ulceration shows signs

of spreading, the application of an escharotic is advisable. The patient should be isolated.

Superficial Cysts.—Small cysts are occasionally met with over erupting teeth. They do not in any way obstruct eruption, and, on being punctured, give forth a small amount of clear fluid. These cysts are lined with "epithelium many layers thick, spheroidal at the growing periphery, and tending to become stellate on the cyst side" (J. G. Turner). Occasionally, the cyst is of abnormal size, indeed, sufficiently large to attract the attention of parents. Under these conditions, puncturing does not, as a rule, bring relief, and it is necessary to remove the gum covering the tooth.

The local disturbances accompanying eruption of the permanent teeth are mainly confined to the third molars, especially the mandibular. When a molar tooth erupts the anterior cusps appear first, and the small portion of gum which lies over the posterior part of the tooth occasionally ulcerates from constant pressure of the antagonizing tooth. The ulceration may become extremely painful and the adjacent tissues may become involved. The patient complains of pain in the region of the fauces, but perhaps the most tender point is where the mucous membrane of the gum becomes continuous with that of the cheek. This condition is best relieved by free incisions, care being taken that the knife divides all the tissues overlying the buccal surface of the tooth. Should this treatment not bring relief, it is advisable to remove the process of gum that is covering the tooth; this can be accomplished with the scalpel and forceps. In addition, fomentation of the mouth inside should be advised, and hot water at a temperature just bearable is perhaps as comforting an application as any, although decoction of poppy-heads is often to be recommended, the opium contained in the poppies acting as a local anodyne. The ulcerated surface should be freely swabbed with hydrogen peroxide. Suppuration may supervene, and in that case the offending tooth must be removed, otherwise trismus may occur. The trismus is said to be produced in most instances by spasm of the masseter muscle, due to reflex irritation; but it is more than probable that it is generally caused by spread of inflammation to adjacent tissues. The insertion of the temporal and pterygoid muscles and the intervening cellular

tissue may, by a process of continuity of inflammation, become affected, and produce closure of the jaws. The latter explanation of the occurrence of the trismus also seems to be more in harmony with the clinical aspect of the majority of cases met with, for, in nearly all of them, the patient is able to effect slight movement in the articulation, which would not be possible if the trismus were due to tonic spasm of the masseter muscle. Moreover, the mobility of the articulation increases as the inflammatory symptoms subside. It appears probable, therefore, that in most cases of trismus the condition is to be attributed to the inflammatory process, but no doubt instances may occur where the closure of the jaw is due to a tonic spasm of the muscles of mastication. The treatment of the above condition is to remove the erupting tooth.

Mandibular third molars, when impacted, may give rise to severe odontalgia in the second molar, the pressure from the erupting tooth causing absorption of the posterior surface of the second molar, leading to exposure of its pulp. The absorption in these cases is not due to the pressure of the crown of the third molar against the cementum or enamel of the second, but to multi-nucleated cells which are developed at the point of contact, and which perform the function of osteoclasts in removing the obstructing tissues. In these cases the second molar should be removed. For further reference to misplaced third molars see chapter vii.

(B) RETARDED ERUPTION

Rachitis.—In children suffering from rickets, the eruption of the teeth is sometimes considerably retarded, and it is not uncommon for the advent of dentition to be delayed until the commencement of the second year. Retarded eruption of the permanent teeth is also met with in those who have suffered from rickets in infancy. A case of this character is shown in figs. 20 to 23. The patient was a female, aged 14, and had been the subject of prolonged rickets in infancy. The retarded eruption in rickets is attributed by some observers to thickening of the tooth sac. The fact that fibrous odontomes are formed in rickety animals supports this view (see chapter xxii.).

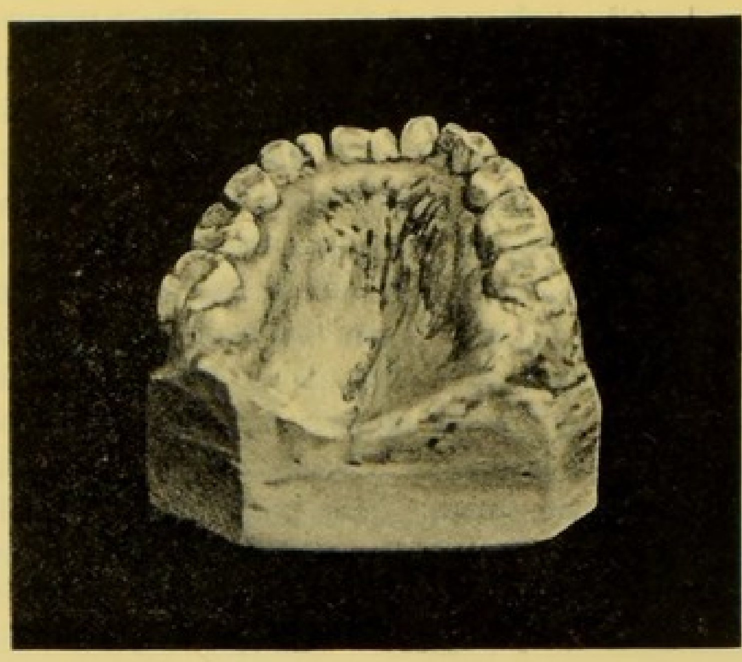

FIG. 20.—Model of maxillary teeth. The only teeth of the permanent series erupted are the first molars. A conical-shaped supernumerary tooth is present between the deciduous central incisors.

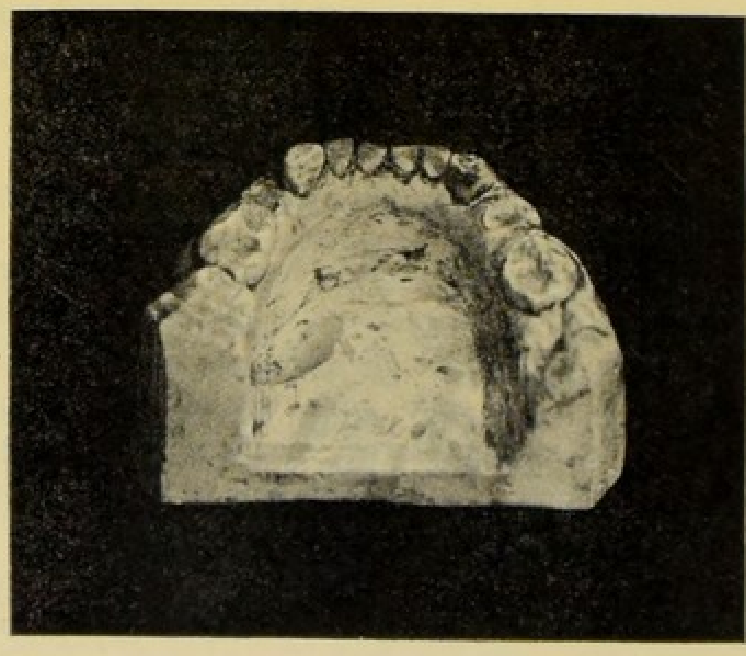

FIG. 21.—Model of mandibular teeth. The only teeth of the permanent series present are the first molars.

The specimen shown in fig. 24 would seem to throw some light on the subject. The animal, a cat which died at the age of three years, had suffered from pronounced rickets. The only teeth present in the mouth at the time of death were an incisor

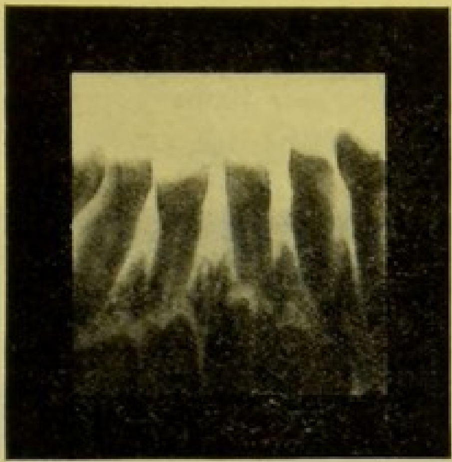

FIG. 22.—Radiograph showing the unerupted mandibular incisors.

FIG. 23.—Radiograph showing the unerupted mandibular premolars.

in the maxilla and an incisor in the mandible, the cusps of a premolar and a molar in the maxilla and a molar in the mandible had also appeared.

In removing the outer alveolar plate to expose the teeth, considerable difficulty was experienced. The bone bordering the oral cavity was of a hard, compact nature, and the premolars instead

of resting in crypts were found to be welded as it were to the bone, the latter being quite ivory-like in character. The maxillary canine rested in a crypt, but the borders of this were of a hard, compact nature.

Syphilis.—The general effect of syphilis on eruption is to delay the process, but in a few instances syphilis may accelerate eruption.[1] (For further details of the effect of syphilis on dentition see p. 89.)

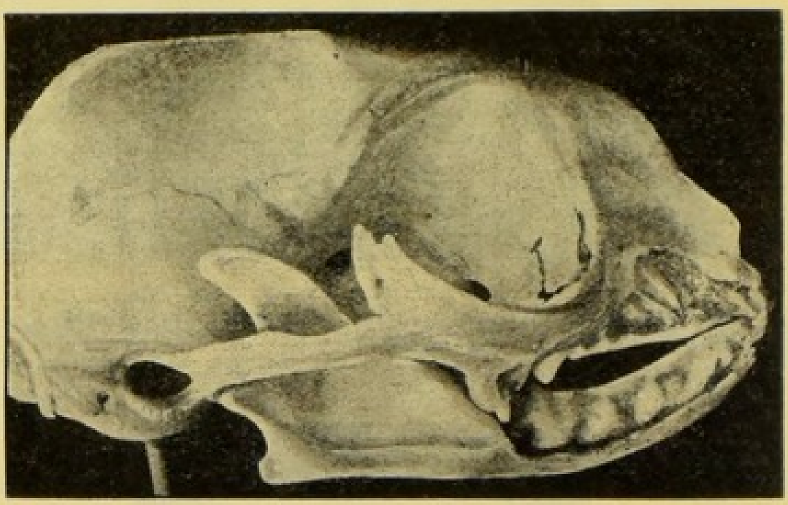

FIG. 24.[2]

Idiocy.—The teeth of micro-cephalics and cretins are usually small, and eruption is considerably delayed. In cretins the eruption of both the deciduous and permanent dentition is often delayed and may also commence irregularly, though in the subsequent growth of the permanent series the trend is towards eventual perfection of the dentition.

It is interesting to note that the administration of thyroid extract, which assists growth in general, also promotes the eruption of the teeth. In cases where no general improvement follows the administration of thyroid, there is no effect on dentition.[3]

[1] See article by Dr. Cavallaro on "Syphilis in its Relation to Dentition," *Cosmos*, November, 1908, to February, 1909.

[2] From *Trans. Odonto. Soc.*

[3] "Teeth of Micro-cephalics and Cretins," by J. G. Turner, *Trans. Odonto. Soc.*, vol. xxxiv, p. 1

Retardation in the Eruption of Individual Teeth.—Occasionally it is found that dentition has occurred normally with the exception of individual teeth which appear only after a considerable interval.

In the maxilla the eruption of the canine may be delayed until the twentieth to twenty-fifth year. Cases occur in which the canine teeth do not appear until quite late in life. Retarded eruption of the canines is much more common in the female than in the male, and is met with in the well-to-do more frequently than in the less favoured classes. The premolars are, at times, retarded in their eruption. In one patient under observation the second right maxillary premolar did not appear until the age of 35. The third permanent molar is frequently retarded and may erupt at any time.

In the mandible the first and second premolars are frequently retarded in their eruption, and the appearance of these teeth may be delayed for two or three years. The second is more frequently retarded in its eruption than the first premolar. The mandibular third molar may erupt at any time after puberty. In one case under observation the right mandibular lateral incisor did not appear until the fourteenth year.

When a tooth appears late in life the process must be looked upon not as an eruption but as an uncovering of the tooth through atrophy of the superincumbent tissues.

(C) PARTIAL ERUPTION

In the deciduous series, a partial eruption of the molars is occasionally seen and is not infrequently associated with a history of rachitis. Under these conditions, the molars occlude, but the upper incisors may overlap the lower teeth so as to impinge on the gum. With the eruption of the first permanent molars, the "bite" becomes more open and a space is formed between the deciduous molars as seen in figs. 25 and 26.

This partial eruption of the deciduous molars may be limited to the first molars, so that with the eruption of the second molars a space will exist between the first molars.

In the permanent dentition partial eruption of the premolars may occur, and in such cases there is frequently a history of retarded eruption. In a specimen of partially erupted molars

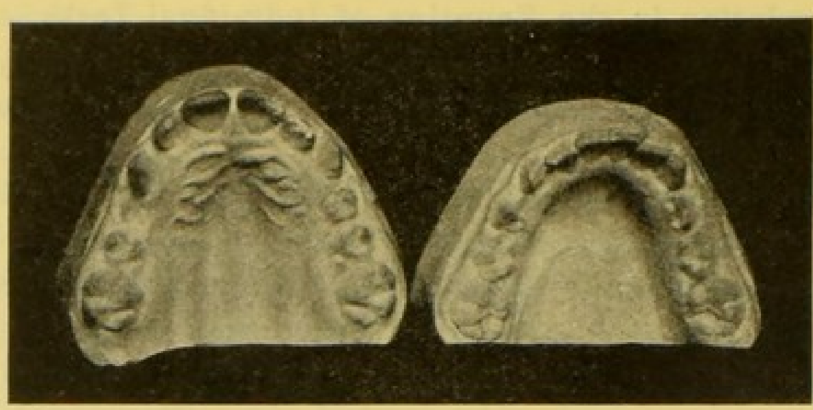

Fig. 25.[1]

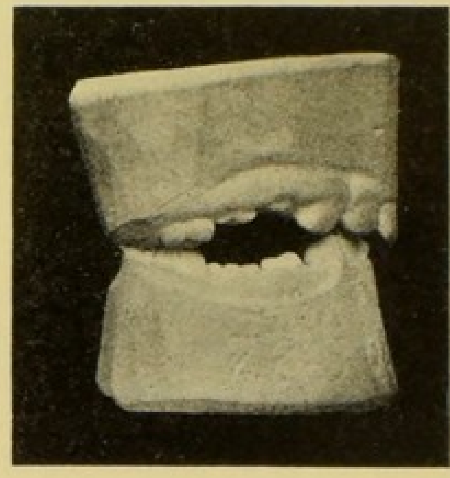

Fig. 26.[1]

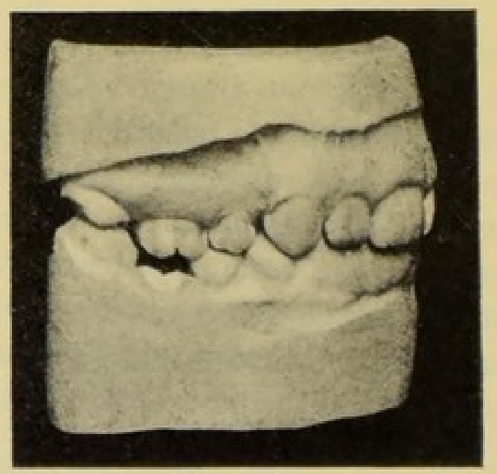

Fig. 27.

[1] From *Proc. Roy. Soc. Med.*

contained in the Museum of the Royal College of Surgeons, the right mandibular molars are barely erupted, the remaining teeth being normal.

In fig. 27 is shown a case where the right first mandibular molar was partially erupted.

(D) IMPEDED ERUPTION

This condition may arise in a variety of ways. The obstructing agent may be a supernumerary tooth, or a persistent deciduous tooth which has become wedged between the approximal teeth owing to the latter having inclined towards each other.

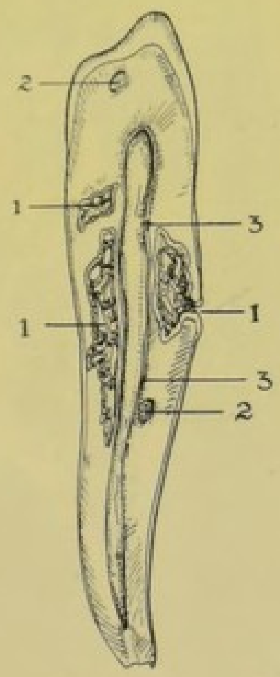

Fig. 28.[1]—1, absorption areas well marked; 2, absorption areas commencing; 3, secondary dentine.

Geminated deciduous teeth may act as impediments, and a case has been seen in which the mandibular central incisor was prevented from erupting because absorption had taken place only at that part of the root corresponding to the deciduous central incisor, leaving the portion of the root corresponding to the lateral incisor firmly imbedded and unabsorbed.

[1] By permission from Ash's *Quarterly Circular*.

(E) PATHOLOGICAL CHANGES IN RETAINED TEETH

Teeth which have been retained or have been hindered in their eruption often show pathological changes in their structure. The change consists in an absorption of the dentine and a

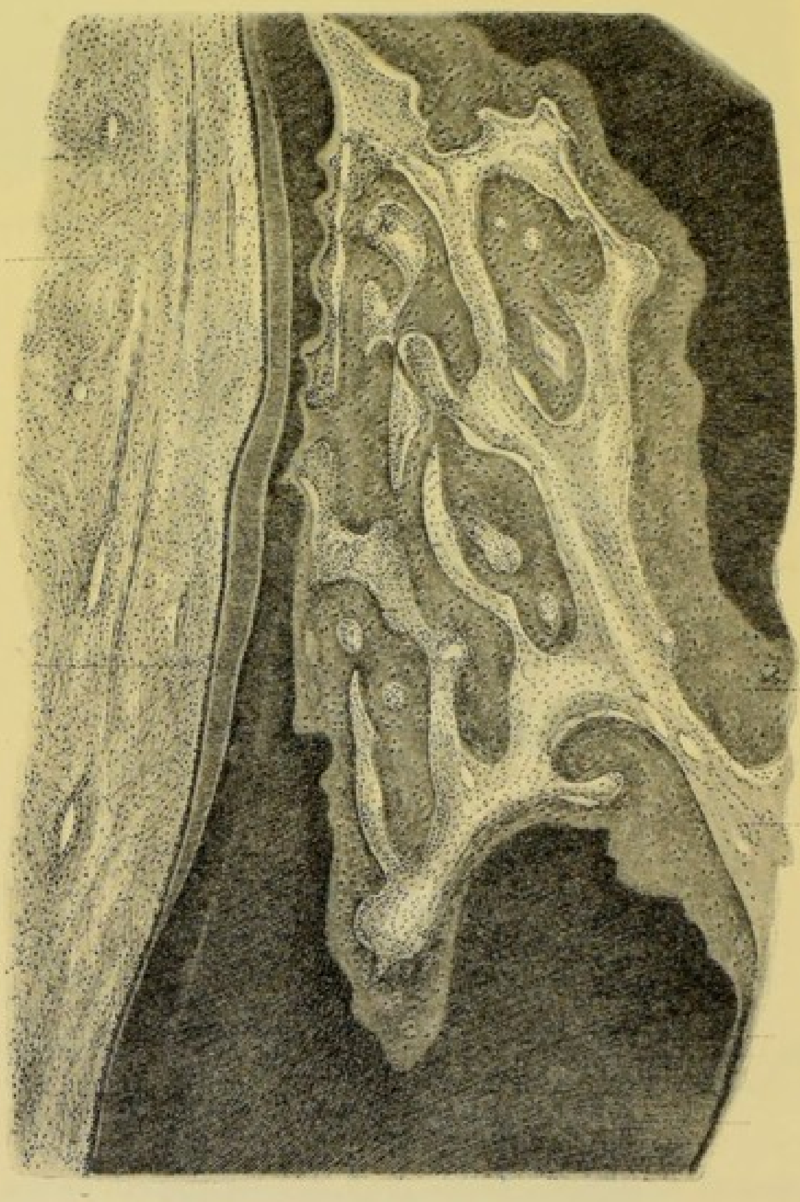

FIG. 29.[1]

replacement of the lost dentine by tissue of an osseous character. A case illustrating these changes is described by Prof. Williger.[2]

[1] Copied by permission from Ash's *Quarterly Circular*.

[2] Translated in Ash's *Quarterly Circular*, January, 1909, from the *Correspondenz-Blatt für Zahnheilkunde*.

A maxillary unerupted canine was removed, and on section showed spots as if the dentine were perforated (fig. 28).

Microscopical examination showed that the dentine had been absorbed and in great measure replaced by osseous tissue (fig. 29). The absorption was due to a growth of tissue from the periodontal membrane and not from the pulp. The presence of secondary dentine on the walls of the pulp canal showed that the pulp had reacted in the same manner as in other injuries of the dentine.[1]

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[1] In connection with this subject, see papers by A. Hopewell-Smith, *Proc. Roy. Soc. Med.*, vol. iii (Odonto. Sec.), p. 9; and by J. F. Colyer, *Trans. Odonto. Soc.*, vol. xxv, p. 66.

CHAPTER III

Variations of the Teeth

Variations in Size—Variations in Number—Variations in Shape—Anomalous Teeth

(A) VARIATIONS IN SIZE

SERIES of teeth vary considerably in size, as illustrated by fig. 30.

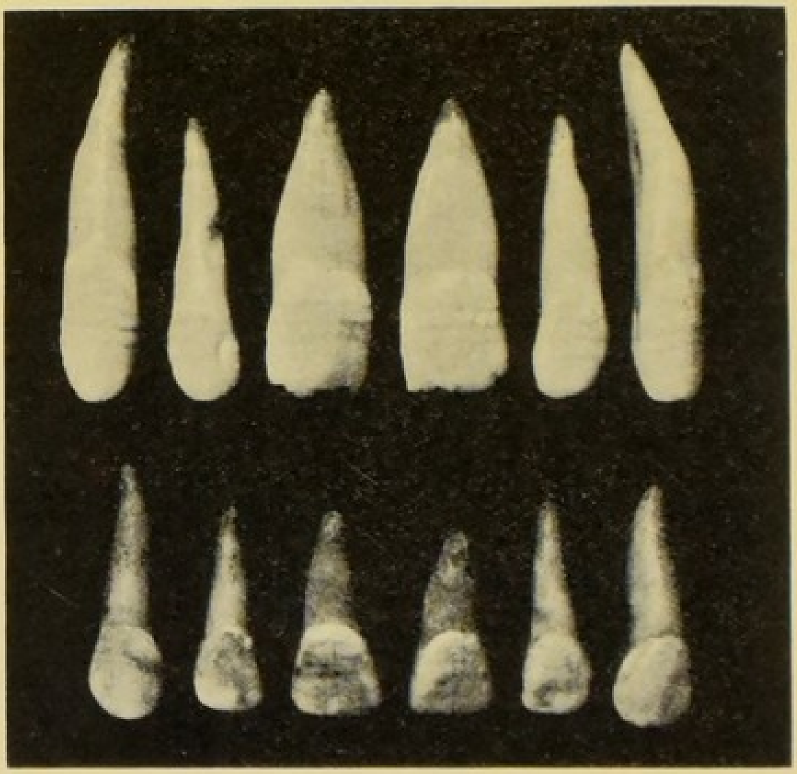


FIG. 30.

As a general rule the individual teeth comprising a series bear a definite relationship in size to one another. Occasionally, however, this relationship is disturbed, and one or more teeth

will be found to be disproportionately large or small in comparison with the rest of the series.

(1) **Permanent Dentition.**—In the permanent series, the tooth which is most frequently developed to an **abnormally large** size (fig. 31) is the maxillary central incisor. Such teeth should not be mistaken for a central incisor geminated with a supernumerary incisor. The second mandibular premolar and the second mandibular molar are, occasionally, abnormally large.

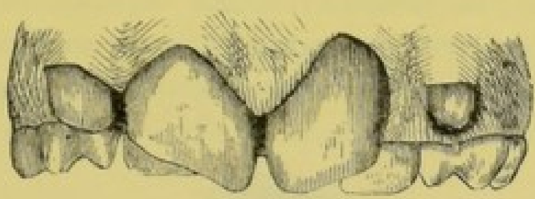


FIG. 31.[1]

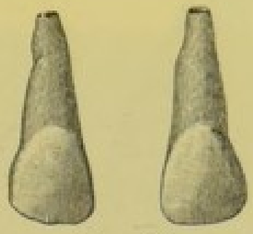


FIG. 32.

FIG. 33.

Diminution in size occurs mostly with the lateral incisors. These teeth may also be modified in their shape, and, in extreme cases, are represented by simple cones; occasionally, however, they may be abnormally large, as shown in fig. 32. The maxillary third molar, like the lateral incisor, is often dwarfed and modified in shape (see fig. 33).

(2) **Deciduous Dentition.**—The maxillary canine or mandibular molar may be proportionately larger than the other teeth. Such teeth have no particular interest unless they persist, in which case it is sometimes difficult to distinguish them from the permanent teeth. If, however, care is taken in the examination of the mouth, and the history of former extractions is ascertained, no error is likely to arise. A deciduous canine can generally be distinguished from a permanent one by:—

[1] From "Manual of Dental Surgery," by A. Coleman.

(i.) The abrupt termination of the enamel at its neck.

(ii.) Its having undergone some attrition of the cutting edge.

(iii.) Its being smaller, in proportion, than the permanent teeth.

(iv.) The enamel, which is usually translucent.

A second mandibular deciduous molar may be distinguished from a permanent one by :—

(i.) The abrupt termination of the enamel at its neck.

(ii.) The absence of the second premolar.

It will, also, be generally found wedged between the first premolar and the first permanent molar, and on a lower level than either of the teeth between which it is wedged.

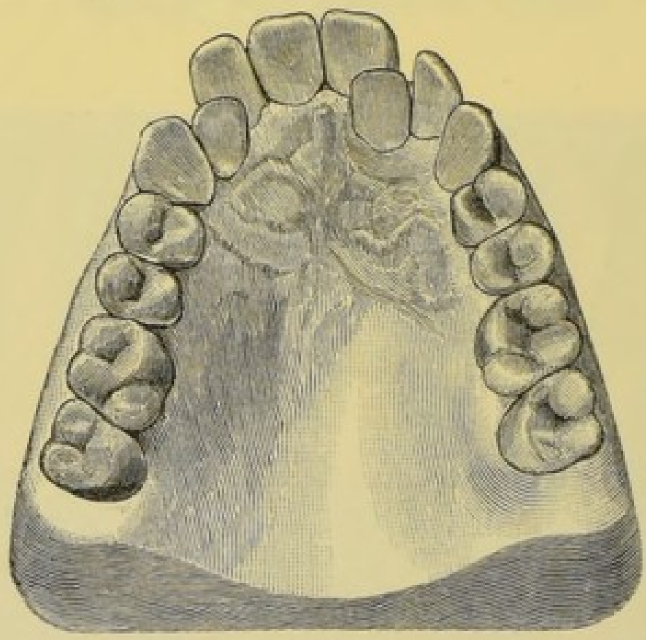


FIG. 34.—Model showing two supernumerary incisors.

(B) VARIATIONS IN NUMBER

(1) Permanent Dentition.—Variations from the normal number of teeth may be classified :—

(*a*) Excess in number.

(*b*) Deficiency in number.

(*a*) **Excess in Number.**—Any tooth in addition to the normal number is known as a supernumerary tooth. Supernumerary teeth may be divided into two distinct groups :—

First. Those resembling normal teeth in shape and character.
Second. Those abnormal in form.

In the first class, normal in shape, the tooth usually resembles a lateral incisor, less frequently a premolar, or a molar, and, in very exceptional cases, a canine. These teeth, as a rule, are found in the neighbourhood of the tooth they simulate. More commonly they occur in the maxillary lateral incisor region, but an extra incisor or incisors in the mandible is by no means rare. In the maxillary incisor region they are generally either larger or smaller than those in the normal position; the condition is often symmetrical (fig. 34). A model showing a supernumerary incisor with the central incisor geminated with another tooth is shown in fig. 35.

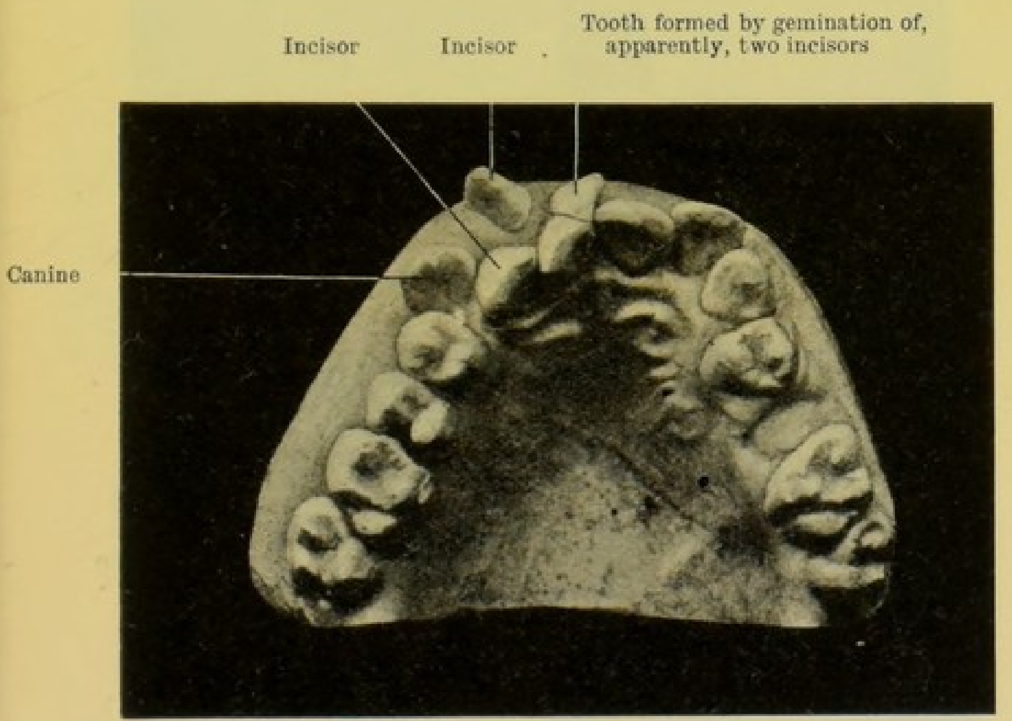


Fig. 35.—A model showing a supernumerary incisor with the central incisor geminated with another tooth.

An extra incisor is often seen in cases of cleft palate, the extra tooth being situated on the mesial side of the cleft. The usual arrangement of the teeth in cleft palate cases is, starting from the median line, central incisor, cleft, badly formed tooth,

canine. The badly formed tooth is always situated in front of the canine, and has been termed the pre-canine. It is the

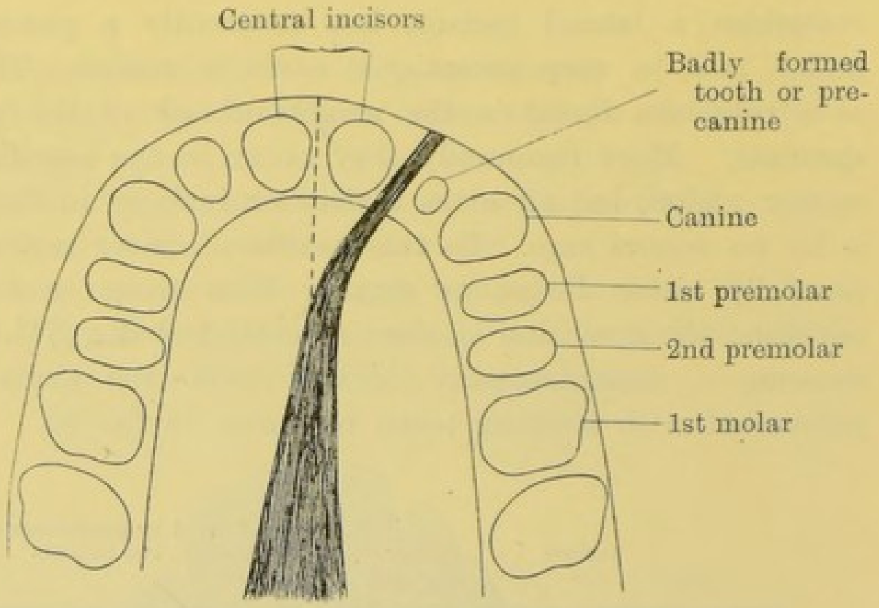


FIG. 36.—Usual arrangement.

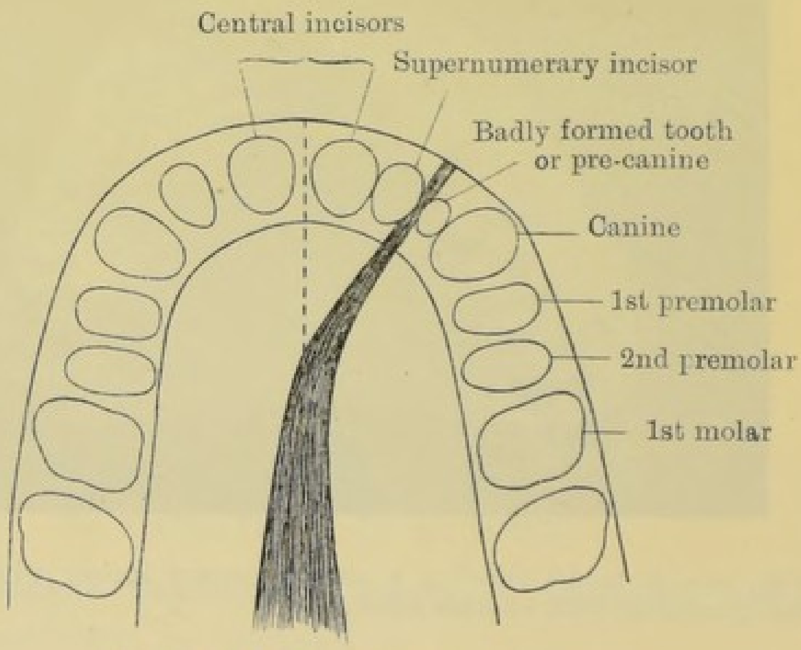


FIG. 37.—Unusual arrangement.

representative of an incisor. When a third tooth is present it is often well formed, and situated on the mesial side of the cleft (see figs. 36, 37, 38).

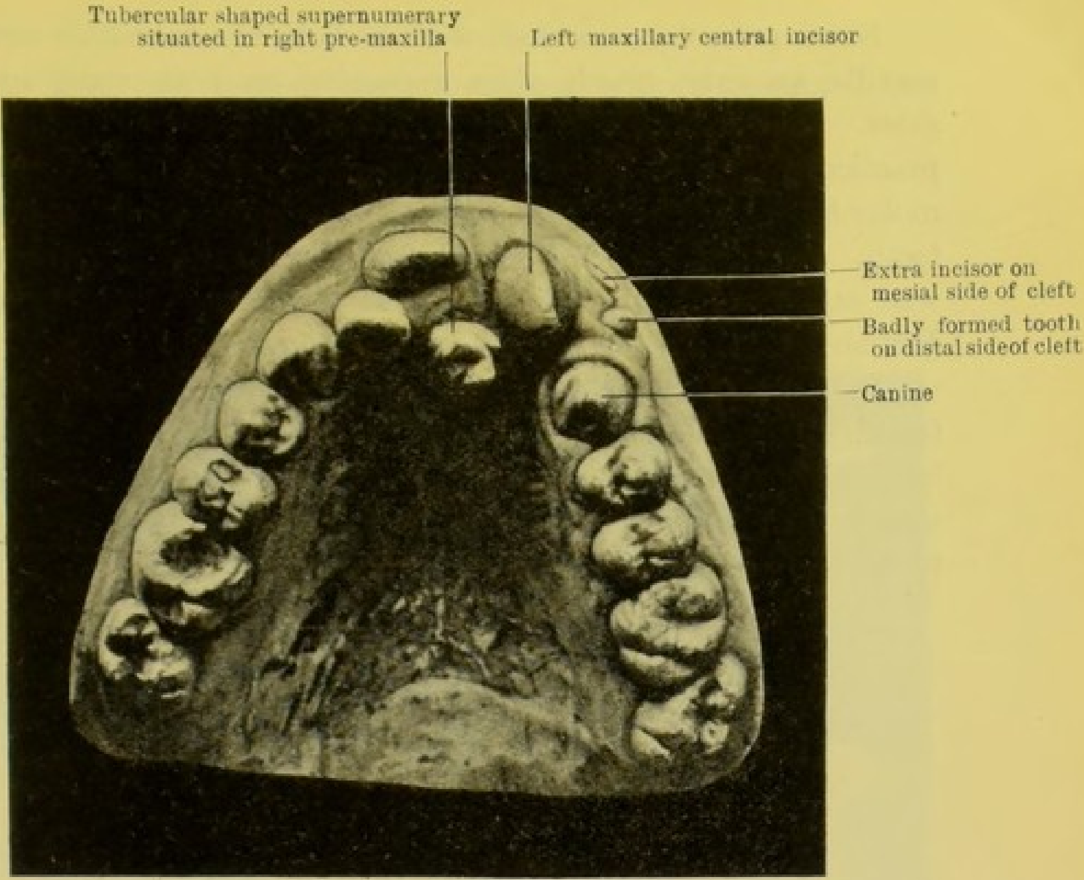

Tubercular shaped supernumerary situated in right pre-maxilla
Left maxillary central incisor
Extra incisor on mesial side of cleft
Badly formed tooth on distal side of cleft
Canine

Fig. 38.

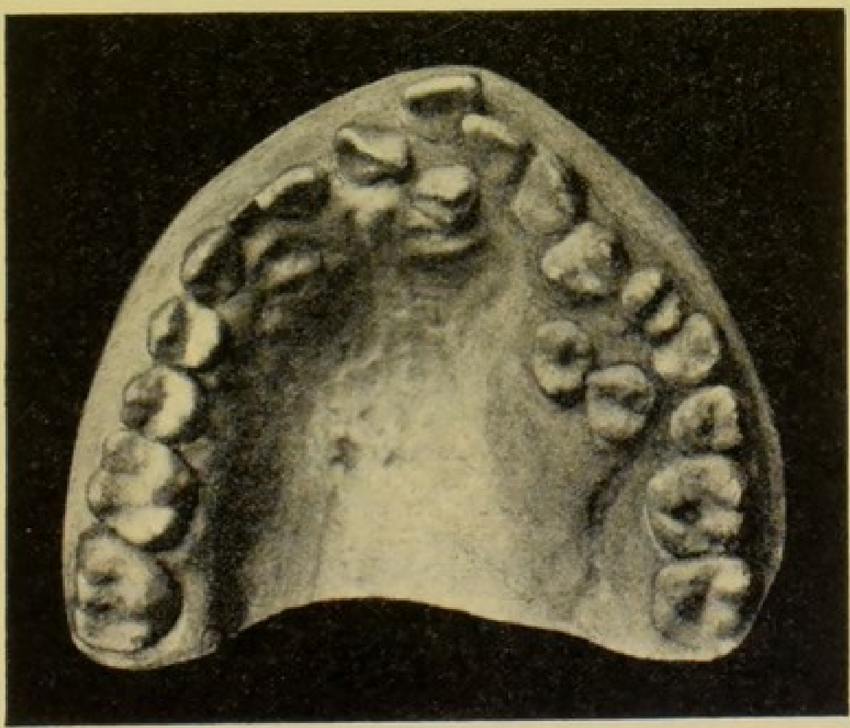


Fig. 39.

Extra premolars are met with in both the mandible and the maxilla, an extra tooth often appearing on both right and left sides. In a remarkable case (fig. 39) which occurred in the practice of Mr. C. Handley, there were no less than six premolar teeth on one side, in addition to two other supernumerary teeth. A model showing five mandibular premolars on one side was exhibited by Mr. P. Linnell at the annual meeting of the British Dental Association held in Manchester, 1892.

In the molar region the additional tooth is usually to be found in the situation of the third molar, erupted either internally or externally to the arch. The additional tooth is usually diminutive in size, and it is by no means uncommon to find the third molar also dwarfed in character.

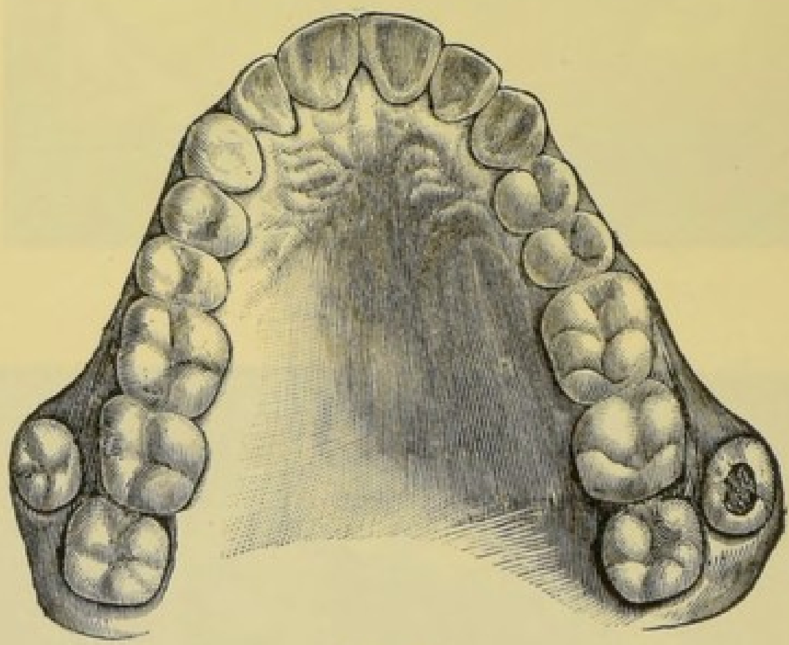


FIG. 40.[1]

Fig. 40. This case was reported in the *Dental Cosmos*, December, 1891. The patient was a man aged 41; the supernumerary teeth had erupted at the age of 35.

Supernumerary molars in the mandible are rare.

A unique case of supernumerary teeth is recorded by Cope.[2] The following was the dental formula :—

[1] From *Dental Cosmos*.

[2] *Journ. Brit. Dent. Assoc.*, vol. vii, p. 254.

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

The first two molars were furnished with accessory lobes. A brother of this patient had—

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

and a sister—

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

a grandmother had—i. $\tfrac{5}{4}$.

Fig. 41.—Varieties of supernumerary teeth.

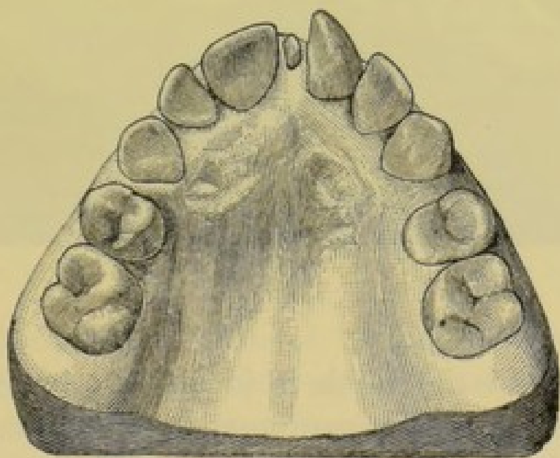


Fig. 42.—Conical supernumerary tooth between the two central incisors.

In the second class, abnormal in shape, many varieties are met with (fig. 41), but they may for convenience be grouped

into two principal types—namely, the conical and the tuberculated (figs. 42, 43).

The *conical supernumerary teeth* are usually met with between the maxillary central incisors; more rarely they appear between the central and lateral incisors, or between the latter tooth and the

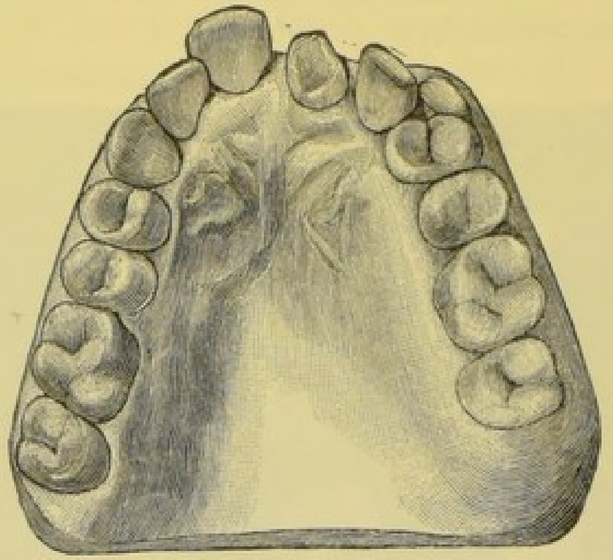


FIG. 43.—Tuberculated supernumerary tooth replacing central incisor.

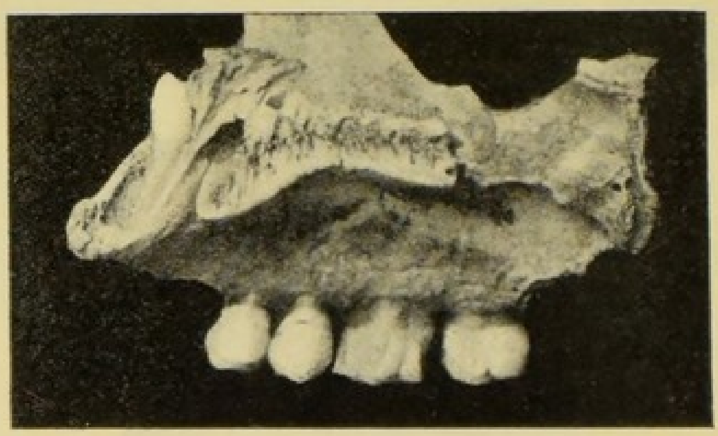


FIG. 44.

canine. In fig. 44 the tooth is in an inverted position in the bone. The cone-shaped supernumerary may erupt posterior to the incisor, and occasionally two extra teeth may be present, one in the left premaxilla, and the other in the right premaxilla.

These cone-shaped teeth are also found in the molar region, and at times appear as accessory cusps, being geminated with

the molars. A rare condition is where an extra tooth is present between the mandibular first and second molars on either side, and in a specimen in the Museum of the Royal College of Surgeons two small teeth are present in the position of the left måndibular first molar; these teeth having appeared after the removal of the first and second molars. In the specimen shown in fig. 45 three small cone-shaped teeth occupy the position of the right mandibular canine; and Dr. E. Urbantschitsch[1] records

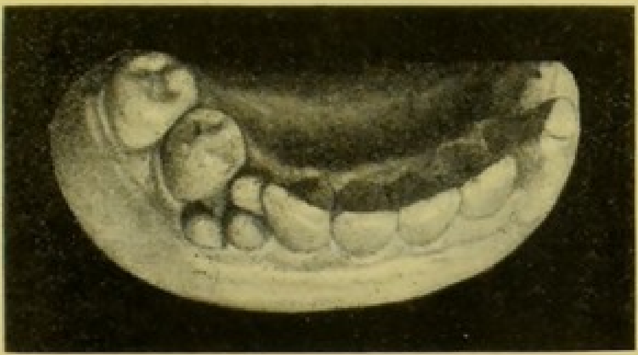


FIG. 45.

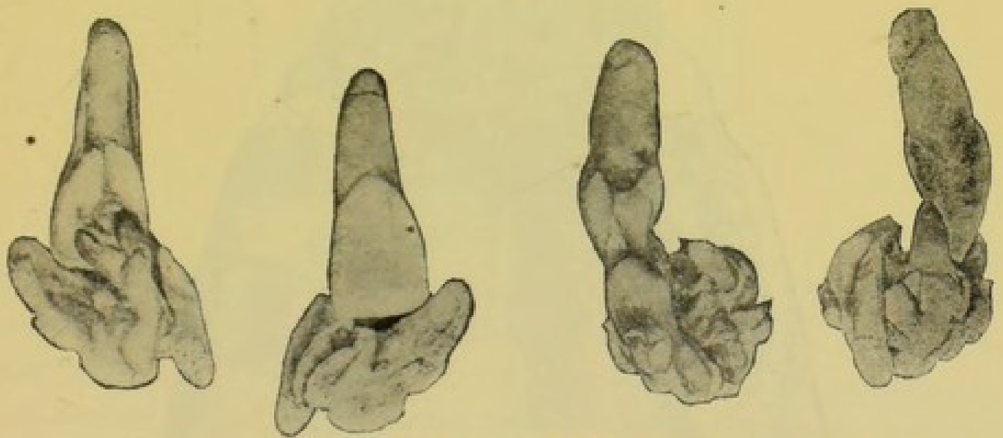


FIG. 46.[2]—Kirk.

Four different views of the normal incisor, with its group of supernumerary satellites, in their correct relative position to one another.

a case where seven small teeth of varying size erupted in the region of the right maxillary lateral and canine. Cone-shaped supernumerary teeth are met with, although rarely, between the upper deciduous central incisors.

[1] Ash's *Quarterly Circular*, October, 1908. Translated from the *Oesterreich-Ungarische Vierteljahrsschrift für Zahnheilkunde.*

[2] From *Dental Cosmos.*

A case is recorded by E. C. Kirk[1] in which thirteen small supernumerary teeth occupied the position of the left maxillary central incisor which was unerupted (fig. 46). Dr. Huey also

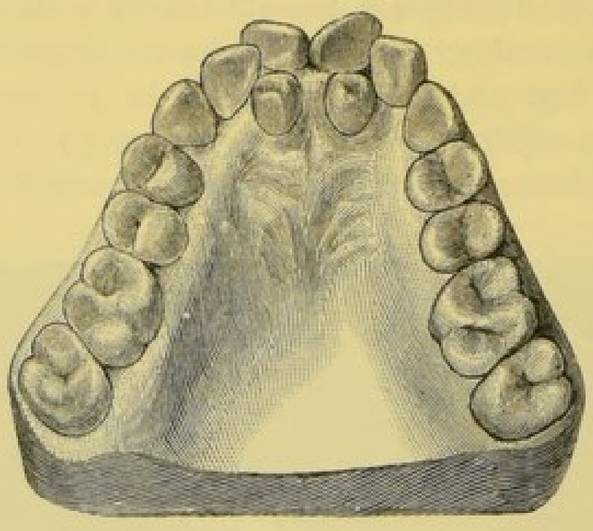


Fig. 47.—Two supernumerary teeth immediately posterior to the central incisors.

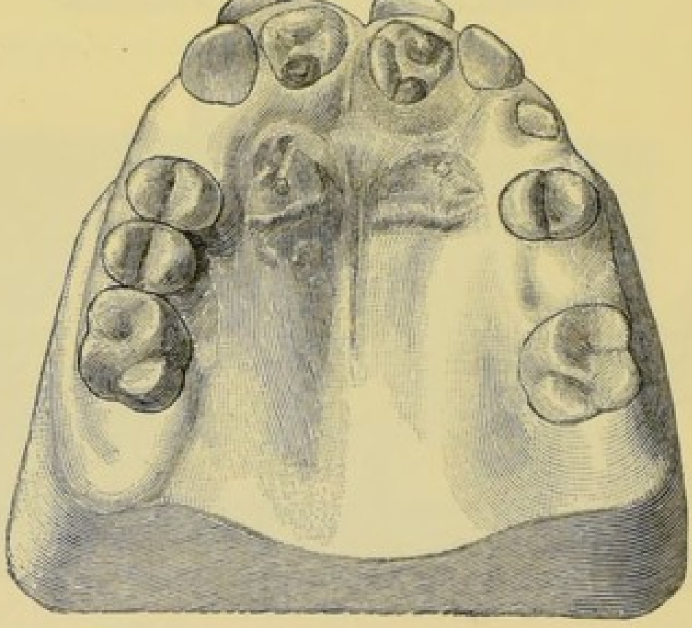


Fig. 48.—Two tuberculated supernumerary teeth immediately posterior to the central incisors.

records a case where thirty-five teeth were present in the bone in the same situation.

The *tuberculated varieties* usually appear on either side of

[1] *Dental Cosmos*, April, 1898, p. 281.

the median line, immediately posterior to the upper central incisors which may be displaced. They are frequently symmetrical, and give rise to a well-defined variety of irregularity (figs. 47 and 48).

The case shown in fig. 49 is of interest, and is copied from the *Dental Cosmos*. The supernumerary here was quite free from the molar.

It is extremely rare for abnormally shaped supernumerary teeth to have more than one root. A conical supernumerary tooth with two roots is shown in fig. 50.

Relation of Supernumerary Teeth in the Deciduous Dentition to those in the Permanent Dentition.—A few examples of supernumerary teeth in the deciduous dentition being followed by a similar condition in the permanent series have been recorded. In the *Transactions of the Manchester Odontological Society* (vol. iv, No. 6), Mr. George Whittaker reports a case

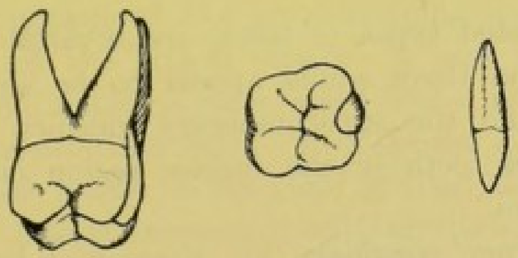


FIG. 49

where two deciduous supernumerary mandibular incisors were followed by permanent supernumerary teeth. A similar case has been recorded by Mr. J. Ackery. Mr. A. Drake[1] records an instance where an extra permanent lateral incisor was preceded by geminated deciduous central and lateral incisors. Such cases are, perhaps, more common than is generally thought, and the comparative rarity of recorded cases is no doubt due in a great measure to the fact that children are seldom seen by the dental surgeon until after the loss of the deciduous incisors. Some statistics showing the frequency with which supernumerary deciduous teeth are followed by supernumerary permanent teeth, and geminated deciduous teeth by geminated permanent teeth, would be both interesting and instructive.

[1] *Dental Record*, December, 1904, p. 555.

4

Origin of Supernumerary Teeth.—It is difficult to account for the presence of supernumerary teeth. The ordinary cone-shaped variety appears in two situations, namely, the median line towards the front of the mouth and in the region of the molars. In these regions masses of epithelium, called epithelial pearls, are frequently met with, and Mr. Bland Sutton suggests that the same tissues which develop them also give origin to the cone-shaped variety of supernumerary teeth.

FIG. 50.—A conical-shaped supernumerary tooth with two roots. From the Museum of the Victoria Dental Hospital.

The tuberculated types of teeth are invariably found in the incisor region, and there would appear to be some relationship between them and the supernumerary incisors. The frequent presence of extra teeth in the incisor region is attributed, by some, to "atavism."

Mr. J. G. Turner[1] considers that there may be a relationship between supernumerary teeth and the developmental fissures in the face and neck.

Dr. W. H. Duckworth has drawn attention to the occurrence in human crania of small dental masses which appear in the alveolar process of the maxilla, and are nearly always found between the last premolar and the first molar. He discusses the possibility that these dental masses are the remains of deciduous teeth, and against this view he points out (1) that they rarely occur in the mandible; (2) that the various races of man present these appearances in altogether different degrees; and (3) that they occur systematically on both sides of the palate with comparative frequency. He inclines to the view that these fragments represent aborted teeth.

[1] *Trans. Odonto. Soc.*, vol. xxxii, p. 33.
[2] *Ibid.*, vol. xxxix, p. 58.

Treatment.—Supernumerary teeth, abnormal in shape, frequently appear before the permanent teeth. They should be removed as soon as they are recognized. In cases, however, where their presence has been overlooked and a crowded condition of the teeth has resulted, it may be advisable, under certain conditions, to retain them.

(*b*) **Deficiency in Number.**—Deficiency in number may vary from a single tooth to the whole series.

The commonest condition is that in which only **one or two teeth** are absent. The maxillary laterals are, perhaps, most frequently missing; after these, the second mandibular premolars and the maxillary third molars. With regard to the absence of the last-named teeth, in all suspected cases care must be taken to ascertain that the teeth supposed to be first and second molars are not in reality second and third molars, the first having been lost at an early age.

The absence of a lateral incisor on one side is often associated with mal-development of the corresponding tooth on the other side. Absence of the lateral incisors is met with in skulls of semi-civilized and barbaric races, and Wright[1] records such a case in the skull of a neolithic man. R. Clement Lucas[2] states that hare-lip and cleft palate in the child is often associated with the absence of the lateral incisors or with an ill-developed incisor in one of the parents.

The absence of the third molars would appear to be more common in highly civilized than in primitive races. Absence of the mandibular central incisors is a rare condition.

Persistence of the deciduous canine is met with in a large number of patients, mostly females. In these cases the permanent successor is frequently present, but situated in an erratic position. The congenital absence of a tooth or teeth can only be determined by means of the X-rays. **The whole group of incisors,** maxillary and mandibular, may be absent, occasionally the premolars, and very rarely the molars. Only one example of absence of molars has come under my notice. Several cases have been reported where a **large number of the permanent teeth** are absent; in these patients the first molars are usually present on either side

[1] *Proc. Roy. Soc. Med.*, vol. ii (Odonto. Sec.), p. 3.

[2] *British Journal of Children's Diseases*, November 19, 1904.

in maxilla and mandible, and one or two badly shaped teeth in the incisor region (fig. 51). In a case reported by Mr. Ackery[1] in a woman, aged 24, only six permanent teeth were present—namely,

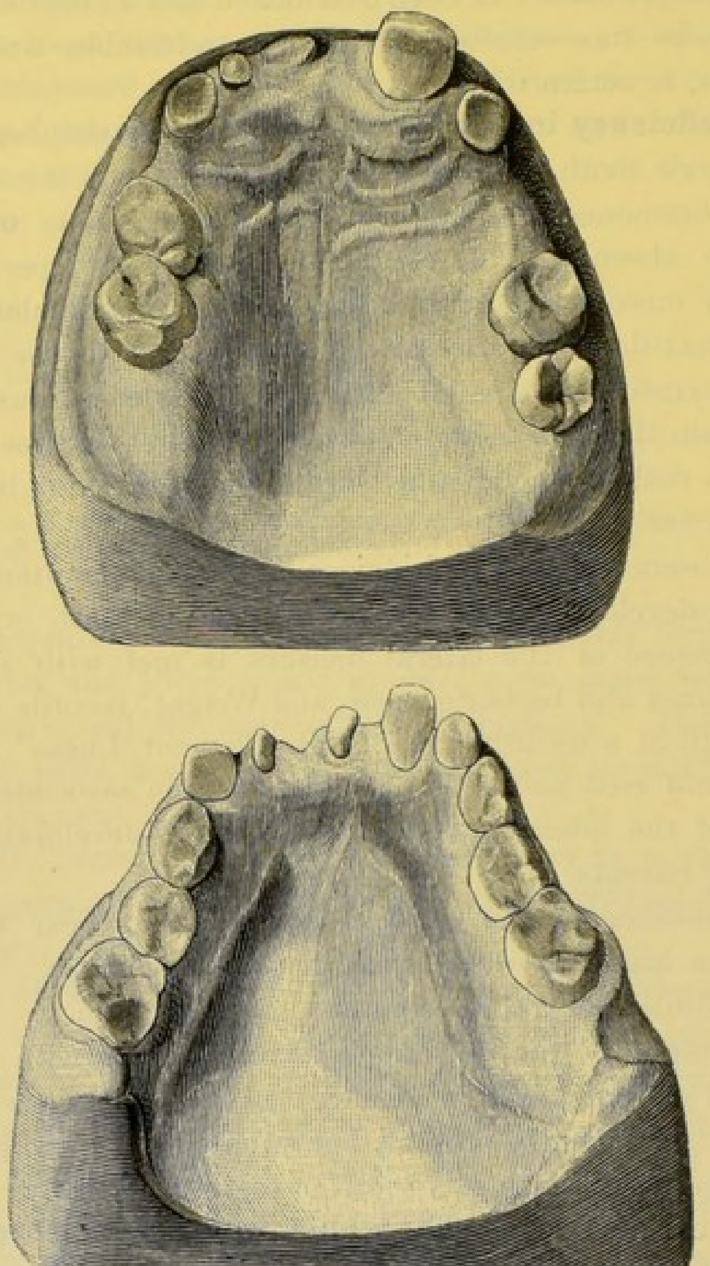


Fig. 51.—Models showing deficiency in number of permanent teeth. The patient was a man, aged 35.

in the maxilla the central incisors and first molars; in the mandible the first premolars. In two boys, twins, aged 16, seen

[1] *Trans. Odonto. Soc.*, 1891, vol. xxiv, p. 40.

by Mr. T. Clarence, there was marked deficiency of permanent teeth in both patients. Their dentitions were—

$$\begin{array}{r|l} 76\ \ 4\mathrm{c}\ 1 & 1\ \mathrm{c}45\ 7 \\ \hline 6\ \ \mathrm{dcba} & \mathrm{abc}\ \ \mathrm{e} \end{array} \quad \text{and} \quad \begin{array}{r|l} 76\ 4\mathrm{c}\ 1 & 1\ \mathrm{c}4\ 67 \\ \hline \mathrm{dcba} & \mathrm{abc} \end{array}$$

One of the most interesting cases is recorded by Dr. Jarre.[1] In this patient there were no deciduous teeth until fifteen months, when a tooth appeared on the maxilla on the left side of the median line. This tooth was conical in form. Four months later, a similar tooth appeared on the right side. At the age of twenty-three months, a tooth erupted in the situation of the right maxillary lateral. About the third year two more teeth appeared in the maxilla on the right and left sides, the size and form of deciduous molars. No teeth appeared in the mandible. At the age of seven years, the three teeth in the incisor region were replaced by three others, still conical in form. The deciduous molars were persistent at the age of 12, when the condition of the jaws was as follows: In the maxilla five teeth, three being permanent, two deciduous; in the mandible no teeth. In this patient the hair on the head was scanty, the scalp being readily seen under it, while on the rest of the body no hairs were present. The nails presented peculiarities. They were covered with white opaque spots and streaks, which occupied the whole thickness of the tissue, this condition having been present since birth. The lenses were normal. The skin was loose and wrinkled. The fact that in this case the teeth, nails and hair had been influenced in their nutrition was interesting.

A remarkable case of **entire absence of teeth** accompanied by marked deficiency of hair is recorded by Guildford.[2] The patient, a man aged 48, was nearly bald, there being only a slight covering of down. Hair was present in the pubic and axillary regions, but the surface of the body entirely lacked the surface hairs usually present. The sudoriferous glands were absent or suppressed, for he had never perspired, and he had no sense of smell or taste. Of his six children two showed signs of inherited abnormality in having only about half the usual number of teeth.

A case of total absence of teeth in a boy aged 16 is recorded

[1] *Dental Cosmos*, June, 1892, p. 468.

[2] *Transactions World's Columbian Dental Congress*, p. 257.

by Mr. W. Rushton.[1] The only other abnormality associated with the condition was in the hair which was of a soft character resembling wool.

Cases of **deficiency of teeth associated with abundance of hair** have been recorded. In the case of Andrian Jeftichfen,[2] the whole face, nose, forehead, cheeks, and ears were covered with long brown hair, which also extended partly down the back. His son, Fedor, at the age of 3 years showed the same tendency to hairiness. The father had no teeth up to 17 years of age, and eventually only erupted four teeth in the mandible and one in the maxilla. The son Fedor, at the age of 3, possessed only four incisors in the maxilla. The Burmese hairy family, consisting of grandfather, mother, and son, are said to have been deficient in the number of their teeth, but there is no reliable record. From the above cases it is evident that there is a correlation between the hair and the teeth. In one class there is a deficiency of both structures; in the other there is a deficiency of teeth associated with a redundance of hair.

Mr. Maggs[3] has recorded a case where **defective development of the permanent teeth** was **associated with malformation of the eyes and anus.** The patient was a girl aged 18. The anus, imperforate at birth, was established by operation. In the maxilla, the incisors and molars were absent. In the mandible ten teeth were present; the teeth were badly formed. The condition of the eyes was as follows: each eye was very deficient in size (microphthalmos); there was almost complete absence of irides, but the lenses were present, as ascertained by oblique illumination. Each eye had thirteen dioptres of myopia, as ascertained by keratoscopy. This myopia was not improved by spherical glasses. The ophthalmoscope showed the discs to be small. There was no coloboma of choroid, but a few patches of opaque nerve fibres were seen in the retina. Vision was defective in each eye. There was nothing suggestive of specific disease. The teeth and nails were normal.

[1] *Trans. Odonto. Soc.*, vol. xxxvi, p. 17.
[2] *Brit. Journ. Dent. Sci.*, vol. xvi, p. 527.
[3] *Trans. Odonto. Soc.*, vol. xxii, p. 181.

(2) **Deciduous Dentition**.—**Absence of** one or more deciduous incisors, either maxillary or mandibular, is **not so common as an excess** in number. These supernumerary teeth simulate in shape those in the neighbourhood of which they are found. They are generally found in the incisor region. In the case which Mr. Ackery reported, and the history of which he followed, the deciduous teeth in the incisor region were succeeded by six permanent teeth. A model showing two supernumerary deciduous incisors is shown in fig. 52, and one showing absence of a lateral incisor in fig. 53.

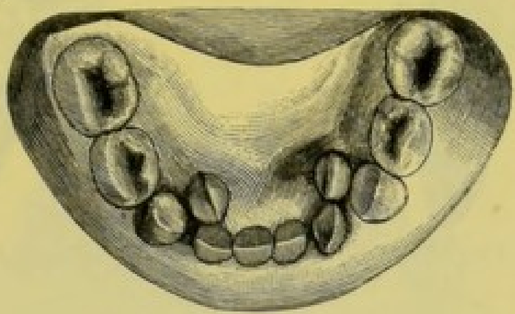


FIG. 52.

FIG. 53.

(C) VARIATIONS IN STRUCTURE

Under this heading are included certain variations in form, shape, or structure. They will be considered under the following heads:—

(1) Gemination.

(2) Enamel nodules.

(3) Variations in the number of cusps and roots.

(4) Variations from the normal, involving many teeth.

(1) Gemination.—This term is used to denote the union of two or more teeth by means of one or more dental tissues.

(*a*) Permanent Dentition

Molars are sometimes geminated, and also lateral incisors and canines, but gemination is very rare between canine and premolar, premolar and premolar, first molar and premolar.

FIG. 54.

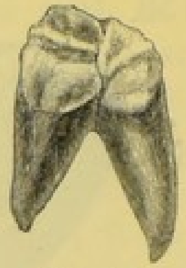


FIG. 55

FIG. 56.

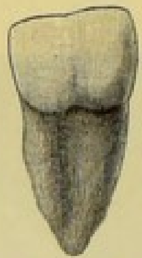


FIG. 57.

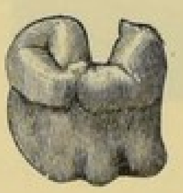


FIG. 58.

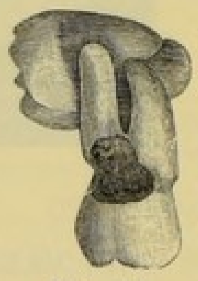


FIG. 59.

Occasionally supernumerary and permanent teeth are geminated, usually in the molar region (fig. 61), but it is not uncommon to find a central or a lateral incisor united with a supernumerary lateral, and, therefore, before expressing an opinion as to the absence of a permanent tooth, care should

be taken to ascertain that it is not united to its neighbour; further, an abnormally large tooth should be differentiated from two geminated teeth.

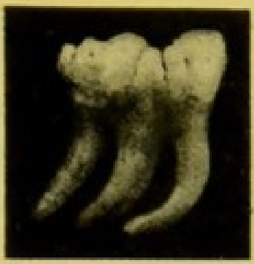


FIG. 60.

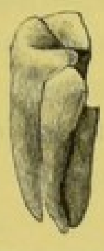


FIG. 61.

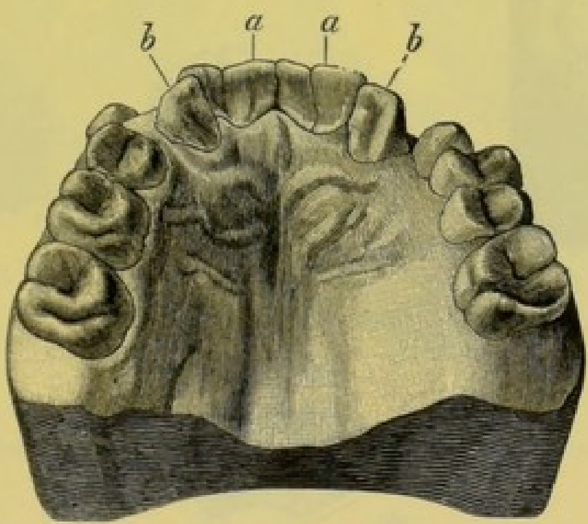


FIG. 62.—*a*, geminated central and supernumerary lateral incisors; *b*, lateral incisors.

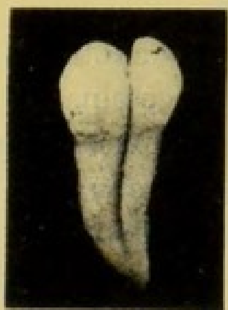


FIG. 63.

FIG. 64.

Geminated teeth may be united throughout their entire length, or the union may be restricted to the crowns (figs. 54, 55).

The following figures show several forms of gemination. In fig. 56 two mandibular incisors united throughout their whole

length are shown, while fig. 57 shows a similar condition in the maxillary teeth ; fig. 55 is a specimen in which the crowns only are united ; in figs. 58, 59, and 60 two molars are geminated ; in fig. 61 a molar and supernumerary tooth are united ; fig. 62 is a model showing symmetrical gemination of centrals with supernumerary laterals.

An example of gemination between two maxillary premolars is shown in fig. 63, and in fig. 64 is shown a specimen composed of four premolars grown together, and in fig. 65 two mandibular

FIG. 65.

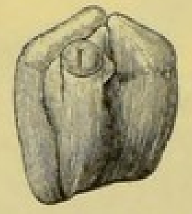


FIG. 66.[1]

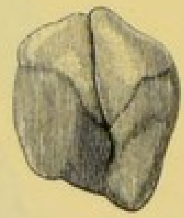


FIG. 67.[1]

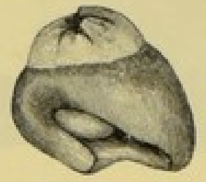


FIG. 68.[1]—This tooth was removed from the region of the mandibular second molar.

premolars are seen wrapped round one another. When the crowns alone are united, the union of geminated teeth is by continuity of both dentine and enamel; but, when the union extends the whole length of the tooth, there is also a continuity of cementum. Geminated teeth may have a single or two separate pulp chambers.

A curious case of gemination has been recorded by Mr. E. Goodman.[2] The mass occupied the position of the right maxillary central incisor, and was found to be composed of three distinct teeth, the appearance presented being shown in figs. 66 and 67 ; the lateral incisor was present.

[1] From *Journ. Brit. Dent. Assoc.*

[2] *Journ. Brit. Dent. Assoc.*, vol. xv, p. 28.

There is reason to suppose that some of the abnormally shaped teeth, formerly termed *odontomes coronaires*, are in reality examples of gemination. The specimen shown in fig. 68 proved, on section, to be two geminated teeth (see fig. 69). The tooth shown in fig. 70 was removed from the maxilla in the molar

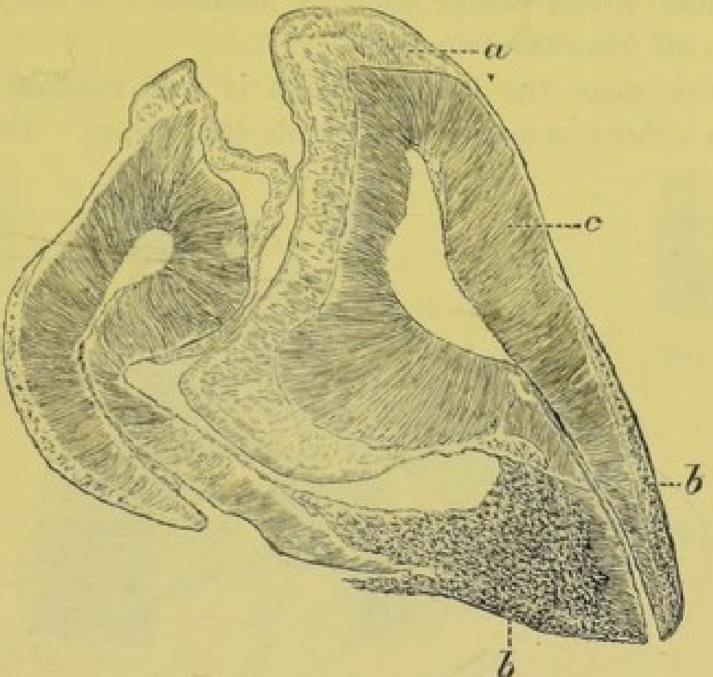


FIG. 69.[1]—Section of fig. 68—*a*, enamel; *b*, cementum; *c*, dentine.

FIG. 70.[1]

region. The greater part of the crown was destroyed by caries. The lower portion consisted of a globular mass of tissue covered by a layer of cementum. A section of this tooth, as seen in fig. 71, indicates the fusion of two teeth with separate pulp chambers. The gemination in this case is not so well marked.

(*b*) **Deciduous Dentition.**

Geminated teeth are more often met with in the deciduous than in the permanent dentition; they are rarely symmetrical,

[1] From *Journ. Brit. Dent. Assoc.*

and occur in the mandible more frequently than in the maxilla. The lateral incisor and the canine are the teeth generally united, but gemination of the central and lateral incisors has also been recorded. Mr. W. Hern has recorded a case where geminated teeth were followed by the absence of a permanent incisor in the same region, which would seem to indicate that only one germ was given off from the two teeth.

In some cases the line of fusion is well marked (fig. 72, *a* and *b*), in others, scarcely perceptible (fig. 72, *c*). The union is

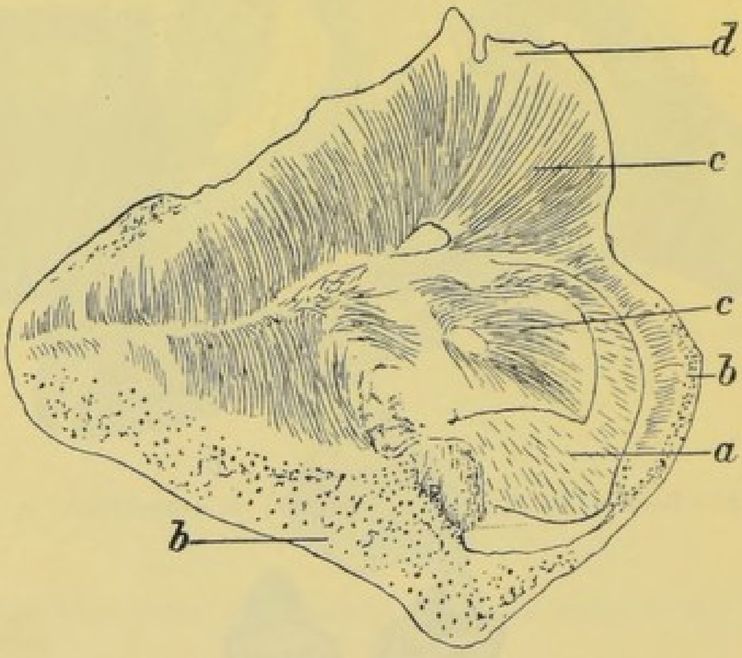


FIG. 71.[1]—*a*, enamel; *b*, cementum; *c*, dentine; *d*, carious dentine forming portion of crown.

by continuity of dentine with dentine; in some examples the pulps coalesce. An example of gemination of three deciduous teeth is shown in fig. 73.

(2) **Enamel Nodules.**—Enamel nodules are those small excrescences, apparently consisting of enamel, occasionally met with upon the roots of teeth. They are generally found upon multiple-rooted teeth, being situated in a position a little below the neck, and often at the junction of two roots. On section, they are found to consist of a cone of dentine covered with a

[1] From *Journ. Brit. Dent. Assoc.*

rather thick layer of enamel (fig. 79). It will often be found that a sharp lamina of enamel connects the nodule with the crown of the tooth. Although generally seen upon multiple-rooted teeth, enamel nodules are occasionally met with on teeth with single roots. The specimen (fig. 78) represents a very large nodule between two palatine roots of an upper molar, while that in fig. 80 shows a nodule situated at the apex of the root of a maxillary molar.

(a) (b) (c)

FIG. 72.

FIG. 73.

FIG. 74.

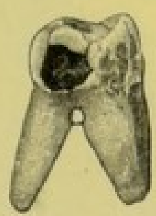


FIG. 75.

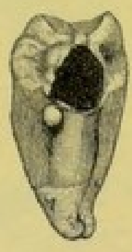


FIG. 76.

Enamel nodules.

FIG. 77.—Maxillary molar with two enamel nodules.

FIG. 78.—Maxillary molar showing large enamel nodule.

The transition from enamel nodules to supernumerary cusps or teeth, and also to those prolongations of enamel which are seen running between the roots of multiple teeth, especially upper molars (figs. 81 and 82), is probably one of degree only. Enamel nodules may be accounted for by dichotomy of the developmental germ, that is to say, a budding from the tissues connected with the process of tooth formation; but Wedl, in accounting for

them, says: "It is obvious that the nodules or ridges which are met with upon the molars are the result of localized continuations of the development of the enamel between the already developed basal portion of the roots, and are produced by the strip of the enamel organs which has persisted longer than the rest."

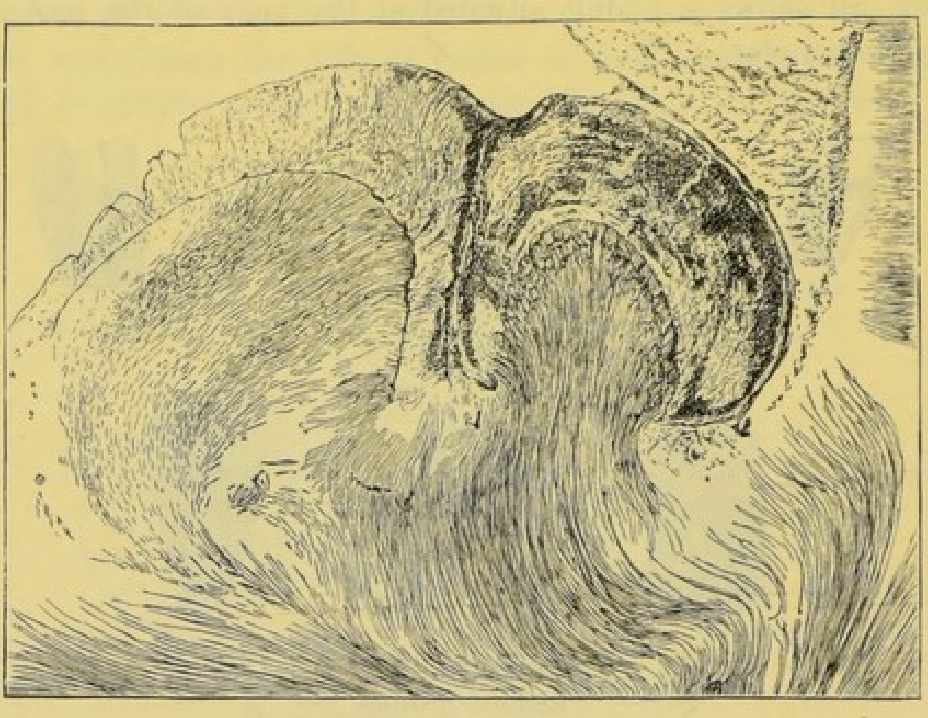


FIG. 79.—Section through an enamel nodule upon a maxillary second molar

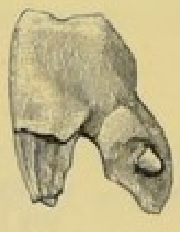


FIG. 80.

(3) Variations in the Number of Roots and Cusps, and in the Direction of the Roots.—In dealing with this division it is only possible to consider a few of the more common varieties. The variations from the normal caused by flexions and torsions of the roots are almost endless; in most instances these variations are due to movements of the developing tooth in mal-

directions through crowding. The flexion of the root may take place at any part of the root from the neck to the apex, and may be single or multiple. The twisting varies considerably in degree.

FIG. 81.—Prolongation of enamel between the roots of a mandibular molar.

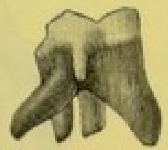


FIG. 82.—Prolongation of enamel between the roots of a maxillary molar.

(*a*) Permanent Dentition. (1) Maxillary Teeth

(**a**) **Central Incisor**.—The following are some of the variations in shape met with :—

(1) A considerable flattening from before backwards (fig. 83).

(2) The crown altered so as to resemble a simple cone (fig. 84).

(3) Disproportion between length of crown and root (fig. 85, *a*, *b*).

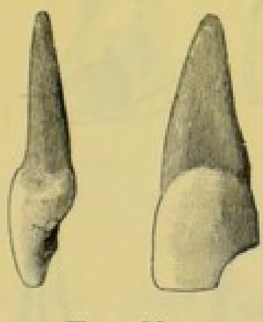


FIG. 83.

(4) Disproportion between width of the crown and the root (fig. 85,*d*).

(5) Marked development of the posterior cervico-marginal ridge (figs. 85,*c*).

(6) Groove running from the posterior cervico-marginal ridge on to the root (figs. 85,*g*).

(7) A bending in of the mesial aspect of the tooth near the neck (fig. 85,*c*).

(8) A bending in the axis of the root and the crown.

(9) A peculiar shape of the labial surface due to thickening of the mesial and labial margins.

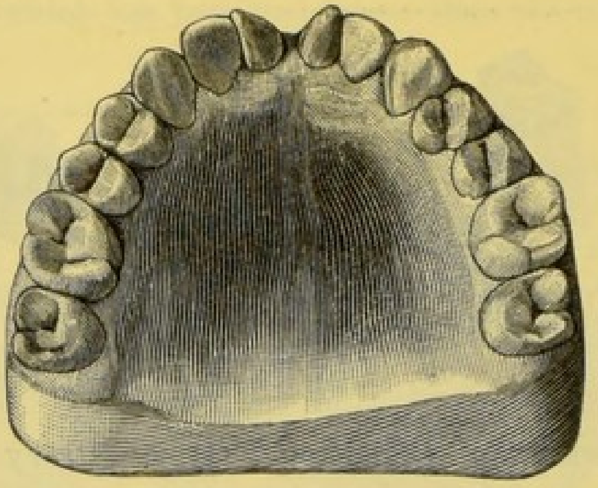


FIG. 84.

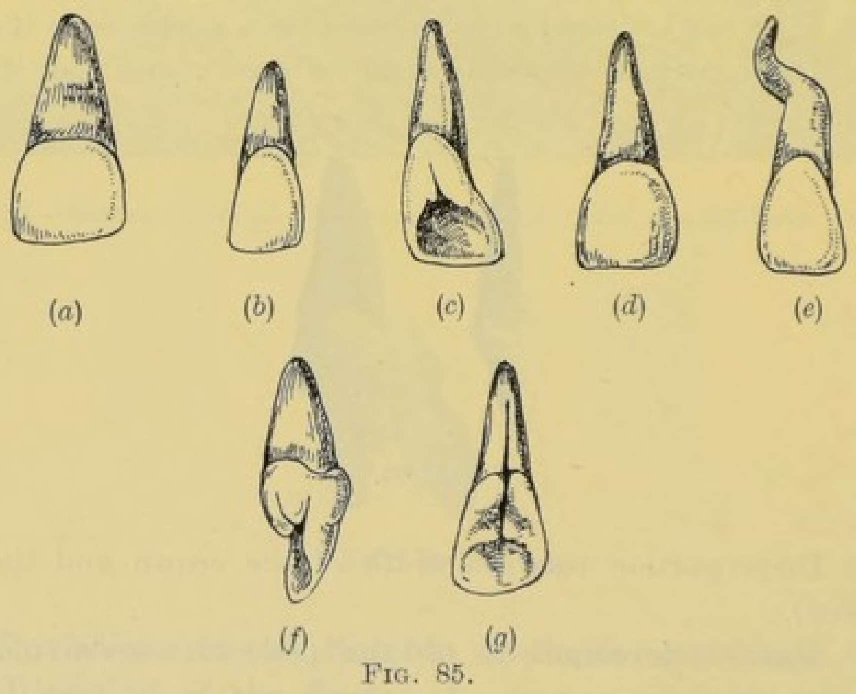


FIG. 85.

(10) A projection from the labial aspect (fig. 85,*f*).

(11) An extra root (fig. 86).

(12) Curvation of the terminal portion of the root (uncommon) (fig. 85,*e*).

(b) Lateral Incisor.

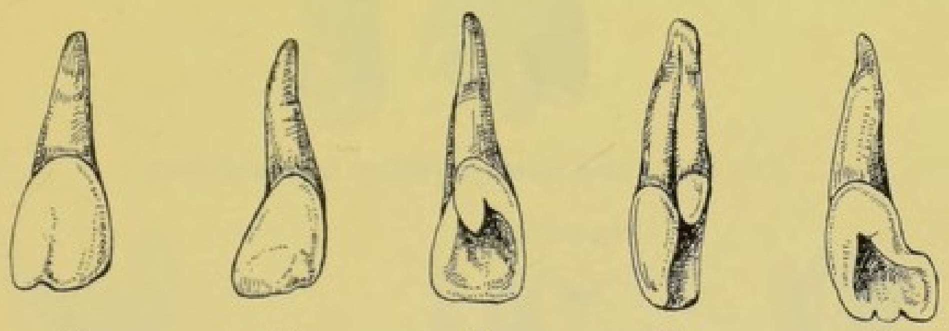
(1) Variation in shape of the crown, the mesial and distal angles being so rounded as to cause the tooth to mimic a canine.

(2) The crown so altered as to appear as a simple cone.

(3) Pronounced lingual fossa due to development of the posterior cervico-marginal ridge (fig. 87,*c*).

(4) Development of a cusp from the posterior cervico-marginal ridge, accompanied by a groove running down the root (fig. 87,*d*).

FIG. 86



(*a*) (*b*) *c*) (*d*) *e*)

FIG. 87.

(5) A notch on the cutting edge towards the mesial angle (fig. 87,*a*).

(6) The root may be considerably flattened and grooved laterally.

(7) Curvature of the root (common) (fig. 87,*b*).

(8) Depression in the mesial aspect of the root near neck (fig. 87,*b*).

(9) A kink on the mesial aspect of the crown (fig. 87,*e*).

(10) An extra root.

(c) Canine.

(1) Excessive length of root. The tooth may measure $1\frac{1}{4}$ in

(2) The root may be grooved and bifurcation of the apex take place. (The latter is very rare.)

(3) Flexion of the root, met with principally in those teeth which erupt external or internal to the arch.

(4) Development of a cusp from the posterior cervico-marginal ridge. This irregularity may be so marked as to cause the tooth to mimic a premolar.

Fig. 88.—Two-rooted maxillary first premolars.

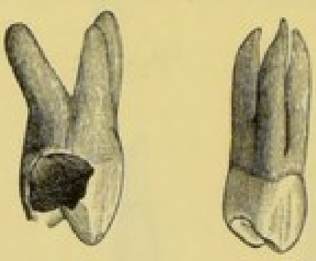


Fig. 89.—Three-rooted maxillary first premolars.

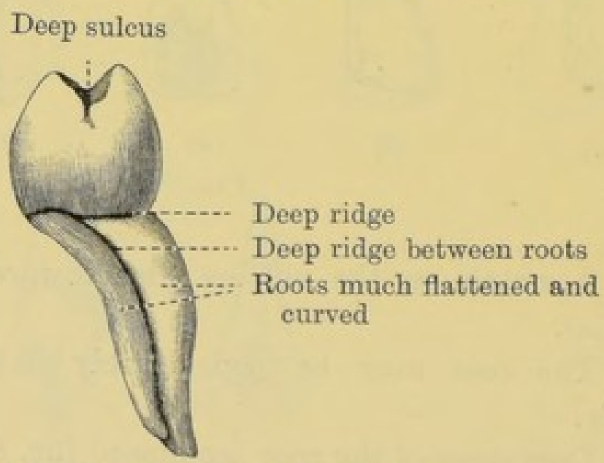


Fig. 90[1].—Side view of tooth.

(5) The cutting edge may be divided into two unequal cusps by a notch.

(d) **Premolars.—The first premolar** is very irregular in regard to the form and number of its roots. Externally the root

[1] From *Journ. Brit. Dent. Assoc.*

nearly always shows signs of bifurcation, and in some cases possesses two or three well-defined roots. When there are three roots they are arranged on the same plan as in the maxillary molar.

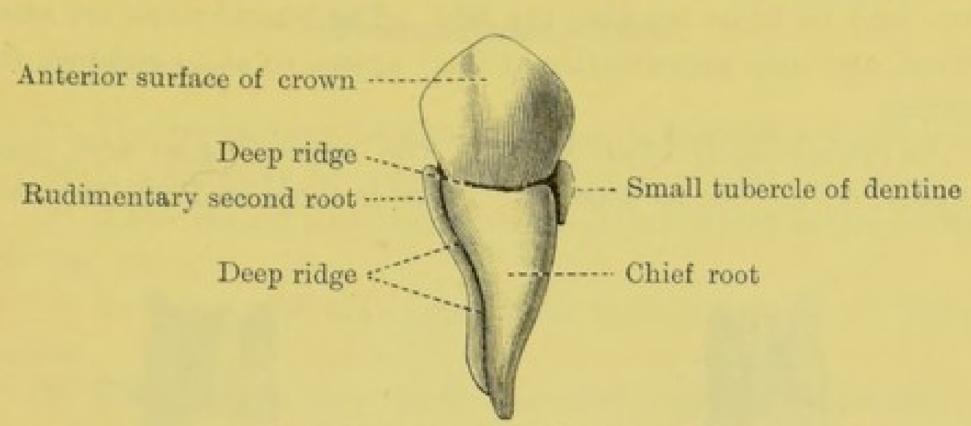


FIG. 91.[1]—Anterior view of tooth.

FIG. 92.

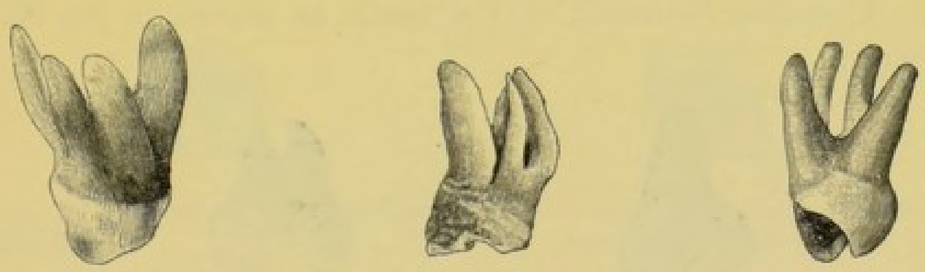


FIG. 93.—Maxillary first molars, with supernumerary roots between the anterior buccal and palatine roots.

A curious first premolar is shown in figs. 90 and 91.[2]

The second premolar is more constant in form than the first premolar. Two or three roots may be present. An extra cusp occasionally appears on the premolars (fig. 92).

(e) **Molars.—The first molar** may have a fourth root. The fourth root is always situated between the anterior buccal and

[1] From *Journ. Brit. Dent. Assoc.*

[2] Described by Mr. J. F. Rymer, *Journ. Brit. Dent. Assoc.*, vol. xvi, p. 162.

the palatine roots. A fifth root is occasionally seen. The roots may be fused together, a union of the posterior buccal and palatine being most common (fig. 94). At times all three roots may be fused together (fig. 95). The buccal roots are often curved, and may approximate at their apices so as to embrace the septum.

An extra cusp is often seen on the mesio-lingual and, occasionally, on the buccal aspects. There is some evidence that the

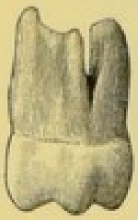


Fig. 94.—Maxillary first molar, the posterior buccal and palatine roots being united by cementum.

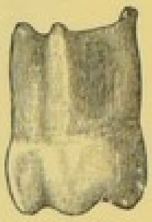


Fig. 95.—Maxillary first molar, showing all three roots united by cementum.

extra cusps in the latter situation are really due to gemination with a supernumerary tooth.

The second molar may present abnormalities similar to the first. A peculiar flattening of the tooth, as shown in fig. 96, is met with.

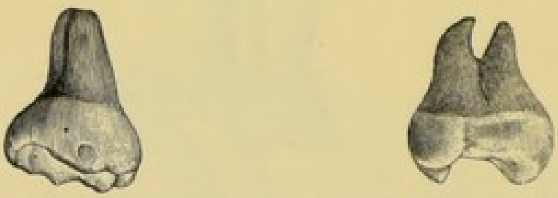


Fig. 96.—Abnormally shaped maxillary second molars.

The third molar presents an immense variety of shapes. The roots may be all fused together, and in one specimen in the Museum of the Royal College of Surgeons the apex is cup-shaped with numerous holes for the vessels of the pulp to enter. The roots may be increased in number, and flexions are often present (figs. 97 and 98).

The normal position of the roots of the molars may be altered by the posterior buccal root being displaced inwards and forwards.

This variation is termed "oblique rooted," and attention was first drawn to it by Mr. Booth Pearsall[1] (see figs. 99 to 102).

(2) Mandibular Teeth

(a) Incisors.

(1) The crown may be altered so as to resemble a single cone.

(2) A notch may be present on the cutting edge (fig. 103,*a*).

(3) A thickening may occur on the labial aspect in the median line (fig. 103,*b*).

(4) An extra root may arise from the approximal or lingual surface.

(b) Canine.—In this tooth the root may be bifurcated, or an extra root may be present. In the former, the variation usually occurs in both canines.

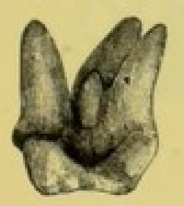


Fig. 97. — Abnormal maxillary third molar.

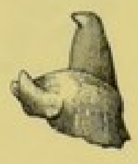


Fig. 98. — Maxillary third molar, showing a peculiar flexion of the buccal roots.

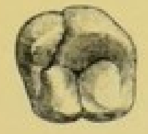


Fig. 99. — Normal left maxillary first molar.

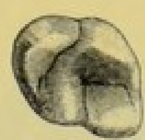


Fig. 100.—Oblique-rooted left maxillary first molar.

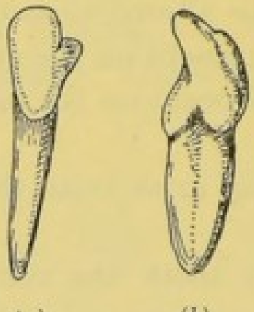
Fig. 101.—Normal right maxillary second molar.

Fig. 102. — Oblique - rooted right maxillary second molar.

(c) Premolars.—The first premolar may have two roots. "When a lower premolar tends to have two roots they are peculiarly formed, the flattened apex being bent round so as to

[1] *Journ. Brit. Dent. Assoc.*, vol. x, p. 38.

form an approach to a second (anterior) root, and this may go on to complete division"—(Tomes, fig. 105). The inner cusp of this tooth is at times but feebly developed, and causes the tooth to simulate a canine.



(*a*) (*b*)

Fig. 103.

Fig. 104.—Two-rooted mandibular canine.

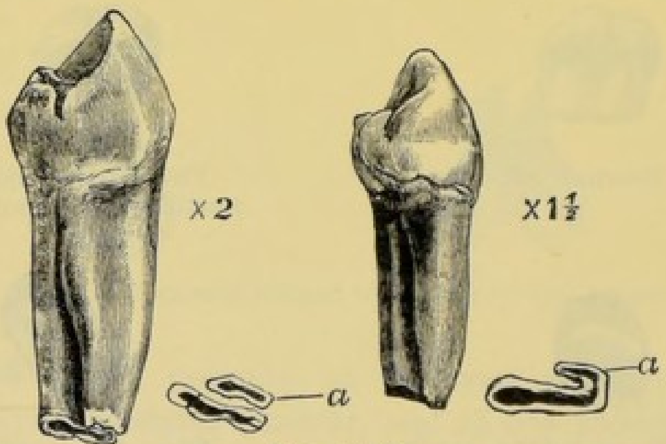


Fig. 105.[1]

Two human mandibular premolars, the roots of which show two stages towards complete division. *a*, Anterior root.

The second premolar is more constant in form than the first. This tooth often has a square-topped crown and presents

[1] From Tomes' "Dental Anatomy."

an extra cusp. A curious abnormality of the second premolar is shown in fig. 106, in which the crown somewhat resembles that of a molar.

(d) **Molars.—The first molar** may have an extra root on the lingual aspect, situated either between the normal roots, or, more commonly, further back, when it displaces the posterior

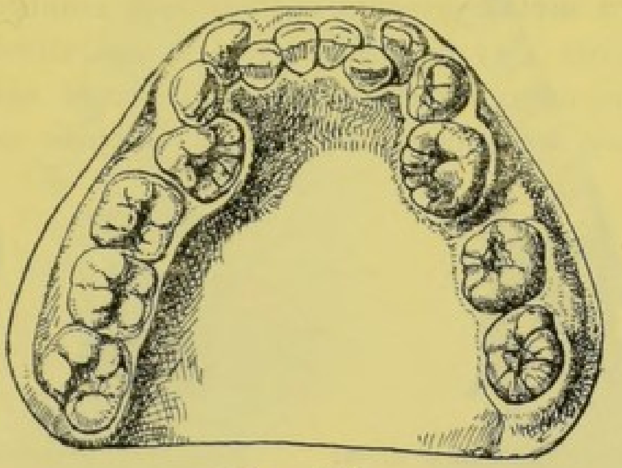


FIG. 106.

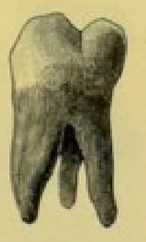


FIG. 107.—First mandibular molar with three roots.

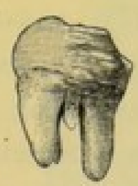


FIG. 108.—First mandibular molar with supernumerary root.

FIG. 109.—Four-rooted first mandibular molar.

root outwards. Rarely an extra root is seen on the buccal side of the tooth (fig. 108). Four are met with (fig. 109). The roots are occasionally fused together, and the normal backward curve may be much exaggerated. Five or even six roots are recorded, but such instances are rare; and examples of these (figs. 110 and

111) are taken from Wedl's "Atlas of Dental Pathology." (It is possible that these are examples of gemination.) Extra cusps are met with on the buccal surface.

The second molar presents abnormalities similar to those found in the first molar; but fusion of the roots of the second molar (fig. 112) is more common than in the first molar.

The third molar presents an increased number of cusps, or the whole tooth may be reduced to a comparatively small size. The roots are often fused together and curved well backwards. At times they are grooved by the mandibular nerve, and, in

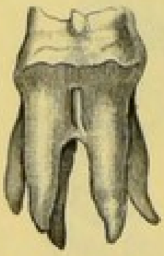


FIG. 110.—Mandibular molar with five roots (Wedl).

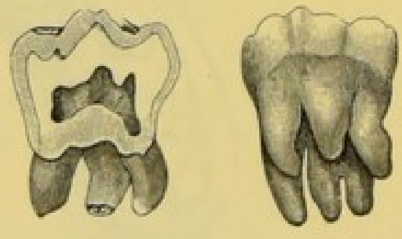


FIG. 111.—Mandibular molar with six roots (Wedl).

FIG. 112.

FIG. 113.

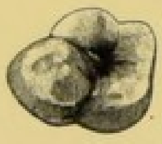


FIG. 114.—Right mandibular third molar, showing peculiar abnormality of the posterior external cusp.

cases recorded, a foramen has existed for the passage of the nerve. In one variety met with, the roots are fused together, while towards the apices each bifurcates, presenting four small roots (fig. 113). A peculiar abnormality of the posterior external cusp is shown in fig. 114.

(*b*) Deciduous Teeth

Additional cusps and variation in the number of the roots are more rare in the deciduous than in the permanent dentitions. The second molar, occasionally, has an additional cusp. Cases of strongly pronounced cusps arising from the posterior cervico-marginal ridge of the incisors and canines are met with.

Variations in the number of the roots are found in the molar region. The maxillary second molar may have four roots

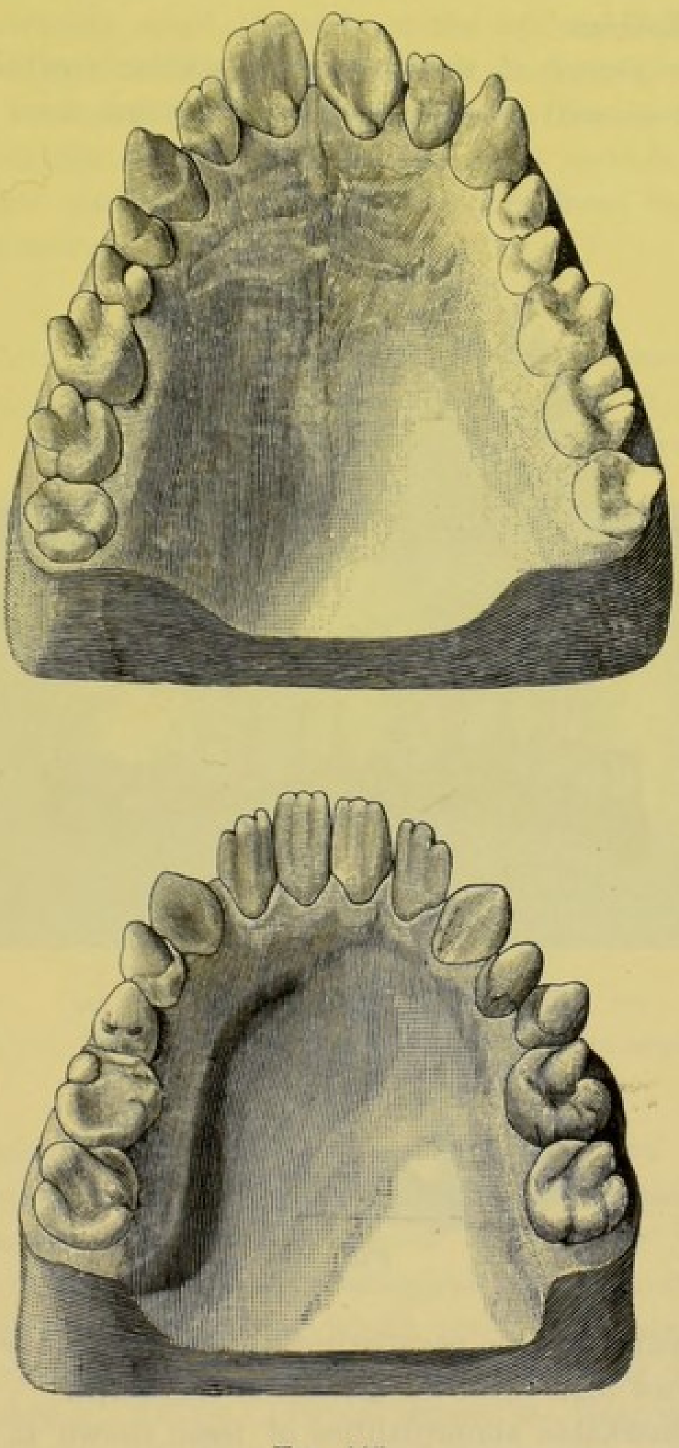


Fig. 115.

and the mandibular three. Occasionally, the root of the mandibular canine is bifid.

(4) Variations from the Normal, involving many Teeth.— A few cases of this character have been recorded. In fig. 115 is shown a case of this character which occurred in the practice of Mr. C. Robbins [1]

In two sisters of this patient a similar condition existed, though not so well marked, and some cousins were also stated

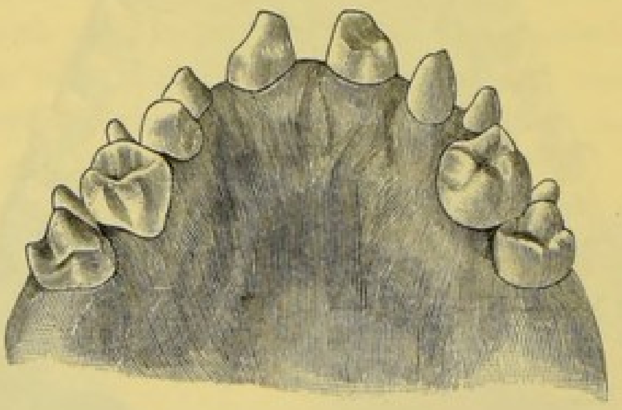


FIG. 116.

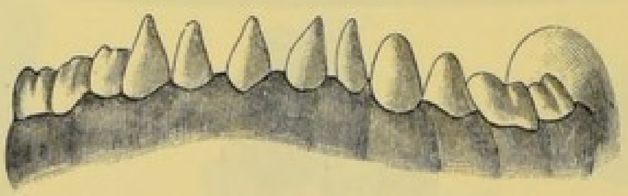


FIG. 117.

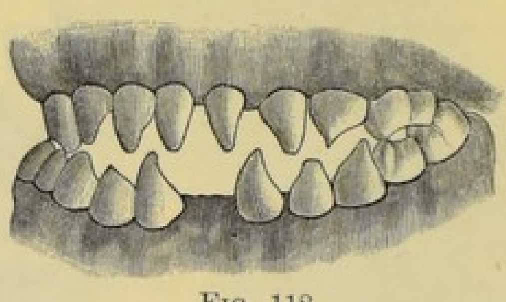


FIG. 118.

to have shown the same peculiarities. The models are interesting, as they throw light upon the genesis of the cusps.

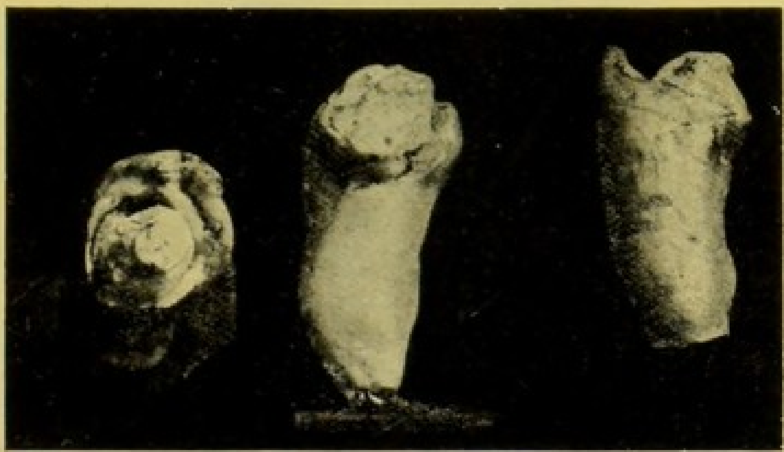
The remarkable abnormalities of teeth shown in figs. 116 to 118 were recorded [2] by Mr. H. Moon. The models were from

[1] *Trans. Odonto. Soc.*, vol. xxiii, p. 80.
[2] *Ibid.*, vol. ix, p. 232.

the mouths of two sisters, fig. 118 being those of one aged 11, and figs. 116 and 117, one aged 15. In the younger sister the hair was short, fine, and scanty. Her eyes were of a grey colour, remarkably small, the sight of the left one being defective from birth. In the elder sister the hair on the scalp was short and scanty, but very fine hairs in more than usual number were developed on the temples and cheeks. The models show that the deciduous maxillary molars are being replaced by premolars cone-like in form.

(D) ANOMALOUS TEETH

Under this heading it is proposed briefly to describe various types of anomalous teeth, which at present it is difficult to classify under any definite headings. It is probable that



(*c*) (*b*) (*a*)

FIG. 119.[1]—*a*, view from base; *b*, view from posterior aspect; *c*, lateral view.

with a more thorough examination of specimens it will be found possible to classify these various abnormalities under definite groups, and by this means gain some idea of the relation they bear to other pathological processes of the teeth.

Abnormally shaped teeth, which show a somewhat similar type of structure to one another, are met with in the pre-maxillary region. In fig. 119 is shown an irregularly shaped tooth removed from a boy, about 17 years of age. There was a sinus in the alveolar process, and this led to a cyst-like

[1] From *Trans. Odonto. Soc.*

cavity. It will be seen on examination that the specimen is cone-shaped, the base of the cone embracing a curious nodular mass which is fused with the base of the cone at the posterior or palatal aspect. A section through the specimen is shown in fig. 120. The outer coat consists of enamel and cementum; within this is dentine, and within this again, and lining the large space in the centre of the tooth, is enamel. Near the occlusal margin of the tooth the dentine forms but a thin streak, the two layers of enamel almost touching each other at this part. In its upward extension on the labial aspect the

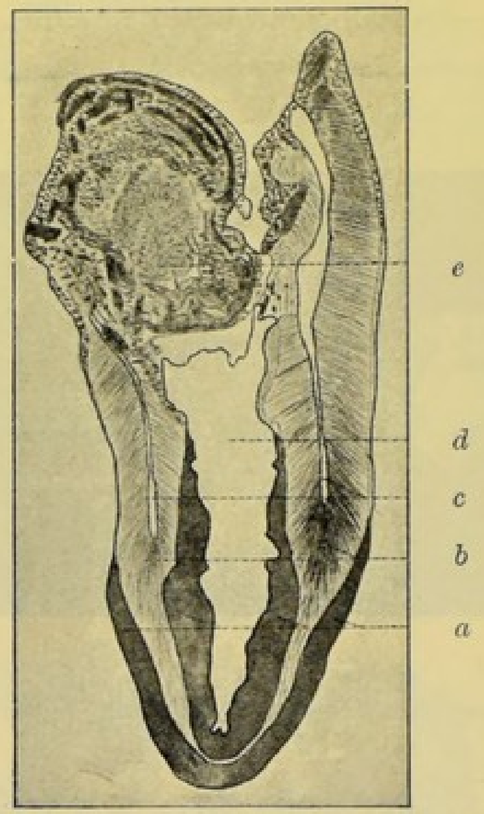


Fig. 120.[1]—*a*, enamel; *b*, dentine; *c*, pulp cavity of external tooth; *d*, cavity lined with enamel; *e*, mass of cemental-like tissue.

dentine increases in thickness, and, in the upper two-thirds, surrounds a pulp chamber; whilst in the posterior or palatal wall the dentine extends upwards until, by means of a very vascular dentine, it becomes continuous with the curious circular mass of tissue embraced by the base of the cone. This globular mass shows in section a well-marked concentric lamination, and is composed of vascular cemental tissue.

[1] From *Trans. Odonto. Soc.*

Mr. Hutchinson[1] has described a similar specimen (see fig. 121) in which the abnormality, however, has advanced a stage further than in the specimen shown in fig. 119 inasmuch as the dentine has almost encircled the mass of cemental-like tissue. In some of these teeth the enamel of the exterior is continuous with the enamel lining the cavity inside the tooth. This is seen in the tooth shown in figs. 122 and 123. The dentine here completely surrounds the internal layer of enamel.

These specimens seem to form a fairly complete series. It is not clear how the enamel-lined cavity arises. It may be due

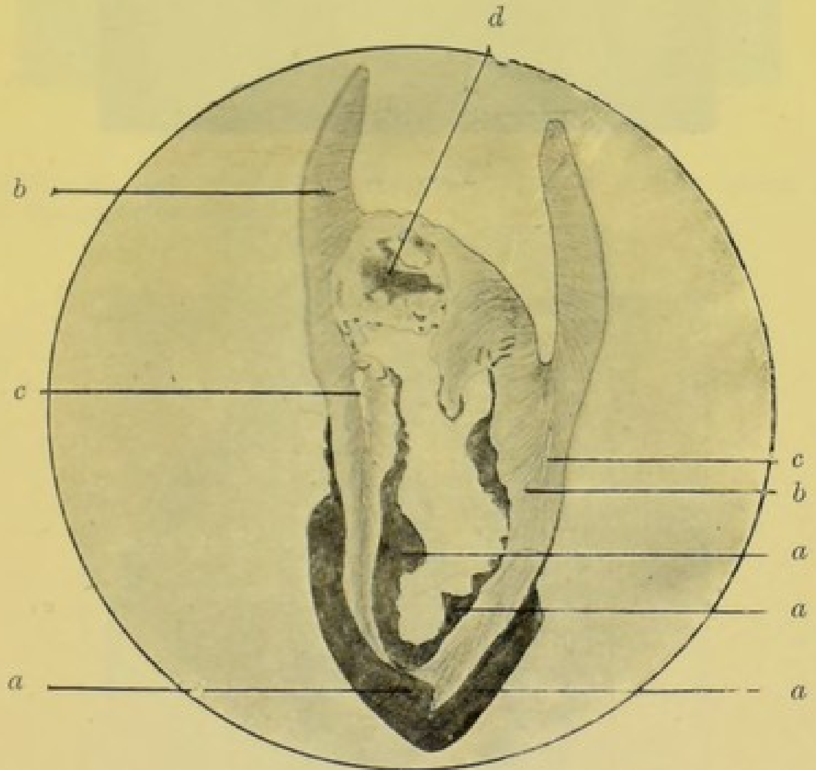


FIG. 121.[2]—*a*, enamel; *b*, dentine; *c*, pulp chamber of external tooth; *d*, mass of cemental tissue.

to an invagination of the enamel organ of the tooth, or it may be the result of the enamel organ of one tooth being pushed, as it were, into the dentine papilla of another. The specimens (figs. 120 and 121) seem to support the latter view. In the specimen shown in fig. 120 the concentric mass was probably independent of the original aberration, and should be regarded as an

[1] *Trans. Odonto. Soc.*, vol. xi, p. 163.
[2] From *Trans. Odonto. Soc.*

enlarged pulp nodule which has fused with the developing tooth. There is reason to suppose that the supernumerary teeth so often met with in the premaxilla can be explained on the ground of

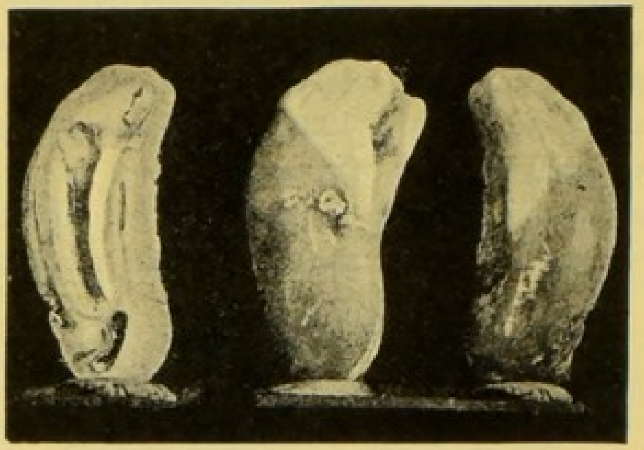


FIG. 122.[1]

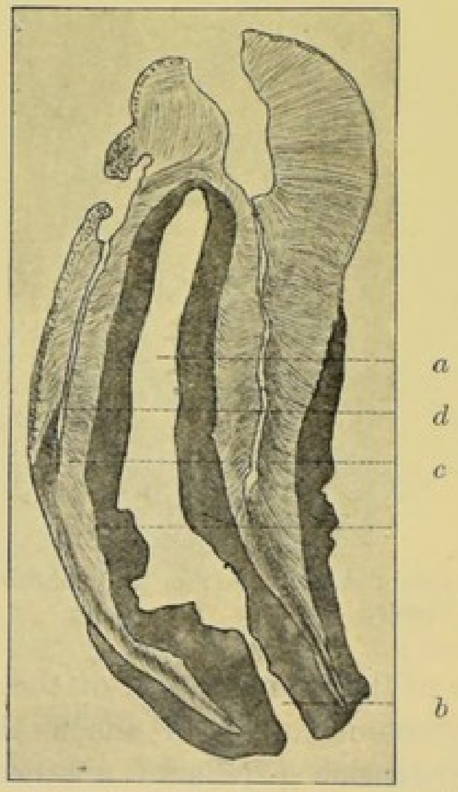


FIG. 123.[1]—*a*, enamel; *b*, space leading from exterior of tooth to cavity in the centre; *c*, dentine; *d*, pulp cavity of external tooth.

"reversion," and it is possible that the class of abnormality referred to above has originated in the same way.

[1] From *Trans. Odonto. Soc.*

A tooth of a remarkable shape is shown in fig. 124. There is no history of the case, but the shape of the crown would seem to indicate that the tooth is a central incisor. The root and crown

(a) (b) (c)

FIG. 124.[1]—a, view of the upper aspect; b, view of the lateral aspect; c, view of the posterior aspect.

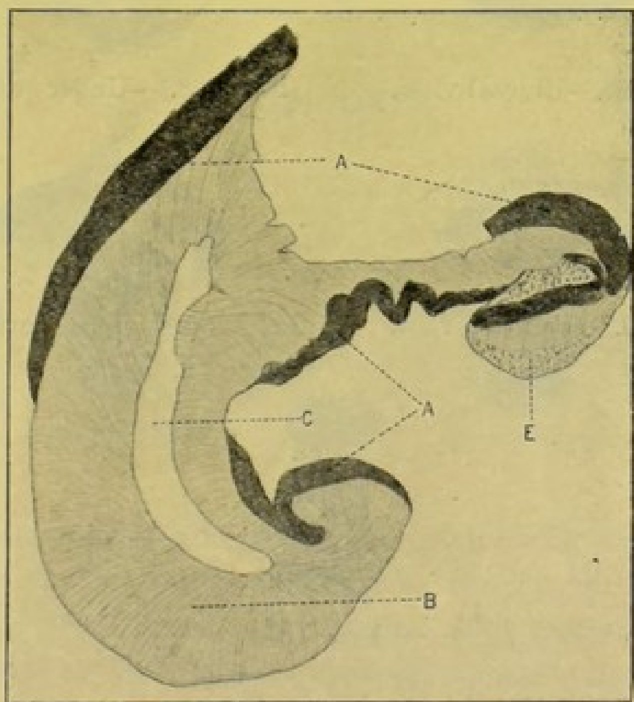


FIG. 125.[1]—A, enamel; B, dentine; C, pulp cavity; E, cementum.

form a curve, the concavity being towards the palatal aspect. Springing from the inside of the curve, about one-third the way

[1] From *Trans. Odonto. Soc.*

from the occlusal margin, is a big loop of tooth tissue. A section of the specimen shows the tissues to be arranged, as shown in fig. 125. It is difficult to form a theory as to the origin of the specimen, as part of the tooth has been destroyed by caries.

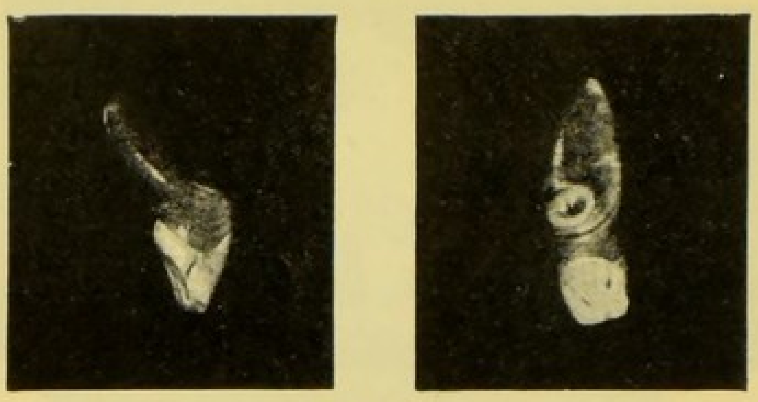


FIG. 126.[1]

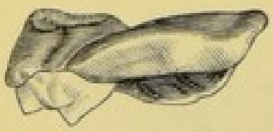


FIG. 127.[2]—Buccal view.

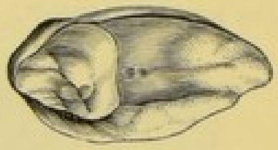


FIG. 128.[2]—Under-surface view.

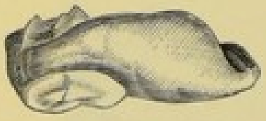


FIG. 129.[2]—Palatine view.

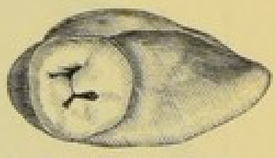


FIG. 130.[2]—Upper-surface view.

FIG. 131.[3]

In fig. 126 is shown a curious tooth removed from the region of the right maxillary lateral incisor. The root is flattened from above downwards, and is bent at an angle to the crown. Situated

[1] From *Brit. Dent. Journ.*
[2] From *Dental Cosmos.*
[3] From *Trans. Odonto. Soc.*

in the root just above the neck of the tooth is a ring of enamel.[1] A specimen somewhat similar in character to the one just mentioned is described by Dr. J. E. Freeston.[2] The tooth occupied the position of the left maxillary canine. Views of this tooth are shown in figs. 127 to 130.

A section of an interesting specimen is shown in fig. 131. The crown of this tooth resembles an upper molar in appearance. "The implanted portion is quadrate in form, and for about two-thirds of its length tapers and then suddenly expands, the end

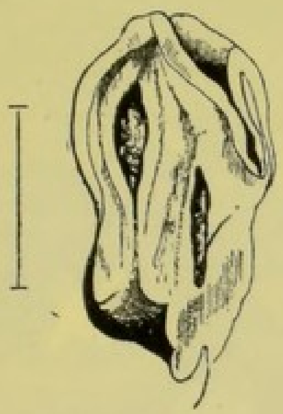


Fig. 132.

Frontal view. Lateral view.

Fig. 133.[3]

forming a deep cup with the concavity looking upwards. The cupped extremity is nearly as large as the crown of the tooth, and is coated with thick cementum. The nerves and vessels enter by several small foramina situated in the edge of the cup. The pulp at the apical end spreads out in a trumpet-shaped manner and approaches close to the surface all round the circumference of the cup."

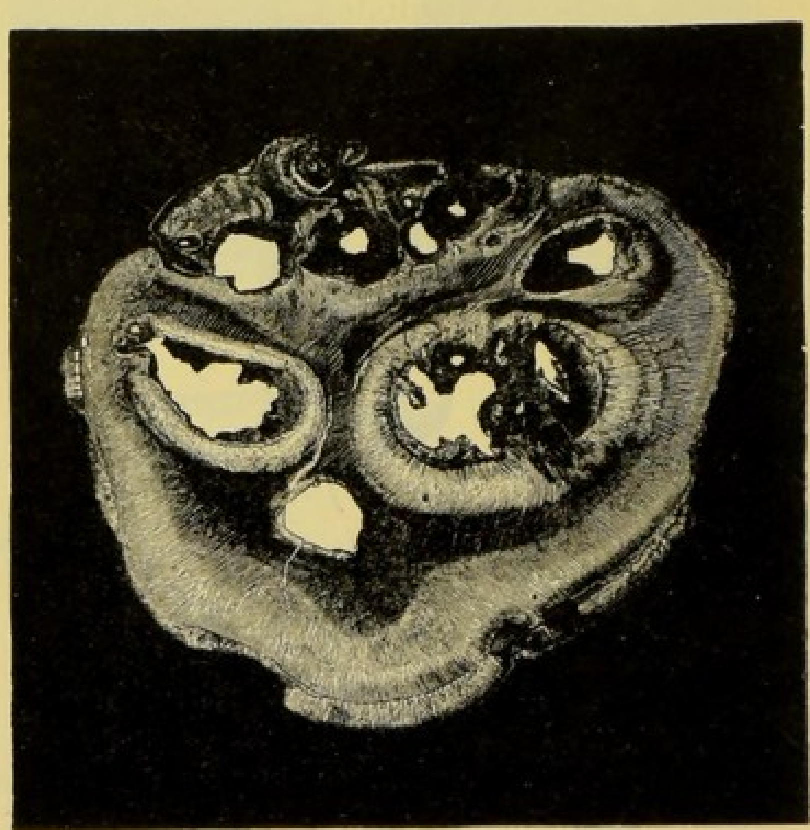
1 Recorded by J. Coltman, *Brit. Dent. Journ.*, vol. xxviii, p. 243.

2 *Dental Cosmos*, March, 1890.

3 From *Dental Cosmos.*

The tooth shown in fig. 132 was removed from the region of the right maxillary central incisor. The section of the tooth shows that there are three distinct canals communicating with what appear to be three distinct pulp cavities.

An anomalous tooth of great interest was described by Dr. Miller.[1] The tooth (fig. 133) was removed from the region of the left maxillary canine. "Sections were cut by means of a



x 10

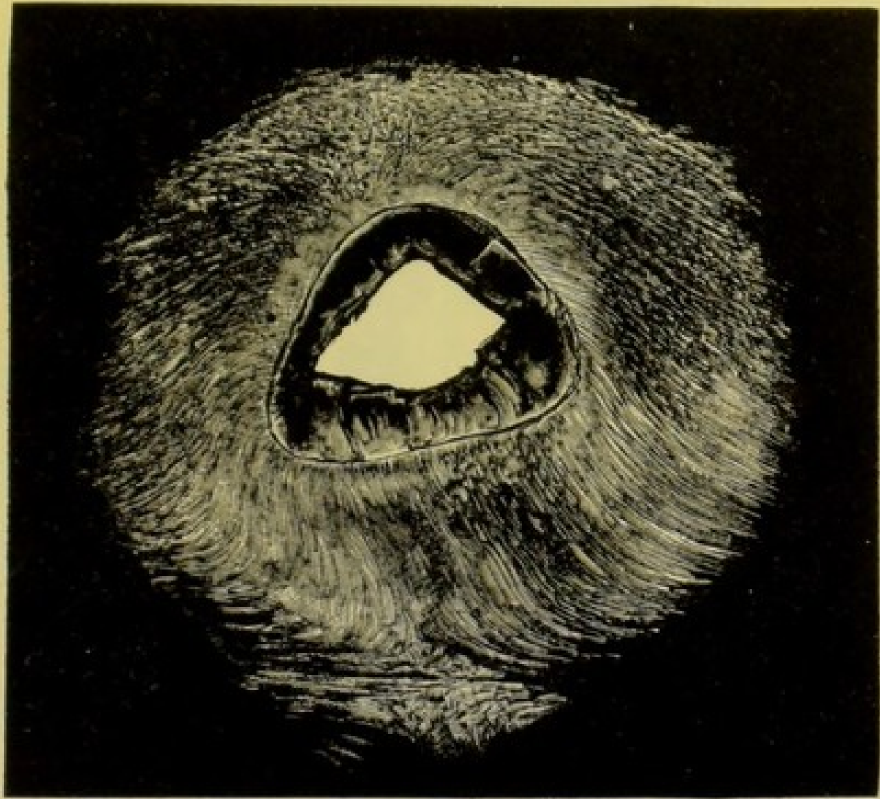
FIG. 134.[2]—Cross-section through the crown near the cusp.

diamond disc and very fine saw from different parts of the tooth, and ground down for microscopic examination." Two of these sections are reproduced in figs. 134 and 135. "A microscopic examination revealed the fact that some fifteen columns of enamel were suspended, something like stalactites, from the dome of the enamel-caps, and some of them extended into the root a quarter of an inch beyond the neck of the tooth. In cross-sections the columns appeared roundish, triangular, or compressed, and of

[1] *Dental Cosmos*, August, 1901.
[2] From *Dental Cosmos*.

various sizes, usually hollow (fig. 135), though some contained a core of a very irregular osseous substance, and some a structureless mass, apparently resulting only from a deposit of calcific matter in the remains of the enamel-organ after it has been partially cut off from nutrition."

"It must be remembered that in these columns the formation of enamel took place towards the centre of the column, centripetally, and the remains of the enamel-organ are therefore to be looked for on the inner surface of the enamel. In figs. 135 and 136



× 75

FIG. 135.[1]—Cross-section of hollow enamel column with surrounding dentine.

two of the enamel columns are presented in cross-section. In fig. 136 we see a ring of enamel, followed by an osseous substance containing lacunæ with long processes, which give the appearance of having originated from the star-shaped cells of the enamel-organ. Inside of this is the core of uncalcified tissue, representing the remains of the enamel-organ. Resorption figures are also present (fig. 137)."

[1] From *Dental Cosmos.*

"The dentine of the tooth was deposited not only in the ordinary manner on the surface of the pulp, but also each enamel column formed a centre of calcification, from which dentine was formed centrifugally. We have accordingly some fifteen centres of dentinification, and as many columns of dentine formed from these various centres, some of which, failing to coalesce, give rise to a number of fissure-shaped pulp-cavities. All these different

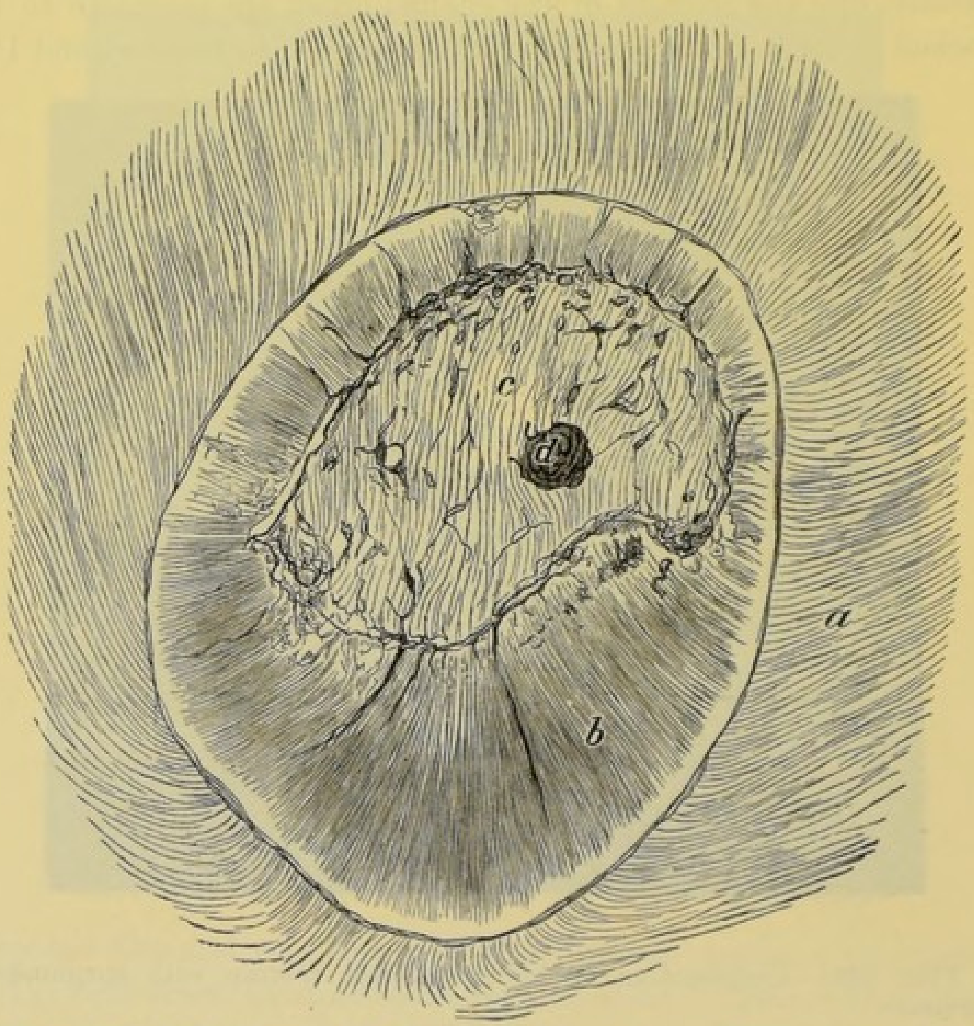


FIG. 136.[1]—Cross-section of enamel column. *a*, dentine; *b*, enamel; *c*, calcified enamel-organ; *d*, uncalcified core of enamel-organ. (Mag. 100 diam.)

formations represent the crowns of so many teeth turned inside out, the enamel being on the inside and the pulp-chamber on the outside of each separate crown."

"A further anomaly presented by this tooth is the absence of

[1] From *Dental Cosmos*.

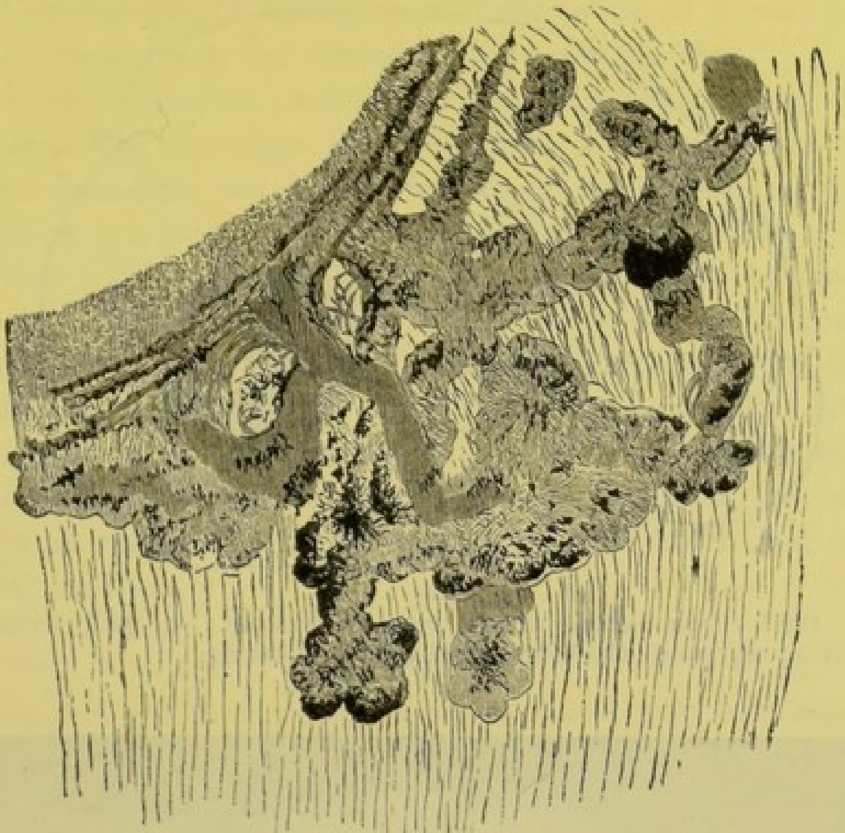


Fig. 137.[1]—Resorption figures in the dentine of the crown. (Mag. 100 diam.)

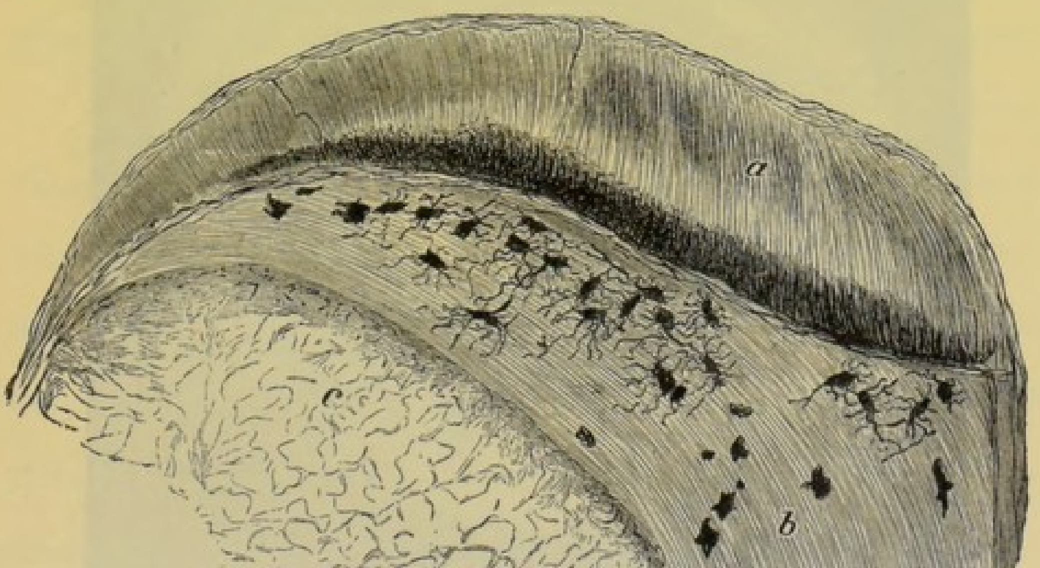
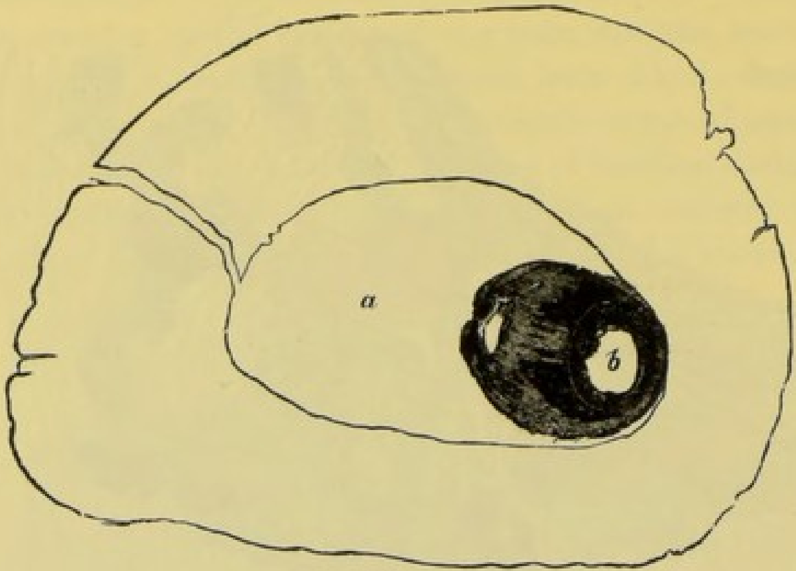


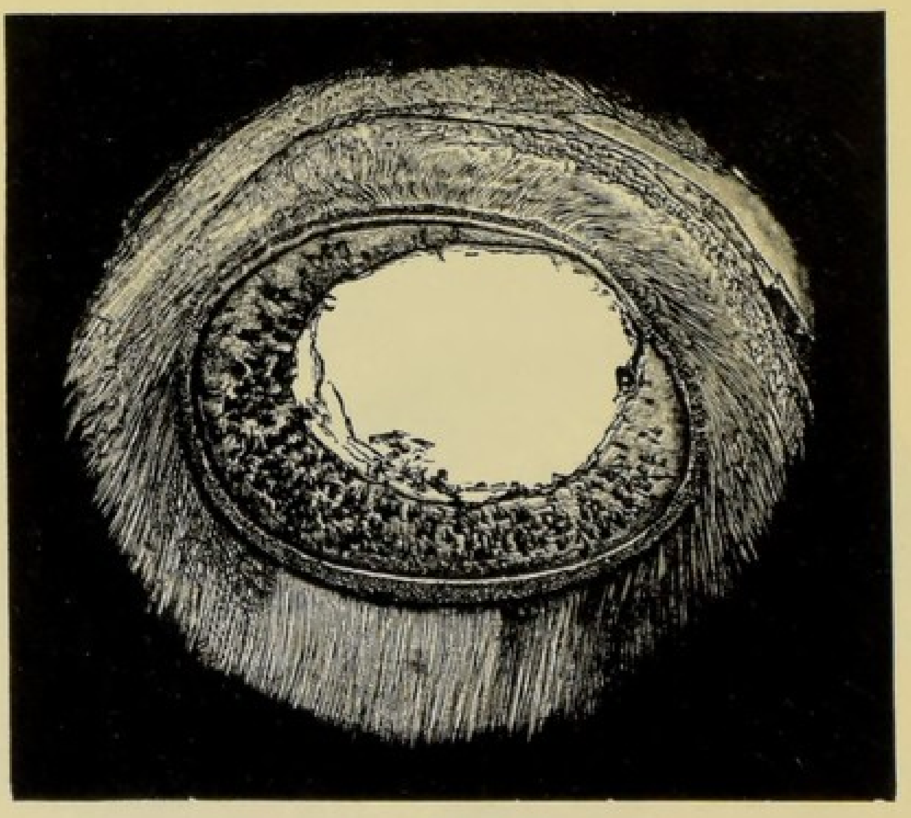
Fig. 138.[1]—From the crown of the tooth. *a*, dentine; *b*, well-formed cement; *c*, structureless calcific matter. (Mag. 100 diam.)

[1] From *Dental Cosmos*.



× 10

FIG. 139.[1]—Cross-section of the root in outline. *a*, pulp canal (the dark portion represents the internal root) ; *b*, its canal.



× 60

FIG. 140.[1]—Cross-section of internal root, showing lining of cement, stratum intermedium, and surrounding dentine.

[1] From *Dental Cosmos*.

enamel on one side of the crown and the presence of well-formed cement corpuscles in the corresponding part (fig. 138)."

"The third anomaly presents itself in the following peculiarities: On looking into the open apical foramen, which is about 2 to 3 mm. in diameter, we see the point of an acicular formation attached to one side of the wall of the root-canal, which we may call a root within a root. It is seen in cross-section in figs. 139 and 140. This root consists, as all roots do, of dentine and cementum, but with the remarkable peculiarity that the cement lines the inside instead of the outside of the root. The inverted root represents the continuation of one of the enamel columns."

The structure of this abnormal tooth suggests that it was possibly an example of an epithelial odontome which had undergone calcification.

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CHAPTER IV

Defective Formation of the Teeth

Defects produced by Syphilis—Hypoplastic Teeth—Hereditary Hypoplasia—Defects due to Local Causes

In this section are described some of the various defects in the structure and form of teeth.

(A) DEFECTS PRODUCED BY GENERAL CAUSES

(1) **Syphilis.**—It is an established fact that congenital syphilis may leave, as one of its marks, a characteristic deformity of certain of the teeth. The manner in which syphilis affects the eruption of teeth was referred to on a p. 32. In this chapter it is

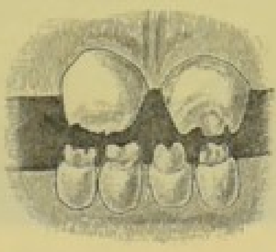


Fig. 141.[1]—Two maxillary and four mandibular incisors (permanent) of a girl, the subject of inherited syphilis, showing the appearance when the teeth have been recently cut.

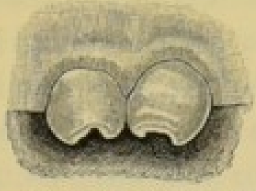


Fig. 142.—Central incisors from a lad, aged 15, the subject of inherited syphilis.

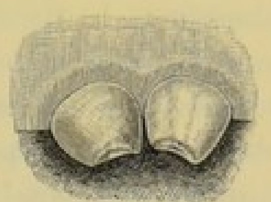


Fig. 143.—Central incisors from a patient, the subject of inherited syphilis, the notches being less deep, but the narrowing more marked than in fig. 142.

[1] Figs. 141 to 143 are from Mr. Jonathan Hutchinson's original paper entitled "On the Influence of Hereditary Syphilis in the Teeth,", *Trans. Odonto. Soc.*, vol. ii, p. 95, Old Series.

proposed to deal with the anatomical condition of the deformity. The teeth generally affected are the permanent incisors, both upper and lower, at times the canines, and frequently the first molars.

The incisors are small, pegtop-shaped teeth. The distal margins of the centrals are generally turned outwards, and it will also be noticed that the alveolar portion of the jaw in the incisor region is imperfectly developed. The teeth are generally affected symmetrically, but exceptions occur, as, for example, when one incisor is perfectly formed and the other presents the typical syphilitic form.

In a healthy tooth when just erupted, the cutting edge is seen to be surmounted by three little tubercles separated by two shallow notches, and, the tubercles being rapidly worn down by attrition,

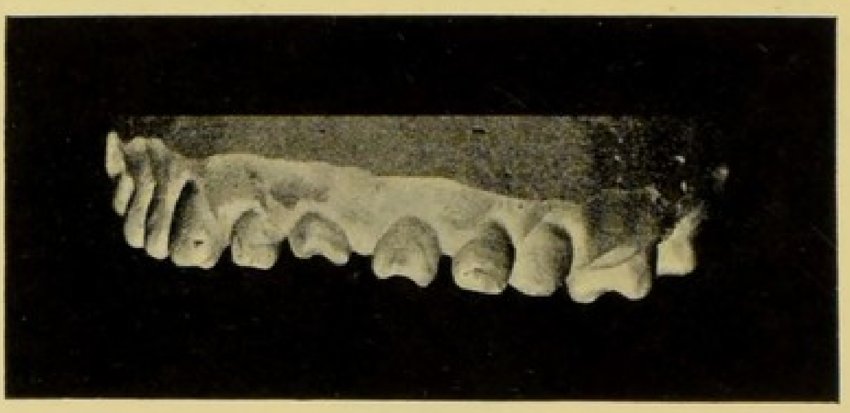


FIG. 144.[1]—Model showing syphilitic incisors.

the cutting edge soon appears quite straight. In the syphilitic tooth, these tubercles and notches are well marked, and the central tubercle is badly developed; the effect of attrition is to produce one central notch between the two outside tubercles. It is this central notch that is said to give to syphilitic teeth one of their characteristic appearances, but, as will be subsequently shown, it must not be solely relied upon in diagnosis, as it appears to be produced in teeth where there is not the slightest taint of congenital syphilis. Syphilitic teeth are said to be "soft" in structure, and, as a consequence, are attacked by caries or quickly worn away by mastication. Many patients, however, are seen with characteristic syphilitic teeth in which the enamel appears

[1] From a photograph by Mr. G. G. Campion.

to be quite normal. The laterals are not always deformed, the centrals being considered by Mr. Jonathan Hutchinson as the "test" teeth. Dr. Leon Williams has found in the case of a syphilitic tooth which he examined microscopically, that the enamel was of very faulty character and that the dentine contained interglobular spaces in abundance.

The deformity of the canines shows itself by a circumferential notch occurring near the cutting edge or point of the crown.

The molars, like the centrals, are smaller than normal. They are dome-shaped, and the crown surface is of an irregular pattern, instead of having well-developed cusps (see fig. 145).

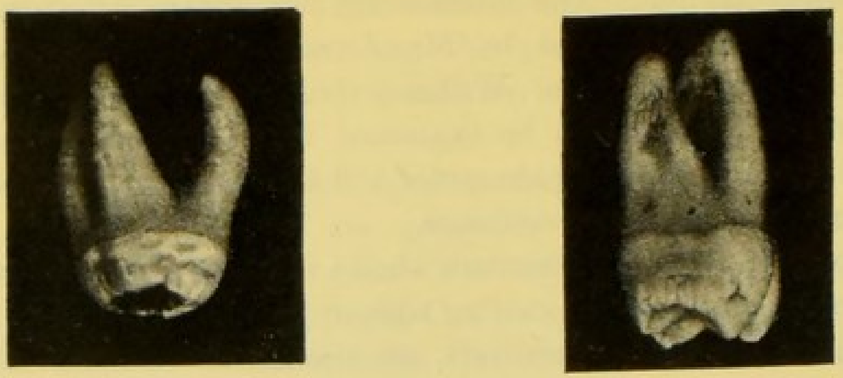
The *Spirochæta pallida* is to be found in the dental follicle in proximity to the vessels and their walls. Figs. 146 and 147 are from a paper by Dr. Pasini.[1]

Dr. Cavallaro, in an exhaustive paper on the Relation of Syphilis to Dentition,[2] confirms the discovery of Pasini that the *Spirochæta pallida* is to be found in abundance in the dental follicle. He shows that a curious modification of the lower ends of growing teeth can often be demonstrated in the form of a constriction of the dental papilla which clinically corresponds to the atrophy of the tooth cusps so often seen. He states that at this part certain changes can be noted in the pulp tissue, the nuclei are better stained, and the infiltration of the embryonal cellular elements is more intense. He also has found in the dental follicles the following alterations—namely, endovasculitis, perivasculitis, and hæmorrhage. In addition to the changes in the follicle, already referred to, he finds certain histo-chemical alterations in the enamel and dentine.

The *diagnosis of syphilitic teeth* is easy. At times, however, abnormal teeth somewhat resemble syphilitic teeth in appearance. For instance, in patients who have suffered from rickets a distinct tapering notched tooth is sometimes seen, and in some cases of hypoplastic teeth, where the deformity is confined to the edge, the central portion wears down more rapidly than the side. The notch produced upon the teeth by the use of a clay pipe should

1 "Demonstration of the *Spirochæta pallida* in the Dental Follicle of a Congenital Syphilitic," *La Stomatologia*, November, 1908, p. 5.

2 *Dental Cosmos,* November and December, 1908; January and February, 1909.



(a) (b)

Fig. 145.[1]—The syphilitic molar (a) is shown in contrast with a normal-shaped molar (b)—both slightly enlarged. The patient from whom the syphilitic molar was removed was under the care of Mr. E. P. Collett. There was a typical history of congenital syphilis.

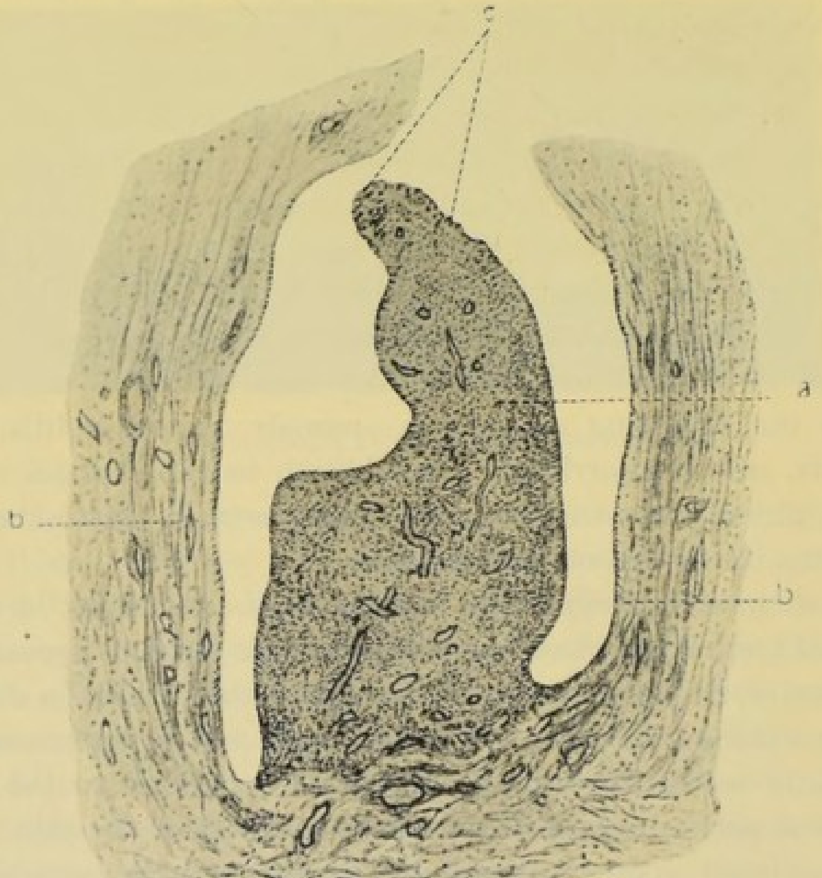


Fig. 146.—a, dental papilla; b, dental sac; c, free extremity of the papilla.

[1] From a photograph by Mr. G. G. Campion.

not be mistaken for a syphilitic notch, as it would be unilateral and altogether different in character. The diagnosis of congenital syphilis can also be confirmed by the presence of other lesions, such as scars radiating from the angles of the mouth, dusky-coloured skin, prominent forehead, broad, depressed bridge of nose, and interstitial keratitis.

Children who suffer from phagedænic ulceration of the mouth, syphilitic in origin, are generally free from the typical teeth. It is as well to remember that the diagnosis of congenital syphilis by no means rests upon the presence or absence of these teeth,

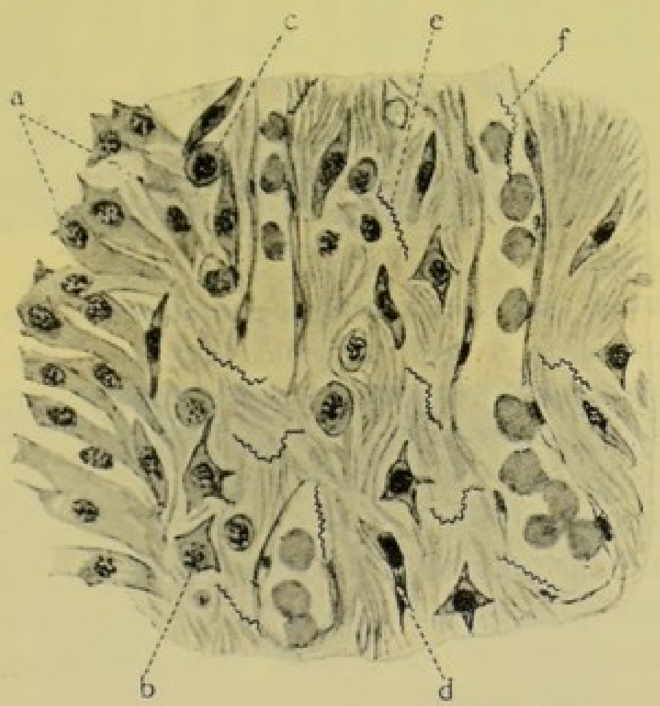


FIG. 147 (from part (*c*) of fig. 146).

(*a*) Odontoblasts of irregular shape and distribution.
(*b*) Polygonal cells, (*c*) Round cells, (*d*) Fusiform cells — of the dental papilla.
(*e*) *Spirochæta pallida* situated in the gelatinous tissue of the dental papilla.
(*f*) *Spirochæta pallida* situated in the lumen of a capillary and partly attached to the endothelium.

for they are only met with in a small proportion of cases. Mr. Moon has suggested an explanation of the deformity. He believes that "the peculiar shape results from a stunted development of the first formed portion of dentine, in other words, a dwarfing of the cusps; and that the single central notch on their cutting

edge is due to a greater diminution in the size of the central than the lateral lobes."

The lesions of syphilis on the teeth are usually seen in the permanent series on the incisors and the first molars, and this is to be attributed to the fact that the maximum intensity of the virulence is during the last months of intra-uterine life and the first three months of extra-uterine life, the time corresponding to the formation of these teeth. A case is reported by Dr. Welander[1] of a lad who acquired syphilis between three and four months of age from his nurse. In this patient, the tooth characteristic of syphilis was present.

The deciduous teeth do not always escape, and the characteristic lesion is occasionally met with in the deciduous incisors.[2] The probable explanation of the escape of the deciduous teeth is that these teeth are formed in the early months of uterine life, when syphilis rarely manifests itself, and, if it does, usually tends to abortion.

(2) **Gout** is said to produce characteristic teeth, but on careful examination it will be found that the "characteristics" are merely the result of early recession of the gums, combined with marked attrition upon the masticating surfaces, making the teeth appear bony with squarish tops, and are therefore not true characteristics.

(3) **Hypoplastic Teeth** (Honeycombed Teeth).—To the naked eye this condition is characterized by a defective formation of the enamel, accompanied, in many cases, by a stunted growth of the portion of the tooth affected.

In the type of hypoplastic teeth most usually met with, the first molars, together with the incisors and canines, are affected, the defect extending from the cutting edges, and involving, in severe cases, the whole of the crown surfaces. In mild cases, the enamel presents only a slight pitting; in more advanced conditions, the enamel is dark in colour and presents numerous deep pits, while in severe cases the enamel covering is slight and the cutting edge of the tooth presents sharp points, giving the tooth a curious spine-like appearance. In another variety, the enamel

[1] *Nord. Med. Archiv.*, vol. 27, No. 3.

[2] See case recorded by Dr. G. F. Still, *The Practitioner*, July, 1904.

is simply deficient in quantity, and shows little or no pitting. In some cases, the rows of pits run transversely across the tooth, separated from one another by well-formed enamel; while other examples are seen in which the surface of the tooth shows transverse grooves, the enamel everywhere presenting a smooth, glossy appearance. In rare instances, the defects run in a vertical

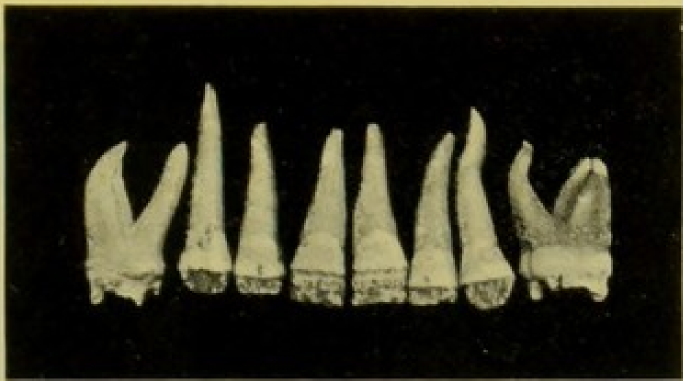


FIG. 148.—Hypoplastic maxillary incisors, canines, and first molars from the mouth of a patient who had suffered from rickets.

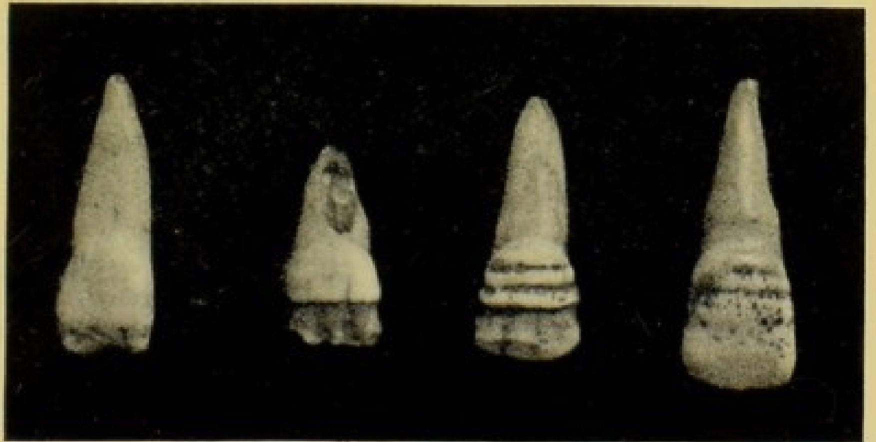


FIG. 149.—Examples of hypoplastic maxillary central incisors.

direction. In some patients, the enamel towards the cutting edge of the tooth may be well formed, the defect starting beyond this point. The amount of deformity may be limited to a transverse band of tissue situated in any part of the crown. Examples of hypoplastic teeth are shown in figs. 148 to 151.

As previously mentioned, the incisors, canines, and first molars are the teeth usually involved in severe cases; the pre-

molars and second molars may also be affected. On the other hand, the deformity may be limited to the occluding surfaces of the first molars. In cases where the defect in the incisors is limited to the centre of the cutting edge, this portion wears down at a greater pace than the sides, giving rise to a well-marked notch, which must be carefully discriminated from the notch resulting from syphilis.

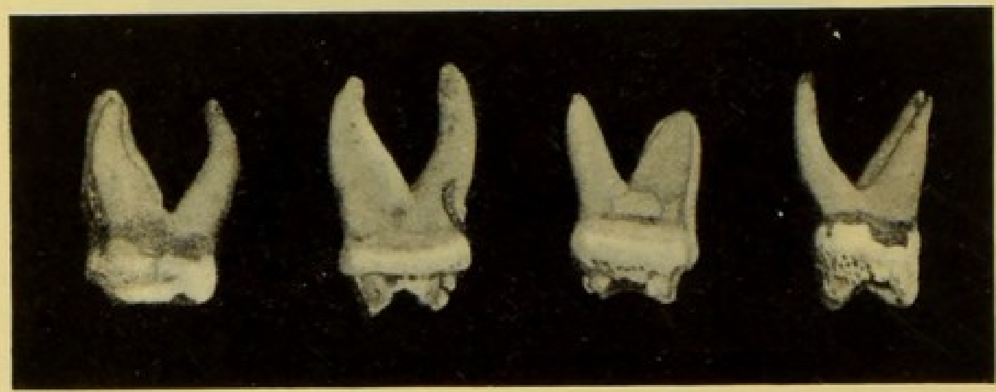


FIG. 150.—Examples of hypoplastic first maxillary molars.

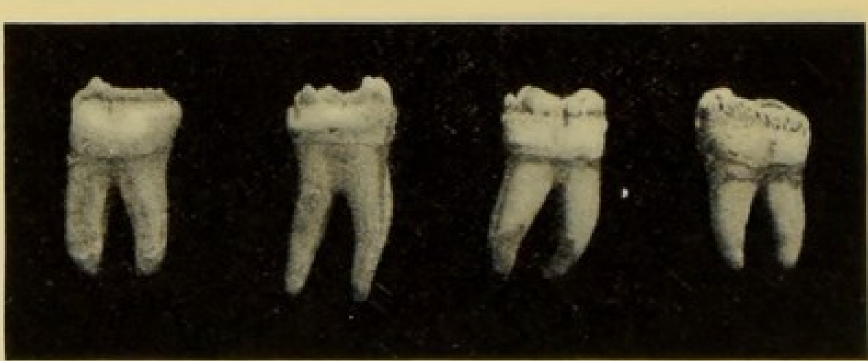


FIG. 151.—Examples of hypoplastic first mandibular molars.

In the skulls of monkeys and other animals showing rickets, hypoplastic teeth are occasionally seen. The specimen shown in fig. 152 is from an Abyssinian lion about 5 years old. The canines, from the tips to half-way up the crowns, are practically devoid of enamel, and the incisors, premolars and molars all show defective enamel in places. The *post mortem* on this animal revealed a condition simulating acute osteo-arthritis.

Hypoplastic teeth are met with in the deciduous dentition. In the specimens figured, this condition is well shown (fig. 153).

In the canine, the enamel has been attacked in the neighbourhood of the neck, proving that the lesion was produced by some cause acting after birth; while, in one molar, the enamel attacked is on the masticating surface, and the lesion was therefore probably due to some arrest of development *in utero*.

Microscopical Appearances.—The enamel will be found to be extremely thin in the position of the pits or grooves, and may,

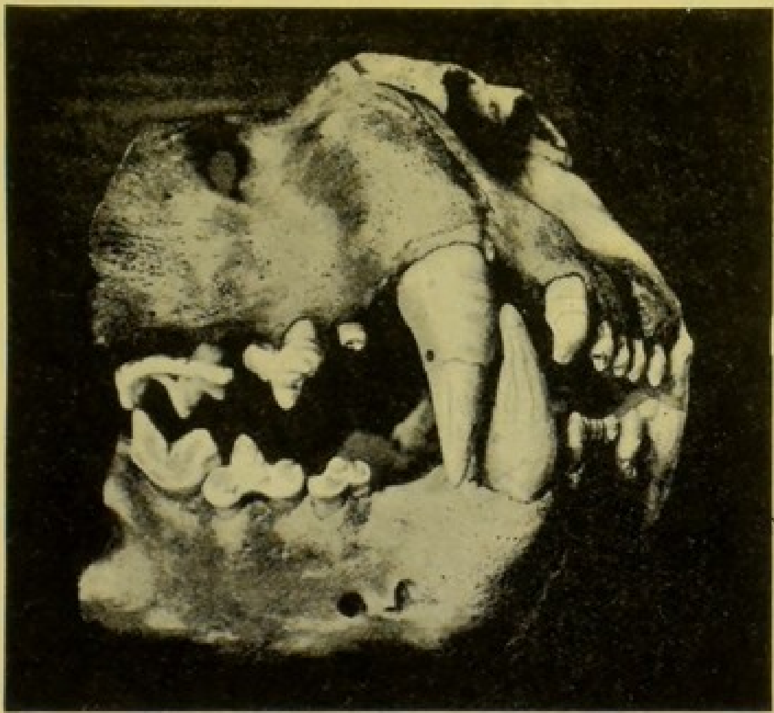


FIG. 152.[1]

FIG. 153.

in some cases, be entirely absent. The striation of the enamel prisms is generally well marked, and the condition known as the "brown striæ of Retzius" is also present. In severe cases, the enamel in parts appears as a homogeneous brown mass. The dentine is seen to contain a large number of interglobular spaces,

[1] From *Trans. Odonto. Soc.*

and in those teeth where the cause has acted intermittently, these spaces will be found arranged in rows taking an upward and inward direction and corresponding to the pits or rows upon the enamel (see figs. 154 and 155).

Dr. Grevers, of Amsterdam, has pointed out that in some cases the defect visible on the surface is continued through the whole thickness of enamel.

Frequency of Hypoplastic Teeth.—These defective teeth are most frequently met with in the lower classes. Mr. Sidney

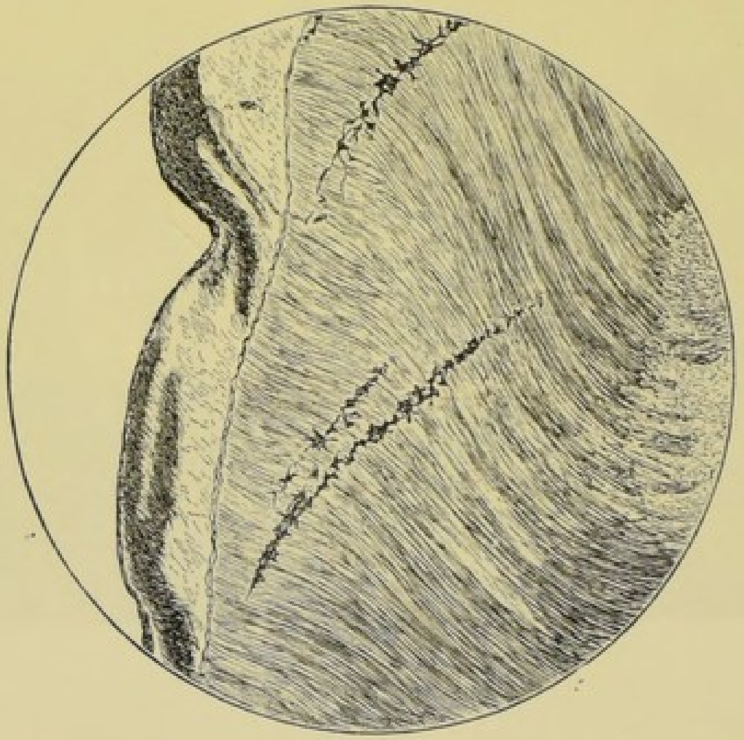


Fig. 154.

Spokes[1] found that in 258 boys in one of the Public Schools 4·6 per cent. had hypoplastic teeth, whilst in 1,463 boys and girls belonging to a Poor Law school the number affected was over 7 per cent., and in 183 from a Poor Law Ophthalmic School the figures reached about 15 per cent. In these figures, enamel defects of the incisors and molars were alone included. Mr. Sidney Spokes found in 250 infants fifteen cases of hypoplasia.

Etiology.—In seeking the cause of the deformity, it must be remembered that the period at which the deformed enamel was

[1] *Journ. Brit. Dent. Assoc.*, 1897, p. 31.

being calcified must synchronize with the activity of the supposed cause. In most cases, the malformation is on the crowns of the central incisors, the laterals, and the canines towards the cutting edges and on the crown surfaces of the first molars. This points to a cause acting during the first two years of life. Mr. Jonathan Hutchinson attributes the deformity to a stomatitis arising from the use of mercury. It will frequently be found on inquiry that patients with hypoplastic teeth were given mercury for convulsions, &c., during teething, or some form of teething powders containing mercury was used. On the other hand, it should be remembered that many patients come under notice to whom no teething powders have been administered, but the hypoplastic

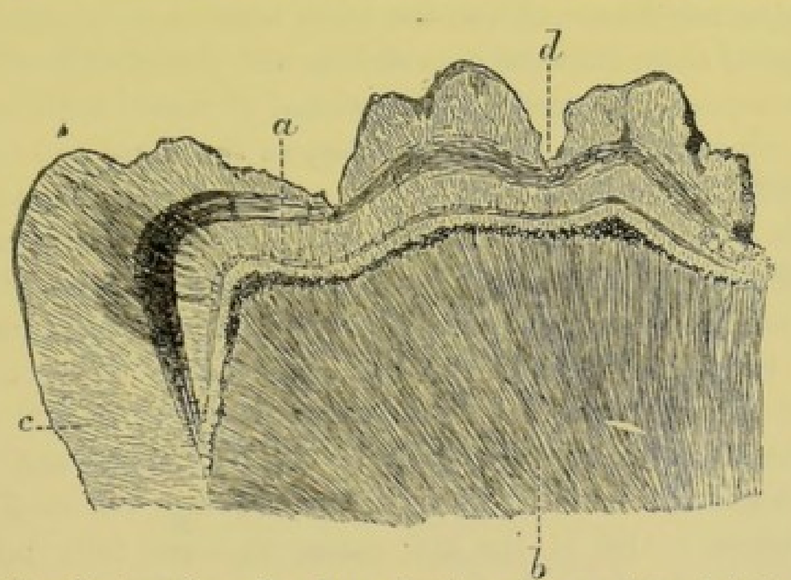


FIG. 155.—Section through a hypoplastic molar. *a*, interglobular spaces; *b*, dentine; *c*, enamel; *d*, a pit upon the masticating surface.

teeth are nevertheless present; and, still further, cases are seen where teething powders, including Stedman's, were freely administered during the process of teething without apparent effect upon the structure of the teeth.

An interesting case came under notice at the Dental Hospital of London. A boy, aged 3½, was sent to me, suffering from well-marked stomatitis due to the administration of mercury. At this period, calcification is taking place in the premolars. These teeth have since erupted with the enamel in all respects perfectly formed. In this case the stomatitis did not lead to hypoplastic teeth—indeed, there is but little evidence to connect

mercury with hypoplastic teeth in the relation of cause and effect.

It has been asserted that the epileptiform convulsions associated with such cases during infancy are the cause of the deformity, while others state that it is the mercury given to cure the convulsions which produces the abnormality. These are not satisfactory explanations; and the following case is of interest as bearing upon the above. A patient, D. P., had three attacks of convulsions during teething for which no mercury was administered. The enamel of the teeth in this patient was slightly deformed. The remaining members of the family had no convulsions, but nevertheless were given a numberless supply of teething powders, and yet the teeth were quite normal. This case goes to show that the convulsions and defective development were associated. It seems more rational to regard both as effects from a common cause, rather than one as the cause and the other as the effect. From the history of many cases it would appear that this defective dental development is due to mismanagement in the feeding of infants, as a large number of children with these teeth have been fed upon artificial foods of a starchy character.

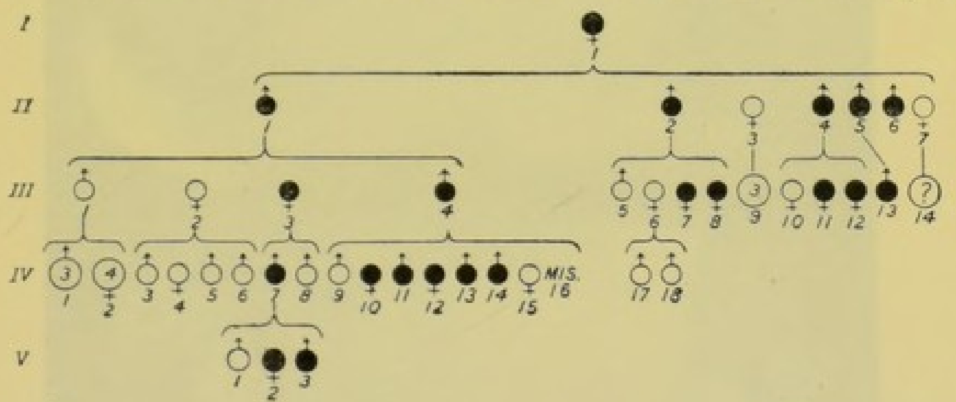
Dr. Kingston Barton, who has given much attention to this question and has kept careful records, states that in 202 children he found 10 cases of hypoplasia in the permanent and 5 cases in the deciduous series. These latter occurred out of 67 hand-fed children. Out of the 202 cases, 54 were fully breast-fed, and in these no hypoplasia was present. He also adds that in two cases of very bad artificial feeding very early and extensive caries occurred.

Lamellar cataract is usually associated with hypoplastic teeth. Mr. N. G. Bennett[1] found the tooth abnormality in 22 out of 26 cases, and in 12 of the cases the defect in the molars extended up to or within an eighth of an inch of the gum margin.

Hypoplasia, characterized by a single horizontal band of defective tissue, can usually be traced to one of the specific fevers, though it must be remembered that an exanthemata occurring during infancy will not in every case affect the teeth. The facts which point to the exanthemata being the active cause in some cases are, briefly, that in children who have had one

[1] *Trans. Ophthal. Soc.*, vol. xxi.

of the eruptive fevers during infancy, but who are otherwise healthy, distinct structural defects can be detected; and that the period during which the defective portion of the tooth was calcifying synchronizes with the attack of the fever. Measles seems to produce the deformity most frequently, and, next after measles, scarlet fever. It might be anticipated that each separate fever would produce characteristic results, but this does not seem to be the case, it being apparently impossible to determine with any certainty which fever has been the cause of the deformity. In support of this statement the following case may be instanced. A. D., when 2 years old, had an attack of scarlet fever, followed at a short interval by an attack of measles. The attacks were only slight, and little or no effect could be detected on the labical surfaces of the incisors, but



● indicates an affected person.
O indicates an unaffected person.

A large circle indicates a childship. The figure inside indicates the number of children. Where sex is known it is added.

FIG. 156[1] (Turner).

on the lingual surfaces of both the centrals and laterals, rather more than half-way up, two slight rings appeared. Both rings were precisely similar in appearance, and were no doubt the result of the two different attacks of fever.

Congenital hypoplasia of the teeth is a rare condition. In one case recorded by S. Spokes[2] the teeth were of a dark brown colour. There were grooves in the long axis of the tooth, and in some places there was a total absence of enamel, while in

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[1] From *Trans. Odonto. Soc.*

[2] *Trans. Odonto. Soc.*, June, 1890, p. 229.

other places the enamel was present in irregular patches. The family history of the patient revealed the fact that a similar

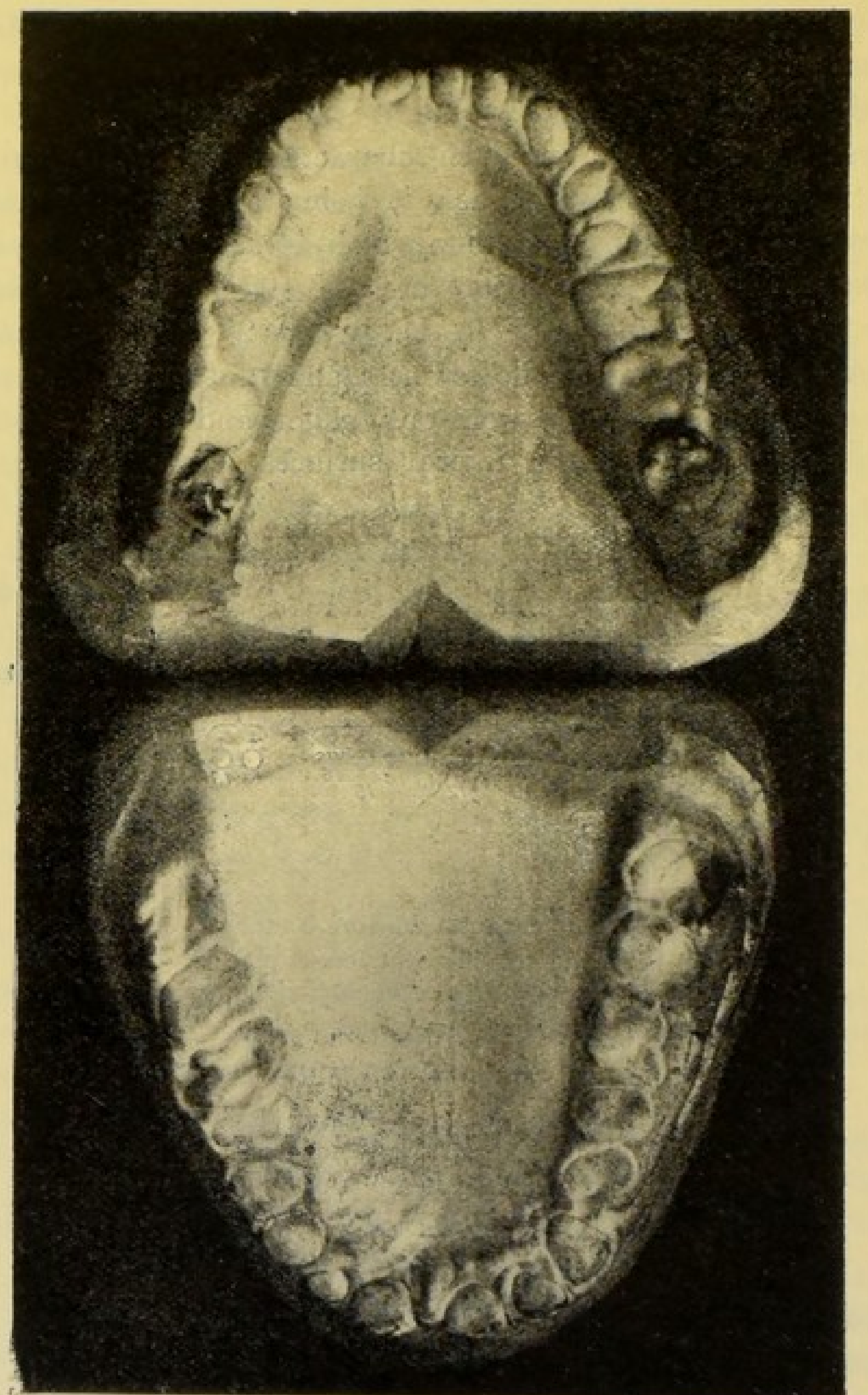

FIG. 157[1] (Turner).

condition existed in many of the members, and that both the deciduous and permanent teeth were affected. The character

[1] From *Trans. Odonto. Soc.*

of the teeth was ascertained in forty-two individuals spread over four generations and, of these, twenty-three had defective enamel.

An excellent account of a family showing this hereditary hypoplasia of enamel was recorded by Mr. J. G. Turner,[1] who was able to trace the defect through five generations. Of the fifty individuals composing the table, twenty-one showed the abnormality (fig. 156). The abnormal condition was always transmitted through abnormals. The defect took the form of a stunting of the teeth, accompanied by marked defect of the enamel, affecting both the deciduous and the permanent dentition (fig. 157). The condition was generally symmetrical, but in one case the maxillary canine was markedly affected on one side more than the other.

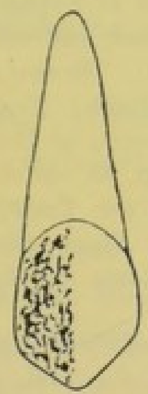

FIG. 158

(B) DEFECTS DUE TO LOCAL CAUSES

Defects in the structure of teeth may, in rare instances, be produced by local causes. The malformation is usually limited to a single tooth and may take the form of a pit, ring, or patch, or may extend to the total absence of enamel. The premolars are usually affected, and Mr. Spokes finds that the condition is more frequently seen in the mandibular premolars and in the second more than in the first. In one case of local defect which came under notice, the distal half of the maxillary left canine was covered with small pits, the mesial half being quite normal (see diagram, fig. 158). In another instance, a patient had a distinct line of pits half-way down the right lower central, and

[1] *Trans. Odonto. Soc.*, vol. xxxix, p. 137.

her mother remembered the child receiving a severe blow on the chin, injuring the deciduous predecessor and leading to its early loss. (See also chapter on injuries of the Teeth.)

In many of the cases a single premolar is affected, and distinct evidence of suppuration in connection with the deciduous predecessor can be obtained.

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CHAPTER V

Abnormalities in Position of the Teeth

General Considerations—Etiology—Classification

(A) GENERAL CONSIDERATIONS

(1) THE NORMAL ARRANGEMENT OF THE TEETH

BEFORE considering the question of abnormal position of the teeth, it is necessary to determine what is to be regarded as normal.

(1) **The Deciduous Teeth.**—If the mouth of a well-developed child of the age of five be examined, it will be noticed that the maxillary and mandibular teeth are arranged in arches with regular curves. The arch formed by the maxillary teeth is greater than that formed by the mandibular teeth, so that, on occlusion, the maxillary teeth overlap the mandibular teeth. On a more detailed examination of the arrangement of the teeth it will be noticed that the maxillary central and lateral incisors overlap the mandibular central and lateral incisors in addition to the anterior half of the canine; the maxillary canine overlaps the posterior aspect of the mandibular canine and the anterior third of the first deciduous molar; the maxillary first molar occludes with the posterior two-thirds of the mandibular first molar and the anterior third of the second molar; the second maxillary molar occludes with the posterior two-thirds of the second mandibular molar and projects a little beyond this tooth (fig. 9).

(2) **The Permanent Series.**—The arch formed by the permanent teeth varies considerably in different races. The canines and incisors form a curve which is the arc of a varying sized circle; the premolars and molars pass back from the canines in straight but diverging lines, the third molar being often set slightly internal to the line. To the above there are many

variants, *e.g.*, the premolars and molars are at times arranged in a well-marked curve, and sometimes in a perfectly straight line diverging only very slightly.

The arch formed by the upper teeth is greater than that formed by the lower. The upper central and lateral incisors overlap the lower central and lateral incisors in addition to the anterior half of the canine; the upper canine overlaps the distal half of the canine and the anterior half of the lower first premolar; the first upper premolar occludes with the posterior aspect of the first lower premolar and the anterior aspect of the second pre-

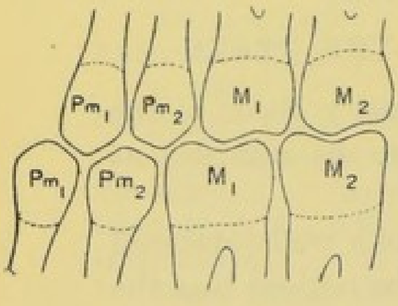


Fig. 159.[1]

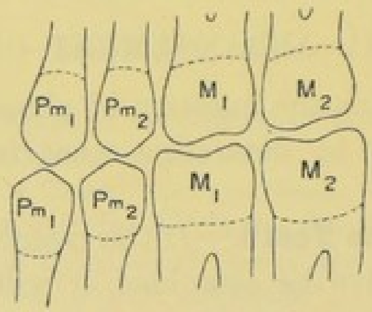


Fig. 160.[1]

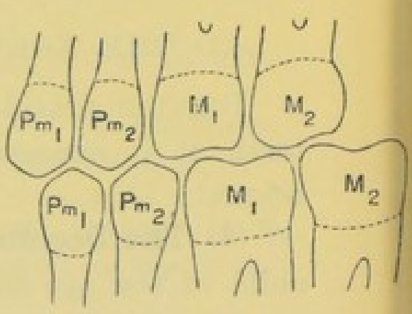


Fig. 161.[1]

In reference to the occlusion of the teeth, the following notation will be adopted:—

N, to indicate that the occlusion of the teeth is normal, fig. 159.

X, to indicate that the mesial surfaces of the molars or premolars are flush, fig. 160.

O, to indicate that in occlusion the mesial aspects of the maxillary molars are in advance of the mandibular, fig. 161.

molar; the upper second premolar occludes with the posterior half of the second lower premolar and the anterior third of the first lower molar; the upper first molar occludes with the posterior two-thirds of the lower first molar and the anterior third of the second molar; the second upper molar occludes with the posterior two-thirds of the second lower molar and the anterior third of the third molar; the upper third molar meets the posterior two-thirds of the lower third molar.

Any deviation from the above arrangement must be regarded as abnormal, but before dealing with circumstances which are responsible for the production of irregularities it is necessary to

[1] From *Proc. Roy. Soc. Med.*

review briefly some points in connection with the development and growth of the jaws and arches.

(2) THE DEVELOPMENT AND GROWTH OF THE JAWS

The maxilla, formed from the maxillary process, arises as a membrane bone external to the cartilaginous nasal capsule and in the neighbourhood of the canine tooth germ by one centre of ossification. From this centre three processes rapidly radiate :—

(1) A nasal process which grows upwards.

(2) An alveolar process which grows downwards, is thickened at its root to form the malar process, and might be called the alveolo-malar process.

(3) A palatine process which grows inwards.

The premaxilla is formed from the meso-nasal process and fuses with the maxilla about the third month, the maxilla overlapping and almost excluding it from the face. At birth, the tooth germs lie in close proximity to the orbital plate, the antrum being represented by a slight depression internal to and just above the follicle of the second deciduous molar.

The crypts of the incisors and canines are complete, but between the first and second molars the septum is still imperfect. The lateral incisor lies slightly posterior to the central incisor, and the crypt of the first molar is in close proximity to it, the canine lying between and anterior. As the time for the eruption of the incisors approaches, the space between the lateral incisor and the first molar increases, the growth of bone at this point continuing until the eruption of the canine. There seems to be some reason to suppose that room is made in the arch for the canine by growth of bone at the suture between the premaxilla and the maxilla.

With the eruption of the second molars the deciduous dentition is complete. An examination of the mouth at this stage will show an interval between the first molar and the end of the alveolar ridge. This interval increases in size until the advent of the first permanent molar. A skull examined at this period, namely, about six years of age, would show the following condition : In the maxilla, the lateral incisors are placed slightly posterior to the central incisors and are directed more vertically. The premolars are embraced by the roots of the deciduous molars

and their crowns are directed inwards, the second more than the first. The first premolar is normally situated close to the lateral incisor. The canine lies above and external to the arch of the incisors and premolars, and is directed slightly outwards. The first permanent molar will be in the process of erupting, and the occluding surface will be directed outwards to a slight extent. The second permanent molar is situated high up in the tuberosity of the bone, with its occluding surface directed downwards, outwards and well backwards.

In the mandible, the lateral incisors lie in a plane posterior to the centrals, and the canines are placed near the lower border of

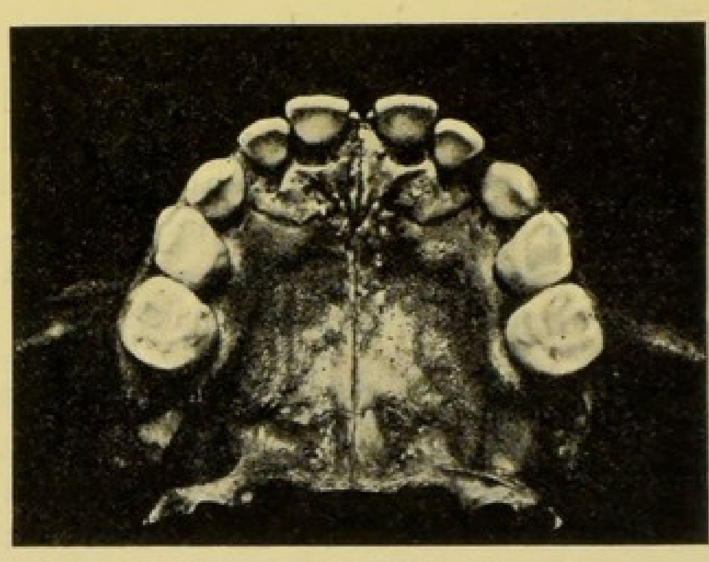


FIG. 162.[1]—In this specimen the premaxillæ are each developed from two centres. The sutures are well marked.

the bone and lie in a plane anterior to the lateral incisors with a slight tilt towards the median line. The premolars are embraced by the roots of the deciduous molars and their crowns are directed inwards. The first permanent molars are directed upwards and forwards, the second being under the base of the coronoid process with the occluding surface directed upwards, forwards and slightly inwards.

Now, in order that a regular arch may result from this somewhat chaotic arrangement of the developing teeth, it is necessary that the growth of the jaw should continue without interference.

Let us consider first of all the replacement of the deciduous

[1] From *Proc. Roy. Soc. Med.*

teeth by their permanent successors. The first change noticeable is the gradual spacing of the deciduous incisors for some time previous to the advent of the permanent teeth. This spacing is usually regarded as a "translation forward of the teeth," the necessary space for the greater breadth of the permanent teeth being obtained, it is said, because the permanent teeth in consequence of the "translation" occupy the arc of a larger circle. It seems, however, possible that a growth of bone does take place in the suture between the premaxillæ and the maxillæ. Evidence

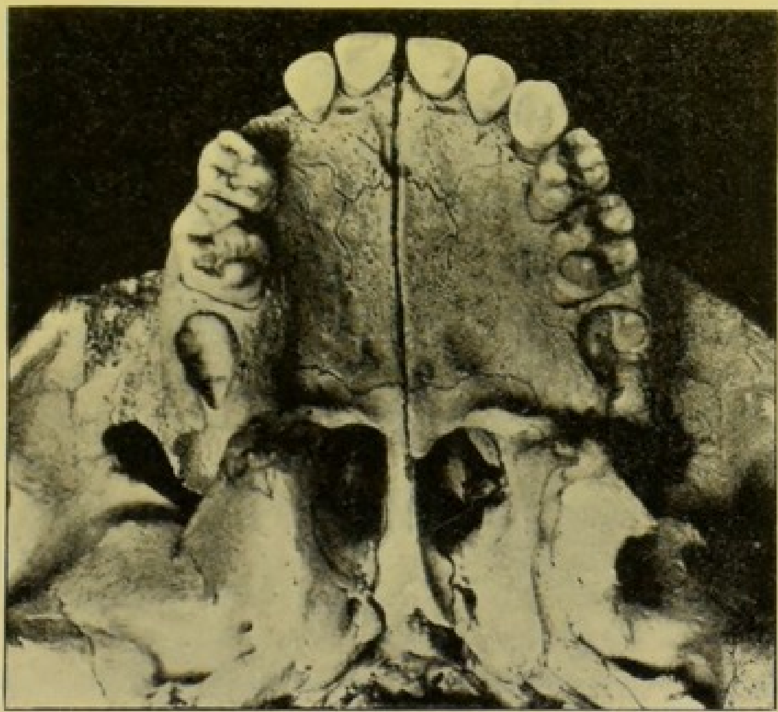


FIG. 163.[1]—In this specimen the suture is carried back into the palate.

in support of this view may be obtained by an examination of skulls of children. In maxillæ showing marked spacing of the incisors the suture is often well marked, while in others showing absence of spacing the suture is often closed. Specimens showing marked spacing of all four incisors are at times associated with premaxillæ developed from two centres. These associated conditions are, however, not always constant, and no definite conclusion can therefore be drawn from cases in which they are associated.

The permanent canine is larger than the deciduous canine, but

[1] From *Proc. Roy. Soc. Med.*

the premolars are smaller than the deciduous molars, the increase in size of the permanent canine being counterbalanced by the decrease in the premolars. The growth of the maxilla backwards provides room for the permanent molars. The growth of the maxilla has been shown by Keith[1] to be dependent on the

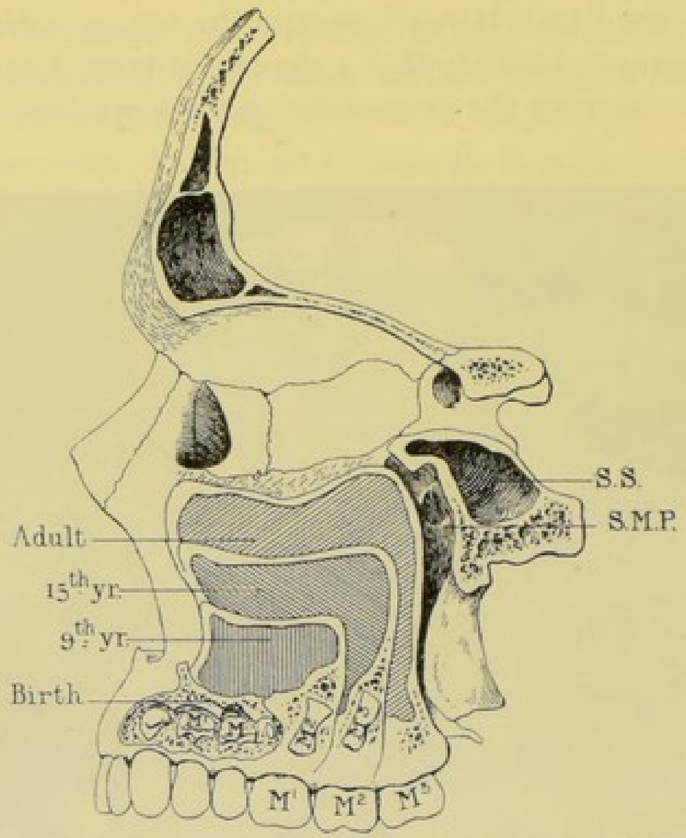


FIG. 164.—The above drawing by Arthur Keith, M.D., F.R.C.S., illustrates the position of the developing molars and the relation of the maxilla to the pterygoid processes. "The diagram is drawn to scale and is founded on material in the museums of the Royal College of Surgeons and of the London Hospital. Four stages are shown (1) at birth, (2) at the 9th year, (3) at 15th year, and (4) in the adult. . . . While the diagram demonstrates clearly the growth changes which occur in the jaw, it must not be forgotten that, in the body, the postero-superior border of the sinus is the fixed, and not the moving point as represented in the diagram."

expansion of the maxillary antrum. At birth, the antrum consists of a slight depression just above the follicle of the second deciduous molar. This depression spreads towards the orbital plate, and, at the end of the first year, has developed forwards over the first deciduous molar and backwards over the first

[1] The Expansion of the Maxillary Antrum," A. Keith, *Brit. Journ. Dent. Sci.*, June 16, 1902.

permanent molar, an extension of the sinus rapidly taking place as the remaining molars are formed.

The effect of the growth of the antrum on the eruption of the teeth can be studied by examining the relation of the teeth to the antrum in a sixth-year skull. The first permanent molar lies in close relationship to the sinus, with the occluding surfaces looking downwards and backwards. "As the tooth moves into position, it rotates so as to bring its crown downwards and backwards, while the sinus spreads downwards and backwards between the roots of the teeth. The growth of the antrum wheels, as it were, the tooth into position. An exactly similar condition occurs with the second and third molars."

"The fulcrum on which this rotation of the bone takes place is formed by the body of the sphenoid, the anterior surface of its great wing, and the pterygoid plates, mainly the internal." (See figs. 164 and 165.)

The mandible is developed in membrane as a single element, and its growth is determined to a great extent by that of the maxilla. At birth, the mandible consists of two halves joined by fibro-cartilage, and at about the sixth month the two segments unite. It is possible that before they unite the segments grow to a certain extent. The replacement of the deciduous teeth by the permanent teeth takes place in a manner similar to that in the maxilla, the space for the molars being obtained by a backward growth of the bone, the growth being correlated with the growth of the maxilla consequent on the expansion of the antrum. A recognition of this fact is necessary in studying the pathology of certain types of irregularities of the teeth.

(3) THE GROWTH OF THE JAWS IN RELATION TO THE TEETH

Under normal conditions of growth, a definite relationship exists between the size of the teeth and jaws. With the progress of civilization, however, there has come about a reduction in the size of the bone out of proportion to the reduction in the size of the teeth. Carter[1] states that "allowing for variation in length

[1] "Some Notes on the Growth of the Jaws," *Proc. Roy. Soc. Med.* Odonto. Sec., vol. i, p. 23.

of the jaw, owing to the correlation between head and jaw length, the greatest variation is in the width of the ascending ramus. The alveolar border is larger in proportion to the rest of the

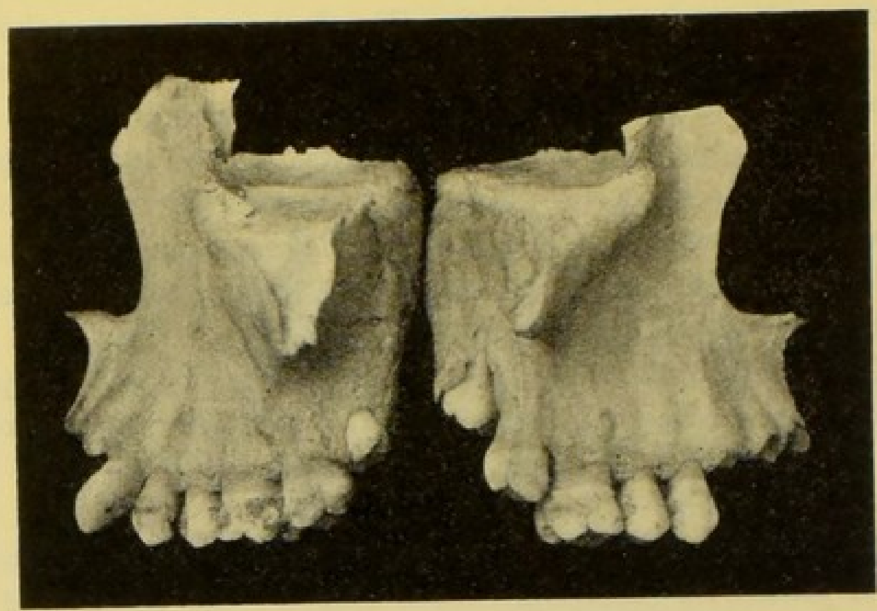


Fig. 165.—Maxillæ showing defective development of the posterior portion of the bone causing irregular eruption of the second and third molars.

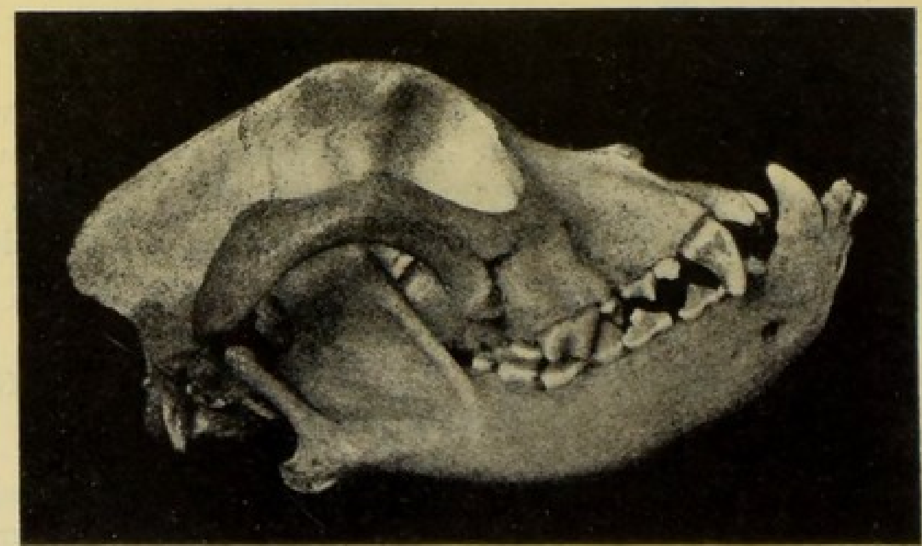


Fig. 166.—Dog. A short-muzzled variety.

mandible in women than in men, and in civilized than in the lower races."

The jaws vary in size more than the teeth, and this fact can

be readily observed in the different breeds of dogs, the amount of tooth structure varying less than the length of the jaws. The shorter the muzzle, the greater the tendency to crowding of the teeth. (See figs. 166 to 169.)

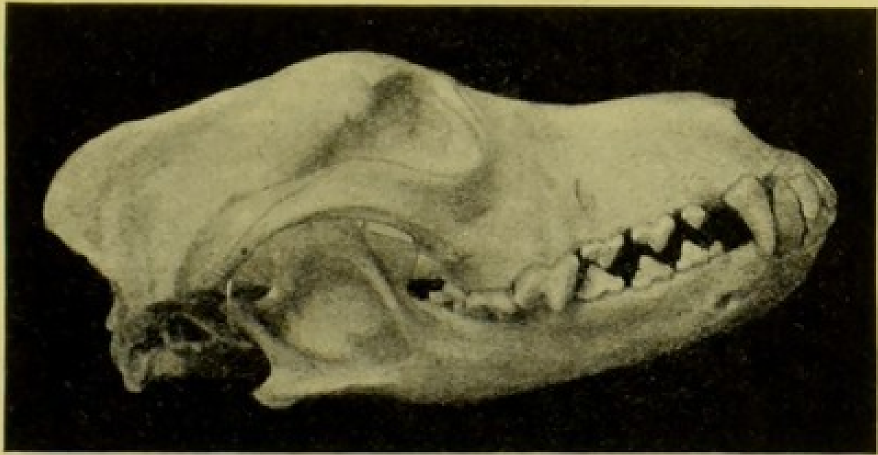


FIG. 167.—Dog. A long-muzzled variety.

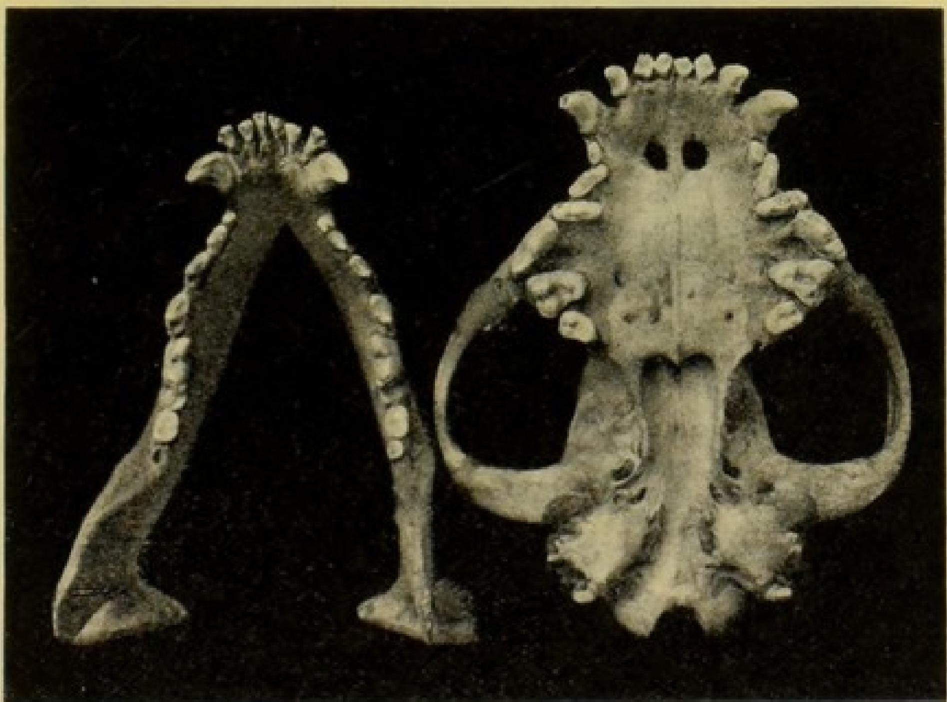


FIG. 168.—Dog. A short-muzzled variety.

"The normal orderly arrangement of the teeth in the jaws is the result of normal growth of the bone. The teeth may react on the bone, but the main factor in the translation of the teeth

to their normal position in the arch is the work of the growing bone. In other words, the arrangement of the teeth in a normal arch is not necessarily dependent on want of room in that arch."[1] (Further reference will be made to this point in dealing with adenoids.)

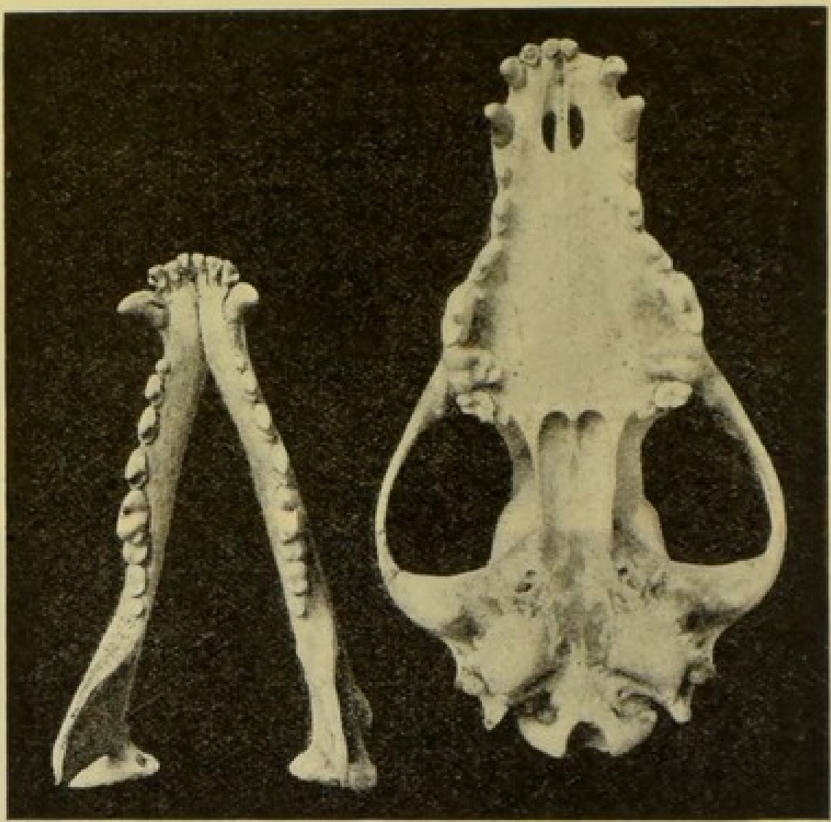


Fig. 169.—Dog. A long-muzzled variety.

(4) FACTORS INFLUENCING THE GROWTH OF THE JAWS

The growth of the jaws depends upon :—

(*a*) The unaided developmental stimulus as determined by heredity.

(*b*) Functional activity.

To the former reference will be made when the question of heredity in relation to dental deformities is considered. Functional activity may be conveniently dealt with under the following heads :—

[1] J. G. Turner, "The Influence of the Growth of Bone in the Arrangement of the Teeth," *Dental Cosmos*, vol. xlvii, p. 43.

(1) The influence of mastication.
(2) The function of the teeth.
(3) The action of the tongue.
(4) The nasal function.

It may here perhaps be pointed out that the proper function of a part is necessary for the due growth of that part, as instanced in the mal-development of the orbit which follows the loss of an eye in youth.

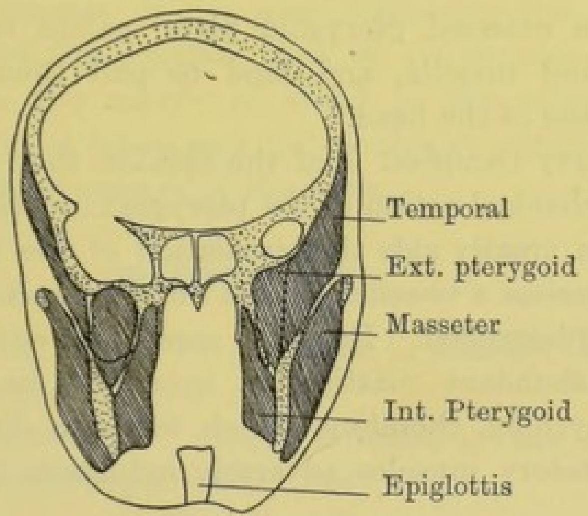


FIG. 170.[1]

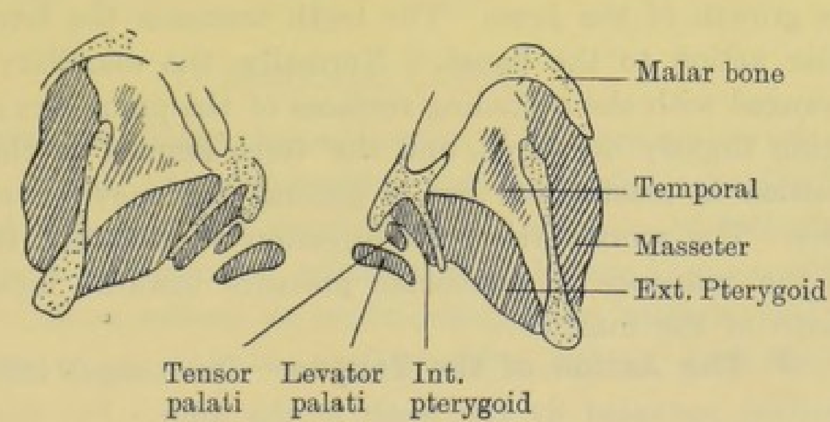


FIG. 171.[1]

(1) **The Influence of Mastication.** — In considering the influence of mastication on the jaws, a brief reference must be made to the relation of the muscles to the bones. In fig. 170 is

[1] Copied from the *Trans. Odonto. Soc.*, by kind permission of Dr. Harry Campbell.

a vertical transverse (slightly oblique) section through the head on a level with the epiglottis, showing the massiveness of the masticating muscles. Fig. 171 is a horizontal transverse section about an inch below the condyles of the mandible, showing the outward direction of the external pterygoids, as well as the close relation of the levatores and tensores palati with the internal pterygoids.

From these figures it will be seen " that the pterygoids, when in a state of contraction, must exercise an outward and backward tug on the external pterygoid plate, palate bone, body of the sphenoid and maxilla, and tend to pull them away from the sagittal plane of the head."

Dr. Harry Campbell is of the opinion that in addition to the actual mechanical action of the pterygoid muscles, their rhythmic contraction greatly aids the circulation of the blood and lymph, and so exercises a beneficial effect on the structures in the immediate neighbourhood. Existing races that live on coarse food requiring abundant mastication invariably have well-developed jaws. Anything, therefore, which tends to diminish the use of the masticatory muscles adversely influences the growth of the jaws.

(2) **The Teeth.**—The positions occupied by the teeth influence the growth of the jaws. The teeth transmit the force of muscular action to the bones. Normally, the maxillary teeth are arranged with the occluding surfaces of the premolars and molars facing slightly outwards, and the force applied to them in this position in mastication has a general tendency to expand the jaws. The more vertical the direction of the teeth the less will be the influence of muscular pressure towards increasing the width of the maxillæ.

(3) **The Action of the Tongue.**—The tongue influences the position occupied by the teeth in the arch. Dr. Sim Wallace[1] considers that the tongue is the common denominator for the correlation of the upper and lower teeth, and he is of opinion that there is an intimate connection between the size and growth of the tongue and the size and development of the jaws. A large tongue, by causing the teeth to occupy a large arch, stimulates

[1] A lucid account of Dr. Sim Wallace's views is to be found in his work on "Irregularities of the Teeth."

the outward growth of the jaws. The pressure of the tongue on the anterior part of the palate during the act of swallowing is probably an important factor in modifying this part of the mouth. In Wallace's opinion the under-development of the tongue and the decreased size of the jaws at the present day are to be attributed to the slight amount of mastication which is now necessary in the consumption of food.

(4) **The Nasal Function.**—The perfect performance of nasal respiration is an important factor in the growth of the maxilla. The use of the muscles of the nose influences the growth of the premaxilla, and the constant flow of air through the nasal passage stimulates the supply of blood to the mucous membrane lining the nasal fossa and the accessory sinuses, and so encourages the general growth of the bone.

(B) ETIOLOGY

The causes giving rise to irregularities in position of the teeth may be grouped under two headings :—

(1) General causes—*i.e.*, causes influencing the growth of the maxilla and mandible generally ; and

(2) Local causes—*i.e.*, causes the effects of which are limited to the alveolar process.

(1) General Causes

(*a*) **Heredity.**—Since the publication of Weissmann's work on the "Germ Plasm," views on heredity have undergone considerable change, and it is now the opinion of the majority of biologists that "there is no scientific warrant for believing that acquired diseases, *i.e.*, those arising as modifications from without, and to which there is no specific predisposition, are as such transmissible."

With regard to irregularities of the teeth, heredity was formerly believed to play a part of no small importance, and conditions such as protruding teeth and contracted arches were thought to be transmitted through many generations. These conditions must now, however, be looked upon as acquired diseases, and therefore not transmissible, the repetition of similar conditions in parents and children being attributed to similarity of

habits and of environment. If a child with protruding teeth has, say, a parent and uncles and aunts with a similar condition, this is not conclusive evidence that the child has inherited the condition; on the contrary, a careful inquiry into the upbringing of the individuals concerned will usually elicit the fact that their habits and environment were similar, and, further, were such as would be likely to produce protruding teeth. Such conditions in both parent and child can therefore be quite rationally accounted for without recourse to the theory of heredity. Moreover, although cases are frequently met with in everyday practice, in which both parent and child have protruding teeth, it is no uncommon experience to find a perfectly good arch in a child whose parents and grandparents present deformed palates. Now, if heredity were the cause of the parent's deformed palate, it would be only reasonable to expect to find a similar condition in the child. Inquiry into these cases will generally show that the deformed palates of parent and grandparent were the result of vicious environment, which was removed in the case of the child, with the result that growth has proceeded in a natural way.

In the light of modern experience heredity may, we think, be left out of consideration in its influence on the transmission of irregularities of the teeth. An instance suggestive of hereditary jaw deformity is to be found in the large mandibles in certain members of the Hapsburg royal line. Charles V., Emperor of Germany, had a mandible said to be protrudent in infancy; his son, Philip II. of Spain, had a similar deformity, as also had Charles II. of Spain. Too much stress must not be placed on these data, for we do not know whether the large mandible was only apparent, that is to say, the fault really resting with a deformed maxilla, the result of disease, and therefore a condition produced *de novo* in each individual, through "vicious environment."[1]

(*b*) **Modern Civilization.** — A fact which must strike any investigator of the etiology of irregularities is the comparative freedom from such defects of ancient races and even modern uncivilized races. This has been well demonstrated by many observers; for instance, Messrs. Cartwright and Coleman failed

[1] An excellent account of the transmission of disease will be found in "Heredity," by Professor Arthur Thomson. Progressive Science Series.

to find any irregularities in the large collection of skulls in the crypt of Hythe Church,[1] and Dr. Nicols (quoted by Talbot), in an examination of thousands of Chinese and Indians on the Pacific Coast and in the Rocky Mountains, searched in vain for a single instance of irregularity. Dr. Talbot himself, in 1881, examined 300 Chinese and found no irregularities either in the teeth or jaws. On the other hand, Dr. J. M. Whitney[2] has found among the Hawaiians "(a people isolated from all others for at least 1,400 years, with no admixture of races), irregularity of the teeth of both maxillæ almost as common as among the mixed races of to-day." A review of facts as recorded by various writers on the question seems, however, to point to a distinct connection between irregularities and modern civilization.

Talbot,[3] who has collected a large number of statistics relating to irregularities, states that the early Britons possessed maxillæ varying in their lateral diameters from 2·12 to 2·62 in., whilst in modern Englishmen the maxillæ vary from 1·88 to 2·44 in., the minimum diameter having thus decreased more than the maximum; and a comparison of the maxillæ of ancient Romans with modern inhabitants of Southern Italy gives a similar result. From these data he infers that a diminution in the size of the jaws has taken place in the inhabitants of England and Italy, but it is not quite clear that these comparisons of the maxillæ of ancient Britons and ourselves, and of ancient Romans and modern Italians, are good ones, for modern Englishmen are only to a very small degree, if at all, descendants of the ancient Britons; and similarly, the present inhabitants of Southern Italy have but little claim to direct descent from the ancient Romans.

It is interesting to note that a diminution in the size of the teeth can be traced in prehistoric times. W. Wright[4] shows that the average molar length in Neolithic and Bronze Age jaws is greater than in those of the early Iron Age.

There is, however, a general consensus of opinion in favour

[1] The skulls, according to Hasted's "History of Kent," probably belong to the year 456. In the opinion of Mr. Prideaux, the greater portion of the skulls belong to the Celtic type, the remainder being Anglo-Saxon. Two skulls are believed to be Roman and two others Lap and Danish.

[2] *Trans. of the World's Columbian Dental Congress*, vol. i, p. 109.

[3] "The Etiology of Osseous Deformities of the Head, Face, Jaws and Teeth," Third Edition, p. 67.

[4] *Journ. Brit. Dent. Assoc.*, February 16, 1903.

of the view that the jaws and teeth of modern races are becoming smaller, the diminution in size being greater in the jaws than in the teeth. Mr. J. T. Carter[1] states that "with the progress of civilization there has been a considerable reduction in the size of the mandible, quite out of proportion to the reduction in the size of the teeth. Allowing for variation in length of the jaw, owing to the correlation between head-length and jaw-length, the greatest variation is found in the width of the ascending ramus. The alveolar border is larger in proportion to the rest of the mandible in women than in men, and in civilized than in lower races." The various breeds of dogs afford good illustration of the fact that, where shortening of the alveolar length has taken place, the size of the teeth has not been proportionately reduced (see figs. 166 to 169).

The cause of the progressive diminution in the size of the jaws has not yet been clearly demonstrated, but, in view of all the ascertained facts bearing on the subject, the change would appear to be attributable generally to the influence of civilization, and more particularly to diet and the preparation of food. Dr. Sim Wallace, who has given considerable attention to the subject, considers that the diminution is not due to heredity, but is "a characteristic developed in each generation as the result of the action of the environment," *i.e.*, insufficient mastication deprives the jaws of the stimulus necessary for their full development, the character of the foodstuffs of the present day being responsible for the insufficient mastication.

Although the general influences of modern civilization may, and no doubt do tend to affect the growth of the jaw, it seems probable that the main causal relationship between the frequency of irregularities and modern civilization is to be traced to the influence of modern diseases on jaw development, and this subject will be dealt with in the next section.

(*c*) **The Method of Feeding in Infancy.**—There is reason to think that the method of infant feeding influences the shape of the palate and dental arch. In a series of measurements made of children free from adenoids the following data were obtained.[2]

[1] *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. i, p. 63.

[2] For the purpose of obtaining measurements the following plan was adopted.

(*a*) The breadth between the first permanent molars, the point chosen

	A	B
Breast-fed	34·85 mm.	26·31 mm.
Hand-fed	34·1 ,, ...	25·61 ,,

In hand-fed children there is a greater tendency to abnormal occlusion than in breast-fed, and the width of the palate compared to the height is also slightly less, being 2·63 in breast-fed and 2·52 in hand-fed.[1] These facts would seem to show that the breast-fed children have slightly broader arches than those fed by artificial methods. The above figures are taken from patients in private practice; figures gathered from patients in hospital show a greater difference between the breast-fed and hand-fed.

It seems quite possible that this variation in the palates and arches of breast- and hand-fed children is due to the difference between the action on the palate of the teat and the nipple. An infant, when at the breast, takes not only the nipple, but a considerable portion of the areola into the mouth, and the tongue is often seen protruding over the lower lip. In the act of feeding the mandible is first slightly depressed and then raised so as to squeeze the breast against the palate, and the milk so expelled is then swallowed. The jaws then separate to admit more milk into the flaccid apex of the breast, and the process is repeated. The general effect of this action is to bring the muscular tissue about the jaws into activity, and the effect on the palate is of a spreading character.

With the modern-shaped bottle the child is held on the left arm, and the bottle is kept at such an angle that the milk passes into the teat; the mandible then exerts a squeezing action and the milk, passing into the mouth, is swallowed. If the bottle is used correctly, but little sucking is performed by the child, the whole act simulating that of the child at the breast; but there is

being the gum margin immediately in line with the fissure in the palatine aspect of the teeth. This is denoted throughout by A.

(*b*) The breadth between the first deciduous molars or first premolars, the point chosen being the gum margin at the point corresponding to the centre of the palatine aspect. This is denoted throughout by B.

[1] To obtain these measurements plaster casts were made of the palate, and these were divided at a point corresponding to the middle of the second deciduous molar or second premolar. Tracings on paper were then made and a line drawn between the gingival edges, and from the centre of this base a line was drawn at right angles to ascertain the height.

WITHOUT ADENOIDS.

Hand-fed.

Hand-fed.

Hand-fed.

Breast-fed.

Breast- and hand-fed.

Breast-fed.

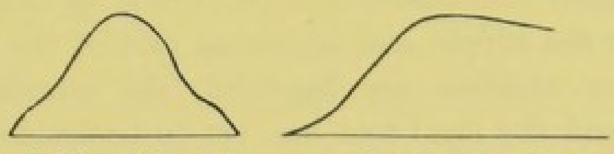
Hand-fed.

FIG. 172.[1]

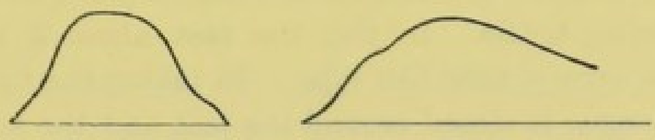
[1] From *Proc. Roy. Soc. Med.*

WITH ADENOIDS.

Breast-fed. Adenoids removed at 6 years.



Hand-fed. Adenoids removed at 2, 4, and 6 years.



Hand-fed. Adenoids removed at 6 years.

Breast-fed. Adenoids removed at 10 years.

Breast-fed. Adenoids removed at 8 years.

Breast-fed.

Hand-fed. Adenoids removed at 8 years.

FIG. 173.[1]

[1] From *Proc. Roy. Soc. Med.*

this difference, the teat is not so tough and resistant as the breast, and the pad in the mouth exerts less pressure on the anterior part of the palate; still further, the backward force of the breast upon the anterior part of the arch is absent.

It would therefore seem that teats for bottles should be made flat and broad at the base, and a little longer than at present. and of a tougher character—in other words, as near an approach as possible to the nipple and adjoining part of the breast. Now that so many children are hand-fed, the question is one of importance, and the ideal teat has yet to be designed. Tracings of the shapes of palates are shown in fig. 172.

The modern feeding-bottle is, however, a great advance on the old tube feeding-bottle. In this the teat, about 1 in. to $1\frac{1}{2}$ in. long, is of a narrow tube-like type. In taking the milk from this bottle, the tongue is closed around the teat and the act of suction is brought into play. The mandible is not used at all, and the whole action of the muscular tissue of the cheeks is towards the median line and not away from it, as is the case with the child at the breast. The action tends to narrow rather than spread the palate, the measurements of models bear evidence of this. In forty-one patients where the tube bottle had been used the average measurements were:—

A		B
32·14 mm.	.. ..	23·05 mm.

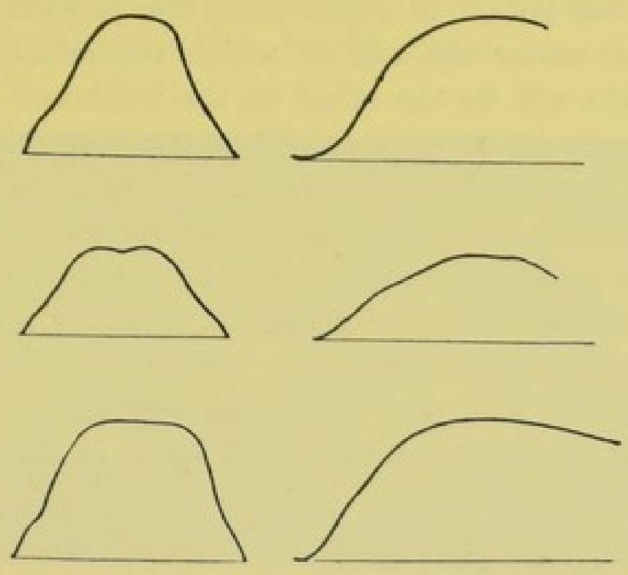
These figures, compared with those of hand-fed by ordinary boat bottles, show a marked diminution in width, especially in the premolar region.

With the tube bottle, the palatal arch is altered, as will be seen from the tracings of three cases shown in fig. 174.

These patients had not suffered from adenoids, and so may be taken as examples of the action of the tube-feeding bottle. The height of the arch is abnormal, the average breadth to the height in four cases being 1·86 compared with 2·52 and 2·63 in cases of hand- and breast-fed children. The drawing marked (*a*) is of a child of Irish parentage, and, although the arch is broader than the average, the relation of breadth to height is 2·26, or well below the average of hand- and breast-fed children.

(*d*) **The Effects of Disease on the Growth of the Jaws.** —Nasal obstruction, arising from the *presence of adenoids*,

Tube Bottles, without Adenoids.



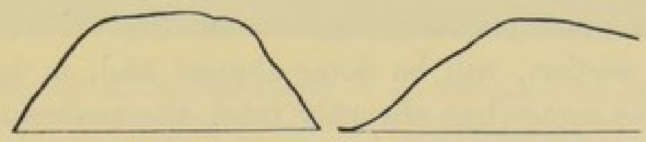
a *a*

Fig. 174.[1]

Tube Bottles, with Adenoids.

Adenoids removed at 5½ years.

Adenoids removed at 13 years. Came on before the age of 6 years.



Adenoids removed at 15 years. Came on after the age of 6 years.

Fig. 175.[2]

[1] From *Proc. Roy. Soc. Med.*

[2] *Ibid.*

greatly influences the growth of the maxilla, the effect produced depending on the period of onset and the persistence of the adenoids. The earlier the age at which the adenoids appear, the more marked will be the effect on the teeth and palate, and the longer they persist the greater will be the damage.

(1) *The Character of the Deformity*.—If the mouth of a child of about 3 to 4 years of age that was breast-fed and that had not had adenoids be examined, the teeth will be found to form a regular arch, with the anterior teeth separated by slight spaces. The vault of the palate in section across the first deciduous molars will be oval-shaped, and, on longitudinal section, will rise with a gentle incline from behind the front teeth to the vault (see fig. 176).

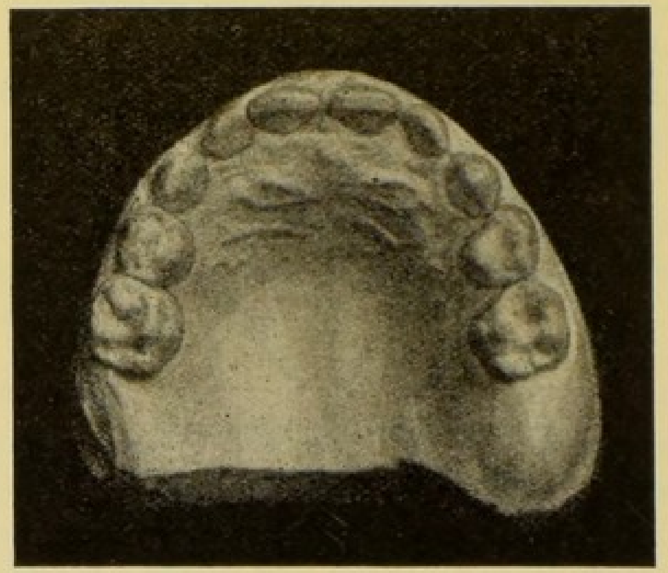


Fig. 176.

In a child that has suffered or is suffering from adenoids, the teeth will be crowded, and the muco-periosteum of the palate will present a somewhat puckered appearance (fig. 177); the vault, on transverse section, will be dome-shaped and, in longitudinal section, will rise somewhat abruptly from the posterior aspect of the incisors. The palate will have the appearance of having been pushed up towards the front (fig. 179). The deciduous molars may occlude too far forward, but this is the exception rather than the rule. If the adenoids have been removed before the age of

six and have not been severe, the effect on the permanent teeth will be to crowd the upper incisors, and the disturbance will range from a slight tilting of the lateral incisors to an irregularity

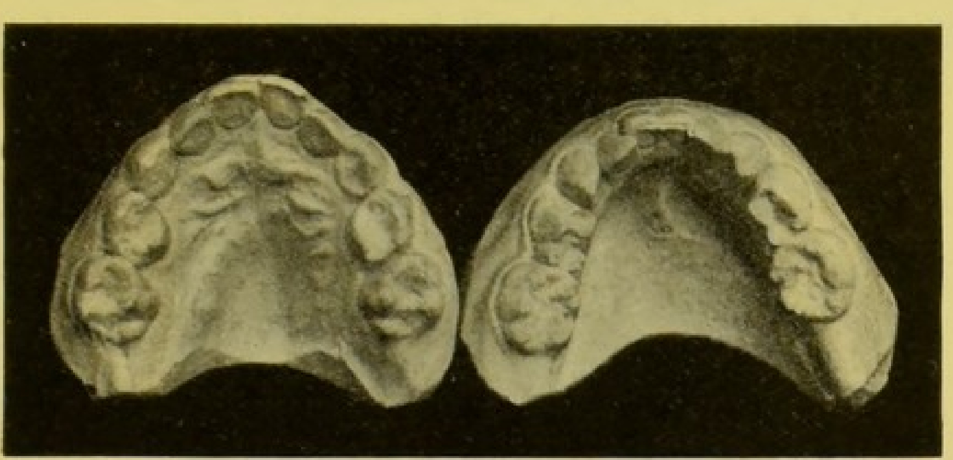


FIG. 177.—Models of a child, aged 5 years 7 months, that had suffered from adenoids from the age of 2 years. The puckered appearance of the muco-periosteum covering the hard palate, and the crowding of the teeth are well shown.

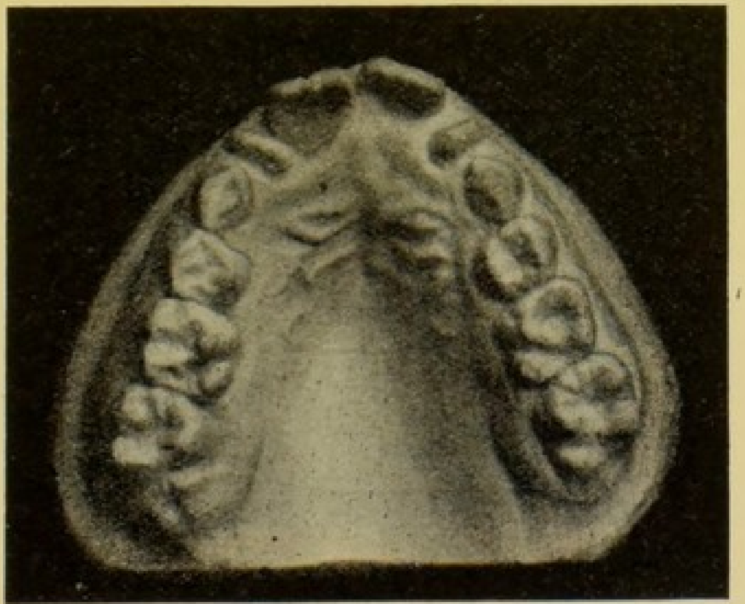


FIG. 178.—Models of the case shown in fig. 177 after the eruption of the incisors. Note the irregular position of the incisors.

involving the four anterior teeth (fig. 178). The first permanent molar erupts in good position, and, provided that the deciduous molars are retained for their normal period, the premolars will

erupt in normal occlusion. The canines, when in place, will show a slight slope of the roots towards the median line. The only permanent irregularity will be the crowding of the incisor teeth.

If the adenoids have been severe and of long duration, an additional effect on the arch will be seen in the region of the

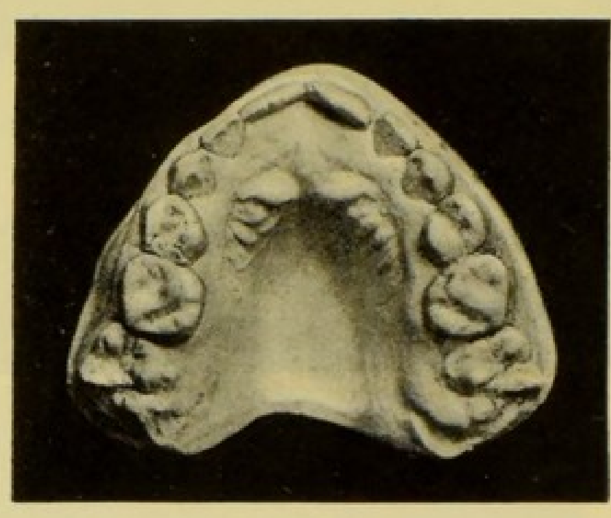


Fig. 179.—Model of a boy, aged 7. He had been operated on for adenoids three times.

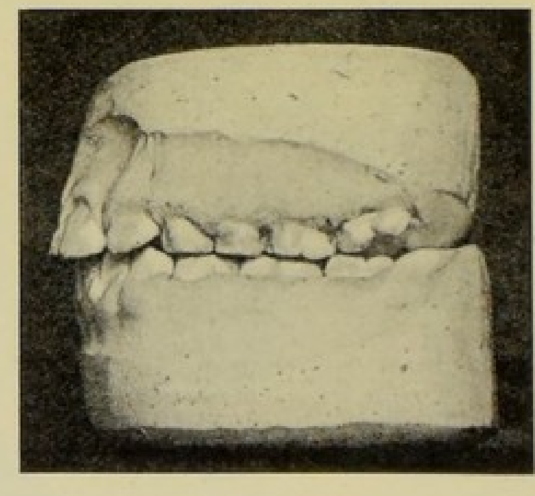


Fig. 180.[1]

first molars. The first molar, when erupted, often fails to assume a vertical position, and lies with a general slope backwards. This is well shown in fig. 180 the models of a child who suffered from adenoids. This tooth is in normal occlusion, but it is not difficult to foresee that, as soon as the second deciduous

[1] From *Proc. Roy. Soc. Med.*

molar is removed, rapid forward movement of the first molar will result in an encroachment on the space for the premolars and an abnormal occlusion.

In some cases the growth in the molar region is so restricted that the first molar erupts in such a way as to lead to absorption

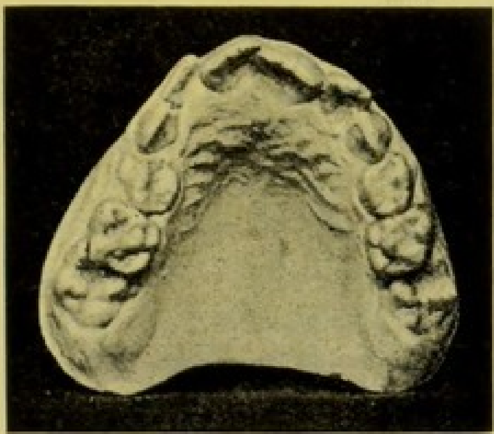


FIG. 181.[1]

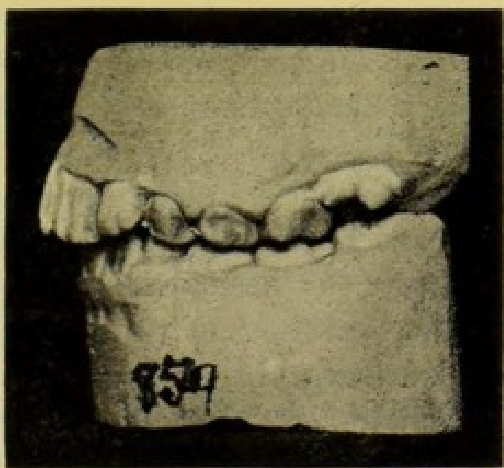


FIG. 182.[1]

of the posterior roots of the second deciduous molar (figs. 181 and 182). Under such conditions, it is obvious that abnormal occlusion must result, and the space for the premolars be considerably curtailed.

If the permanent molars do not move forward, the premolars

[1] From *Proc. Roy. Soc. Med.*

and canines erupt in normal position, and the only deformity of the arch that remains is the slight irregularity of the incisors. Where the molar does move forward, a certain amount of general crowding of the premolars and canines results.

There would appear to be a slight decrease in the width of the arch in children with adenoids, as compared with those free from adenoids, the difference being just under 1 mm. The subjoined figures would appear to substantiate this view.

	A.	B.
	Breast-fed.	
Without adenoids ..	34·85 mm.	26·31 mm.
With ,, ..	33·80 ,, ...	25·19 ,,
Difference ..	1·05 ,, ...	1·12 ,,
	Hand-fed.	
Without adenoids ..	34·10 mm.	25·61 ,,
With ,, ..	33·56 ,, ...	24·90 ,,
Difference ..	0·54 ,, ...	0·71 ,,

The measurements recorded above are from patients treated in private practice.

In persons who have suffered from adenoids, the third molars often erupt with the occluding surfaces facing backwards and outwards.

Many of the gross lesions of the jaws so often associated with adenoids must not be regarded in the light of cause and effect. They are usually the result of adenoids in conjunction with other contributory causes such as rickets, lip-sucking, &c. The influence of these latter will be considered subsequently.

Tracings of the palates of children who have suffered from adenoids are shown in figs. 173 and 175.

(2) *The Factors Producing the Deformity.*—A considerable diversity of opinion exists as to the precise manner in which the deformities of the palate associated with adenoids are produced. In a previous section, attention was drawn to the factors influencing the growth of the palate, and one of these was stated to be the proper performance of nasal respiration. In nasal obstruction, this function is in abeyance, with the result that the growth of the jaw is considerably hampered.

Dr. Campbell, dealing with the subject of nasal respiration,

says, "When we reflect that a person normally breathes some twenty thousand times through the nose in twenty-four hours, and that the constant flow of air through the nasal passage attracts an abundant supply of blood to the nasal mucous membrane, for the purpose of warming and moistening the air, giving off to it about two quarts of water per diem, it is manifest that the cessation during the developmental period of the respiratory function of the nose must interfere with the proper development of the nasal apparatus, just as early excision of an eyeball tends to defective development of the corresponding orbit."

The interference with growth would appear to occur mainly in the region of the premaxillæ and the molars. Lack of use of the muscles of the anterior nares, in addition to the loss of stimulus to the nasal mucous membrane, inhibits the growth of the premaxillæ. The restriction of growth from this cause would seem to afford an explanation of the almost constant association of crowded incisors in cases where adenoids develop during the first six years of life. The want of growth in the molar region is due to the lack of expansion of the antrum arising from disuse, and the want of growth of the maxilla is correlated with a diminished growth of the mandible.

The slight decrease in the width of the arch seen in patients with adenoids may be due to the general want of growth of the maxilla through lack of expansion of the antrum. Some authors, however, hold the opinion that such narrowing is due to the constant tension of the cheeks on the dental arches, in addition to the absence of pressure of the tongue against the maxillary teeth. It is doubtful whether this pressure of the cheeks actually exerts much influence on arches where all the teeth are present, but where early loss of teeth has occurred, or where there has been rickets, the effect is likely to be more marked.

The high arch of the palate, so often associated with adenoids, has been accounted for in several ways :—

(1) It is maintained by some that the high arch is due to the lateral pressure of the cheeks crushing in the arch in the region of the premolars and molars. This view is open to criticism, as the amount of narrowing is extremely slight and would not account for the amount of deformity seen.

(2) Others hold that the flow of air through the mouth on its

way to the trachea abstracts the contents of the naso-pharynx, and so produces a negative pressure in that cavity, and an increased pressure on all its walls. In this way, the palate is pushed up, and the sides of the arch approximated. Against this view it is urged that the main obstruction is at the back of the fossa, and not at the front. The anterior part of the palate is of considerable thickness, and the vomer, which is fairly strong posteriorly, would offer some resistance to an upward movement in the middle line. An upward movement of the palate would lead to a deflection of the part of the septum formed by the vomer, but there is not sufficient evidence of this in those with vaulted palates.

(3) Another view, and one which is probably the correct one, is based on the fact that nasal obstruction interferes with the growth of the sphenoid and septum. "The hard palate in the infant is normally high arched, and at birth it lies above the level of the Eustachian tubes but later on becomes considerably lower. This alteration is due to the downward growth of the hard palate, so that one factor in the production of a highly arched palate is a lack of development of the walls of the nose, more especially of the sphenoid and the septum." Any factor, such as adenoids, will interfere with the growth of the nasal septum, and so retard the proper development of the hard palate and consequently its descent.

All views considered, it would seem rational that the palatal deformities associated with adenoids should be attributed mainly to deficient growth of the maxillæ and that some slight degree of influence should be accorded to the tension of the cheeks, and the tongue.

Rickets.—There is no evidence to show that rickets by itself can be regarded as the cause of deformed arches, but owing to the fact that the bones in rickety persons are imperfectly formed and yield more readily to pressure, the deformities resulting from adenoids and from the use of the "dummy," or from thumb-sucking, will be more marked if rickets is present.

(2) Local Causes

(*a*) **The Premature Removal of Teeth.**—With the removal of a tooth from the arch there is a tendency for the approximal

teeth to close together. In the maxilla, this is brought about by the muscular pressure of the lips, the tension of the cheeks and the forward movement of the permanent molars ; in the mandible, by the action of the tongue and the tilting movement of the permanent molars. The extent of the deformity depends on the tooth removed, the time of removal, the occlusion of the teeth, and the development of the bones.

The following examples will illustrate these points. If a second maxillary deciduous molar is removed after the eruption of the first permanent molars, the latter teeth will tend to move

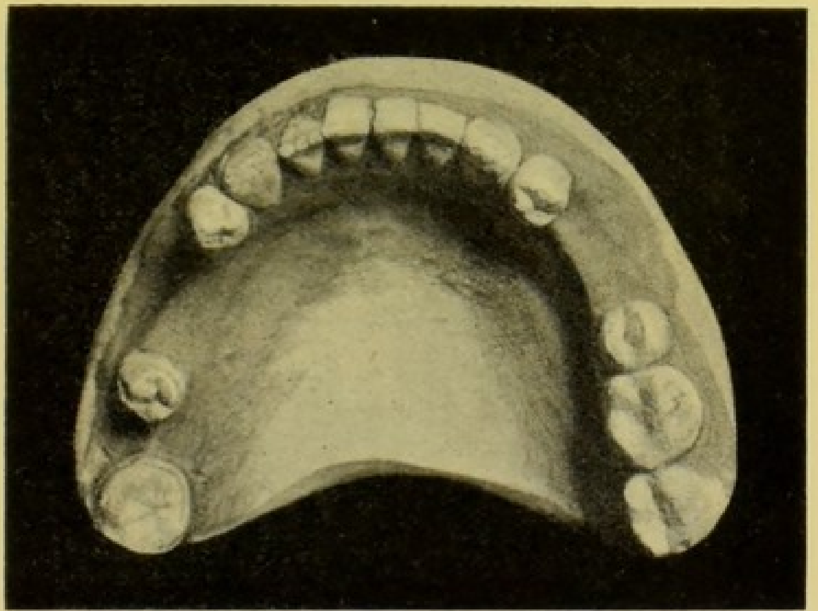


Fig. 183.—Model showing movement backwards of the second mandibular premolars following early extraction of the first permanent molars.

forwards, and the first deciduous molar backwards. The amount of movement of the permanent molar will vary according to the degree of interference with the growth of the bone in the molar region. If there has been normal growth, and if the first molar is in good occlusion with the mandibular tooth (*i.e.*, interdigitation of the cusps well marked) the amount of forward movement will be but slight. If, on the other hand, there has been interference with the growth of bone, the tendency of the permanent molar to forward movement will be marked, even though the occlusion may be good. The tendency of the first deciduous molar to move

backwards is brought about by the muscular pressure of the lips, but the lips will not exert much influence if the occlusion with the mandibular teeth is good.

If a second deciduous molar is removed before the permanent molar has erupted, the movement forward of this latter tooth will be marked, and it will in some cases encroach upon the whole space previously occupied by the deciduous tooth.

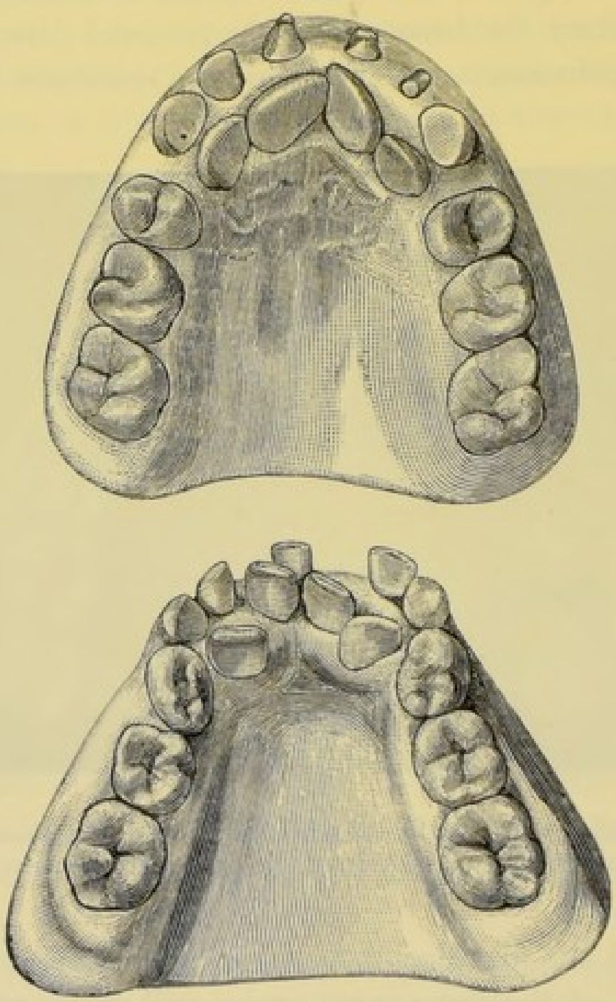


Fig. 184.—A case of irregularity accompanied by persistent deciduous teeth.

If a deciduous canine is removed at an early age, the closing of the space is mainly due to a spreading movement of the incisors, brought about in the maxillary arch by the lips and in the mandibular arch by the tongue; the deciduous molar may also move forwards, but this will depend mainly upon the forward pressure of the permanent molars.

In cases where the lower first permanent molars have been removed prior to the eruption of the second premolars, the latter teeth occasionally erupt far back in the arch, as shown in fig. 183.

(*b*) **Caries of the Teeth.**—Loss of tissue from caries on the approximal surfaces allows the teeth to close on one another. A forward movement of the permanent molars often occurs from this cause.

(*c*) **Persistence of Deciduous Teeth.**—The loss of the deciduous teeth is, under normal conditions, due to absorption of their roots. Absorption is brought about by the action of the "absorbent organ," which is a mass of cells possessing osteoclastic and probably phagocytic properties. The stimulus calling into existence this mass of cells is the erupting permanent tooth.

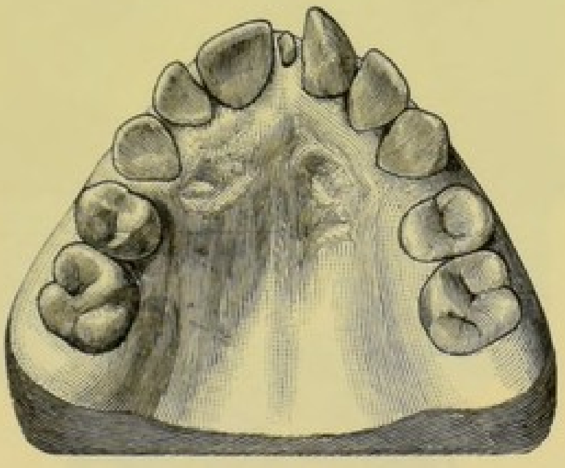


Fig. 185.

Under normal conditions, the whole of the root of the deciduous tooth lies in the line of eruption of the permanent tooth, and absorption gradually proceeds until the entire root is removed; the crown falls away and its place is taken by the permanent tooth. If from some cause, such as crowding, the erupting tooth does not take its normal line, only that portion of the deciduous root which lies in its course is absorbed.

Deciduous teeth which are pulpless or necrosed undergo little absorption. Such teeth obstruct the movement of the erupting tooth, deflect it from its course, and so cause it to erupt in an irregular position.

Cases of irregular permanent teeth in which the deciduous teeth are still present are therefore due to :—

(i.) The original mal-direction of the erupting tooth.

(ii.) The presence of necrosed or pulpless deciduous teeth.

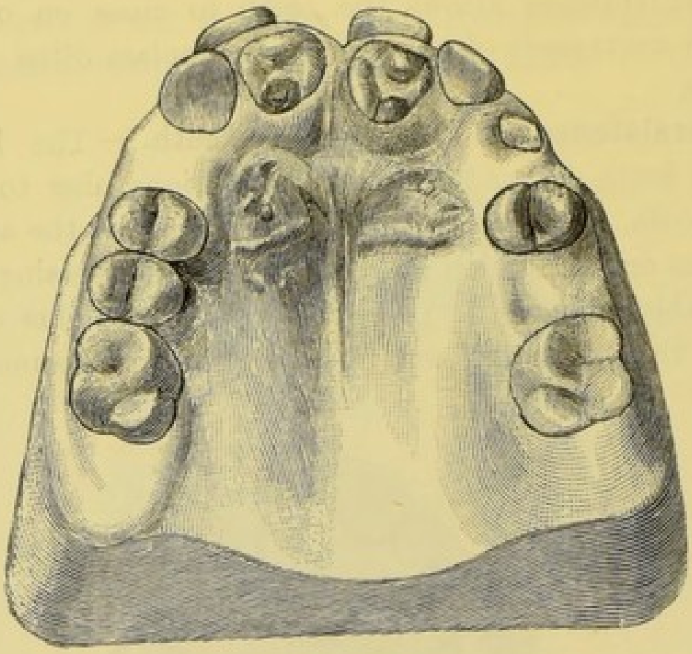


Fig. 186.

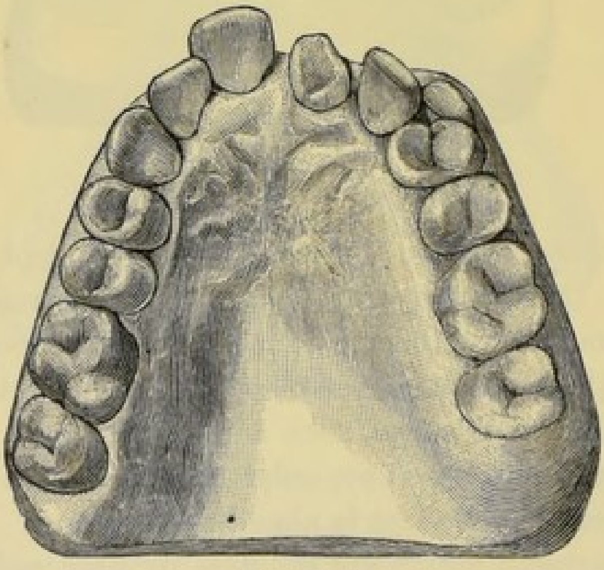


Fig. 187.

(*d*) **Supernumerary teeth** often cause irregularities. A divergence of the upper central incisors is at times due to the

presence of a supernumerary tooth, usually peg-shaped. An example of this is shown in fig. 185. Displacement of the incisors internal or external to the arch, or a general crowding of the teeth, may occasionally be traced to the presence of supernumerary teeth. Examples are shown in figs. 186, 187, and 188.

(*e*) **The frænum of the upper lip**, instead of blending with the muco-periosteum on the anterior aspect of the alveolar process, may be continued between the incisors and blend with the tissues in the region of the anterior palatine foramen. Under such conditions, every movement of the lip causes the frænum to

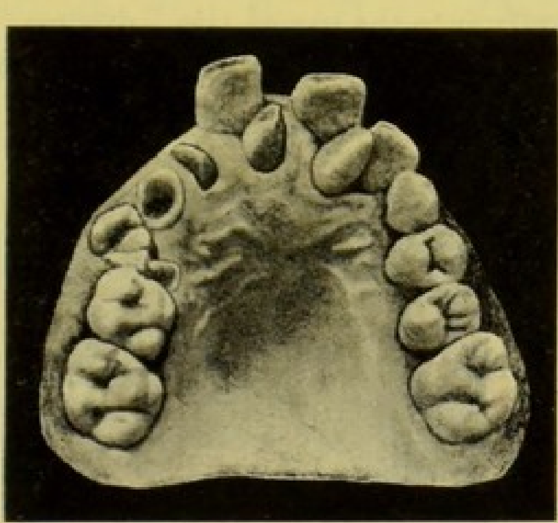


FIG. 188.

press on the teeth, and thus to separate them. This cause of divergent centrals was first pointed out by Mr. H. Moon. A persistent labial frænum of the lower lip occurs, but much less frequently.

(*f*) **Habits**.—Certain habits are contracted by children, such as finger-sucking and lip-sucking, which, if persisted in, will produce deformed arches. In the habit of sucking the thumb or finger, the palmar surface of the thumb is placed against the palatal surface of the central incisors, the mandibular teeth being closed on the dorsal aspect. The pressure exerted causes the maxillary central incisors to protrude, so that the lower lip passes behind them, and aggravates the protrusion when the

mouth is at rest. At times the thumb or finger is inserted between the teeth in such a manner as to cause the teeth to impinge on the lateral surfaces. Under such conditions, the maxillary incisors and canines are forced outwards and frequently upwards, producing a type of irregularity known as "open bite." Sucking of the lower lip or tongue may also produce protrusion of the maxillary teeth.

The prolonged and persistent use of the "baby comforter," or "dummy," is a fruitful source of dental deformity. Fig. 189 shows the models of a child, aged 5, illustrating protrusion of the maxillary arch from this cause. The protrusion was well marked in this child when seen about 18 months old.

Careful inquiry into the use of the "dummy" would seem to show that, if its use is persisted in, deformity of the maxillary

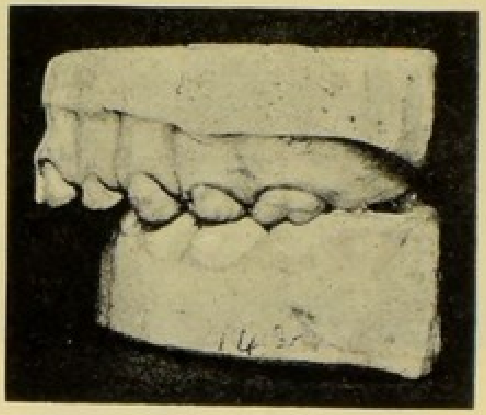


Fig. 189.[1]

dental arch will almost certainly result, the amount of deformity depending on the persistence with which the "dummy" is used, the period over which its use extends, and the presence or absence of rickets.

(*g*) **Miscellaneous Causes.**—Alveolar abscess in connection with the deciduous teeth sometimes leads to irregularity in position of permanent teeth, while cicatrices, hypertrophy of the gums, injuries, malformation, and diseases of the jaws may also be cited as local causes.

[1] From *Proc. Roy. Soc. Med.*

(3) Classification

No classification of the various types of irregularities of the teeth which can be regarded as entirely satisfactory has yet been suggested. The arrangement suggested by Dr. Angle has, of recent years, received considerable attention, but it is open to

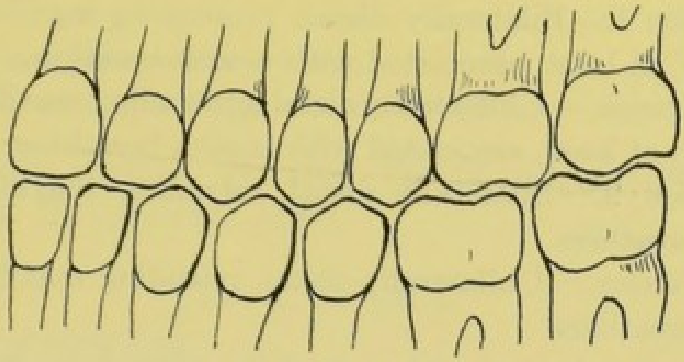


Fig. 190.

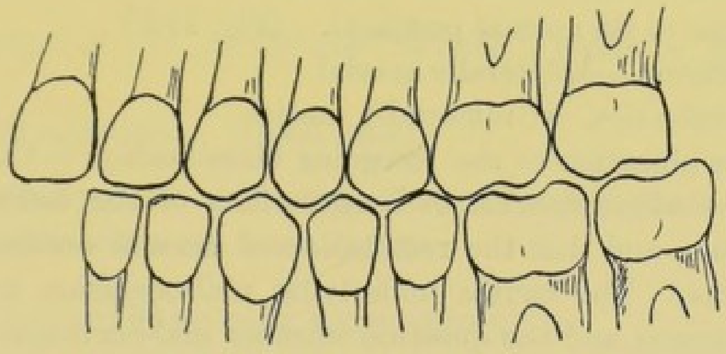


Fig. 191.

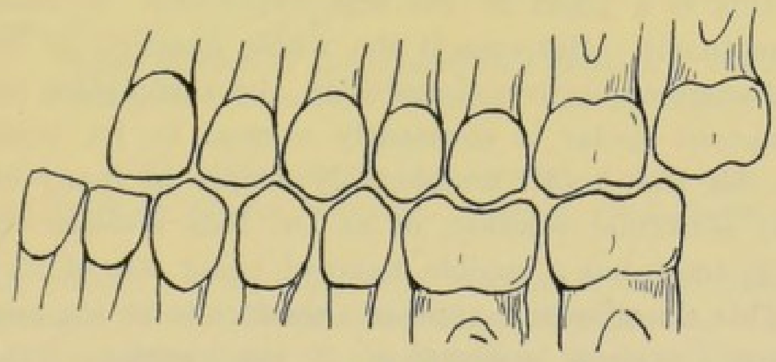


Fig. 192.

objection, inasmuch as it is based on the normal occlusion of the teeth, and the first permanent molar is adopted as the "key to occlusion." Three classes are recognized by Angle.

CLASS 1.—Arches in normal mesio-distal relations (*i.e.*, those in which the maxillary molar occludes in its normal position). (Fig. 190.)

CLASS 2.—Lower arch distal to normal in its relation to the upper arch (*i.e.*, those in which the maxillary molar occludes in advance of its normal position). (Fig. 191.)

Division 1.—Bilaterally distal, protruding maxillary incisors. Primarily, at least, associated with mouth-breathing.

Subdivision.—Unilaterally distal, protruding maxillary incisors. Primarily, at least, associated with mouth-breathing.

Division 2.—Bilaterally distal, retruding maxillary incisors. Normal breathers.

Subdivision.—Unilaterally distal, retruding maxillary incisors. Normal breathers.

CLASS 3.—Lower arch mesial to normal in its relation to upper arch (*i.e.*, those in which the maxillary molar occludes posterior to its normal position). (Fig. 192.)

Division.—Bilaterally mesial.

Subdivision.—Unilaterally mesial.

The objection to the foregoing classification is that it assumes that the whole trouble of irregularities of the teeth lies in mal-occlusion, and that the restoration of normal occlusion is always desirable. The causes underlying mal-occlusion are not taken into account and the question whether mal-occlusion is associated with abnormal growth of the jaws is apparently not considered, although this is a point of the first importance in relation to rational treatment. But even if the whole question of irregular teeth were summed up in mal-occlusion, the assumption that the first permanent molar is constantly normal in its position is erroneous, for that tooth undoubtedly erupts in many cases in an entirely abnormal position, or as Dr. Sim Wallace remarks, "this shifty tooth has a terrible habit of being out of its proper place." This classification appears therefore to be too restricted, thus giving a narrow conception of the problems that have to be dealt with and for this reason it cannot be regarded as satisfactory.

A classification which embraces both etiological and clinical considerations seems to be necessary and would be more workable. The subjoined classification is therefore suggested.

(A) Irregularities of the Teeth associated with Normally Developed Jaws.

(*a*) Due to persistence of labial frænum.

(*b*) Due to persistence of deciduous teeth.

(*c*) Due to early extraction of teeth.

(*d*) Due to habits.

(*e*) Due to injury.

(*f*) Due to supernumerary teeth.

(*g*) Due to complete displacement of teeth.

(B) Irregularities of the Teeth associated with Abnormally Developed Jaws.

Clinical Varieties.

(*a*) General crowding.

(*b*) Protrusion of the maxillary incisors. (Superior protrusion.)

(*c*) Protrusion of the mandibular incisors. (Inferior protrusion.)

(*d*) Lack of occlusion. (Open bite.)

(C) Irregularities of the Teeth associated with Congenital Defects of the Jaws.

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CHAPTER VI.

Abnormalities in Position of the Teeth.—Treatment

Treatment in General—The Movement of Teeth by Mechanical Appliances—The Movement of Teeth by Surgical Methods

(A) TREATMENT IN GENERAL

(*a*) **Prophylactic.**—The more accurate our knowledge of the causes producing irregularities becomes, the better equipped shall we be to prevent such conditions arising.

Breast-feeding must be insisted on whenever possible, but if hand-feeding has to be adopted, then for preference it should be by means of the spoon or feeding-cup.

The use of the comforter should be strongly deprecated. Every care should be taken to prevent caries of the deciduous teeth. A diet requiring plenty of mastication is essential, and proper nasal breathing should be assiduously encouraged. Should nasal obstruction be caused through the presence of adenoids, or from any other condition, treatment should be accorded as speedily as possible, in order that proper nasal respiration may be restored. If a child is breast-fed, and its teeth are maintained in a healthy and efficient state, and nasal breathing promoted, there is little danger of irregularities arising during the second dentition.

Careful supervision of the mouth during the period of dentition will go far to prevent or, at least, to simplify irregularities.

The early treatment of caries in the deciduous molars will often prevent their premature loss, while the timely removal of a deciduous tooth will often prevent a permanent one from assuming an abnormal position. Special attention should be bestowed upon the first permanent molars. Any cavities which appear should immediately be filled. If caries does appear on the anterior surface of the permanent molar, the advisability of removing the

deciduous tooth and making the surface of the permanent molar self-cleansing must be considered. The successful preservation of the first permanent molar far outweighs in importance the slight moving forward of the tooth which might result from the removal of the second deciduous molar. To secure good results, children's teeth should be examined at least three times a year, and the necessity for constant supervision should be impressed on the parents.

(*b*) **Remedial.**—Whenever there is doubt as to the best method of treatment, it is advisable to take **models of the mouth,** to be studied in connection with a chart on which the condition of the teeth has been carefully noted. In this way, points often become apparent which would be missed by a mere examination of the mouth. In cases coming under observation at an early stage, it is advisable to take models periodically, so that the development of the mouth can be watched and perhaps some light gained as to the best method to pursue in the treatment.

The teeth must be carefully examined, with special reference to the following points: —

(i.) The general character of the teeth.

(ii.) The presence and extent of caries, especially on the approximal surfaces.

(iii.) The directions of the roots of the teeth. (The value of this point is referred to on p. 216.

(iv.) The occlusion of the teeth.

The last point is of special importance if extraction is indicated. Many of the indifferent results obtained after treatment by extraction are due to teeth having been removed without regard to occlusion.

There is a tendency for the teeth to shift their position in the mouth, and this movement has been termed **"travelling of the teeth."** In this natural movement the "bite" or occlusion of the teeth plays an important part. If a normal articulation (fig. 193) be examined, it will be observed that the opposing teeth present inclined planes to one another, and this is particularly noticeable in the premolar region. In each act of mastication, pressure is brought to bear upon these surfaces, and as long as the resistance remains equal in all directions the tooth retains its position. Remove this resistance, wholly or in part, and the force exerted by the muscles will in each act of mastication tend

to drive the teeth in the direction of least resistance. Take, as an example, the case diagrammatically illustrated in fig. 194. The first molars have been removed. Each time the posterior plane of the second lower premolar strikes the anterior plane of the second upper premolar the tendency will be to drive the latter tooth in the direction of least resistance, namely, backwards. When once this tooth has travelled backwards, the resistance to the movement of the second lower premolar in the posterior direction is removed, so that the force of the posterior plane of the first upper premolar striking the anterior plane of the lower second premolar will tend to drive the latter also in a backward

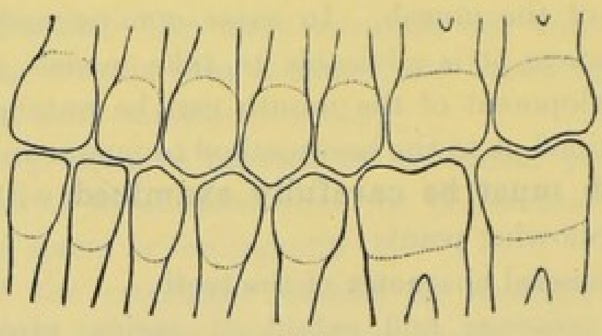

Fig. 193.

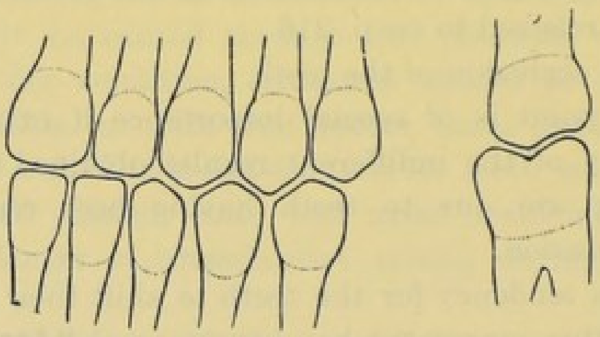

Fig. 194.

direction. In like manner, the posterior plane of the first lower premolar will tend to drive back the first upper premolar. In addition to the power derived from the muscles of mastication, the force exerted by the lips, tongue, and the process of eruption are important factors in producing the natural movement of teeth. The lips exert force in a backward direction, the tongue in a forward direction. When employing extraction for the correction of an irregularity, an endeavour should be made to "unlock" the

bite. This will be more easily understood by a reference to fig. 195. For the sake of argument we will suppose that the canine has erupted externally to the arch. To provide space the first upper molar only is removed. The bite will remain locked—in other words, the second premolar will require mechanical means to train it in a backward direction, and even then will occlude with the molar—an unsatisfactory condition. Mechanical means will also be required to retract the first premolar. If the lower first molar is removed as well as the upper, mechanical methods can be to a very great extent avoided, and there will be less interference with the efficiency of the bite.

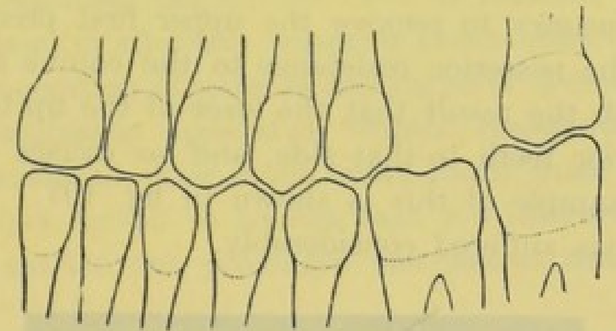

FIG. 195.

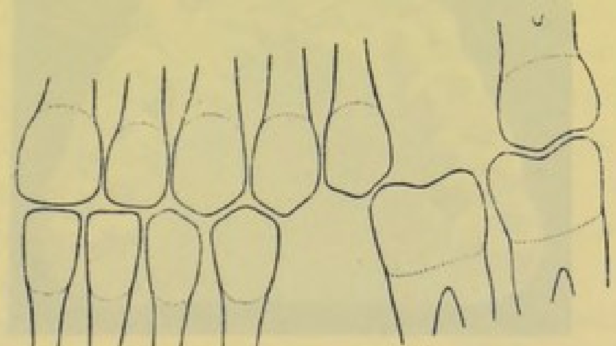

FIG. 196.

When removing teeth in both maxilla and mandible, opposing teeth should if possible be selected. A glance at the diagram (fig. 196) will show the disadvantage of not following this course. In the upper the first molar has been removed, and in the lower the second premolar. There is considerable destruction of the masticating area, and moreover mechanical methods must be used to retract the teeth. Removal of the upper and lower second

premolars, or the upper and lower first molars, would have interfered far less with the masticating area, and would have unlocked the bite and allowed the teeth to travel backwards unaided by mechanical means.

In employing extraction the desirability of maintaining the **Teeth in their proper relationship to the Median Line of the Face** should, for æsthetic reasons, be borne in mind. Any deviation to one side or the other in the direction of the incisors causes an appreciable disfigurement, and, in the case of girls, this is important from an æsthetic point of view. The centre of the mouth is likely to shift when the bite is unlocked on one side and not on the other. Take, as an example, a case where it has been necessary to remove the upper first premolar on the left side. The posterior resistance to the canine and lateral is removed, with the result that the force of the lip tends to drive all the anterior teeth to that side, and so causes the centre to shift. An example of this is shown in fig. 197. The patient's appearance has suffered considerably.

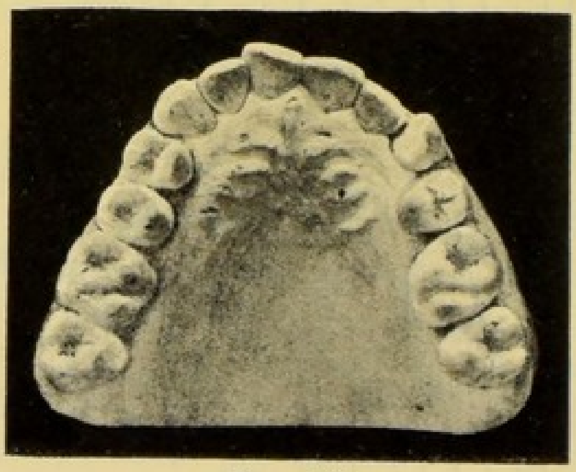

Fig. 197.

Removal of the first right upper premolar as well as the first left upper premolar would have prevented this, because the posterior resistance on both sides being removed, the lips would have forced the anterior teeth back equally on both sides.

Removal of one second upper premolar will not cause the centre to shift, because the bite will be locked by the first upper premolar occluding with the lower premolars, but removal of the fellow tooth in the lower will remove the posterior resistance

and permit the first premolars—upper and lower—to shift back, and so produce an alteration in the centre of the mouth. Other examples could be quoted. Removal of the first upper and lower right molars and the first upper left molar would cause the centre to shift towards the right side, because the bite is locked on one side and not on the other.

Radiographs of the teeth will be found most useful in cases where doubt exists as to the directions of the roots of teeth, or as to the presence or absence of unerupted teeth.

In any case where there is a question of treatment by mechanical methods, the **general health and temperament** of the patient must be considered. With weak, nervous children, mechanical treatment should, for obvious reasons, be avoided if possible. Again, in all cases requiring mechanical treatment, the thorough co-operation of parents and patients is most essential to success. Regulating apparatus, unless constantly worn and properly attended to, does much more harm than good. If the practitioner has reason to believe that his instructions will not be faithfully carried out, prolonged mechanical treatment should be avoided.

Other points to be considered are the **age** and the **sex** of the patient. With regard to the former it should be remembered that the difficulty of moving and retaining the teeth in a new position increases with the age of the patient. As a rule, it is not advisable to attempt correction of irregular teeth by mechanical means in adults. The older the patient, the more difficult the teeth are to move and retain in a new position. Again, the older the patient the greater the danger of starting pathological changes in the periodontal membrane.

In deciding on the method of treatment, attention must be given to the **facial expression and type of face.** For example, a narrow arch may be accompanied by a narrow face with a small mouth and correspondingly small features, all of which are in harmony. Expansion or spreading of the arch under such conditions might mar the character of the face.

The removal of the canine usually produces an ugly flatness of the upper lip and allows the angles of the nose to sink.

In cases where, with protrusion of the upper teeth, the lower lip is unduly flat, but the lower teeth are crowded, with perhaps

the canines slightly prominent, an attempt to regulate the canines by bringing them into line will tend to increase the flatness of the lower lip and to accentuate the protrusion of the upper teeth.

(B) THE MOVEMENT OF TEETH BY MECHANICAL APPLIANCES—REGULATING APPLIANCES

The movement of teeth by mechanical means is accomplished by the use of certain forces acting from a fixed base known as "the point of delivery." The resistance of the point of delivery, or anchorage, must be greater than that of the tooth or teeth to be moved. This is essential, and is frequently overlooked.

The point of delivery is usually obtained from the resistance of teeth either by means of a well-fitting plate or by embracing two or more teeth with a clamp or band, the force to be used being attached to the plate or band as the case may be. In a few forms of apparatus the occiput is utilized as the point of delivery. Regulating appliances are thus divisible into two main groups: (*a*) removable, (*b*) fixed.

(*a*) **Removable Appliances.**—The successful working of a regulation plate depends mainly upon the fit, and great care should therefore be taken in obtaining models of the mouth. The best material for the plate is vulcanite. The back teeth should usually be capped, as the real point of delivery is obtained from the teeth, and by capping them a much firmer hold can be obtained. Plates must be carefully adjusted to the bite of the opposing teeth. The plate should be tried in the mouth, and the bite adjusted by the aid of a proper articulator. It is well to allow the lower teeth to bite "well home" into the vulcanite. In this way, the plate is kept more firmly in position, and, when the mouth is closed, the opposing teeth also act as part of the point of delivery.

The Forces Employed for Moving Teeth. — (i.) **The screw** is perhaps the most powerful. The forms suggested by Dr. Angle are neat and efficient.

The screw must be adjusted at regular fixed intervals, only a slight degree of force being applied at each visit. The force exerted by a screw is not continuous, but this is evidently no disadvantage, as the results obtained from screw force in regulating teeth are entirely satisfactory.

(ii.) **The Wedge.—Hickory wood** compressed laterally is mostly used. The saliva moistens the wood, causing it to expand and so exert force. In using wooden wedges, the grain of the wood should lie parallel to the direction in which it is proposed to move the tooth. The wedge will be found most useful in forcing incisors forward. The method of adjusting the wooden wedge is shown in fig. 198.

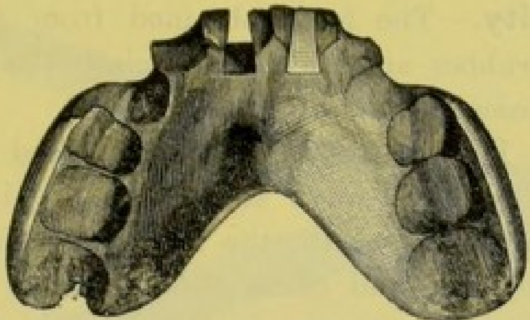

FIG. 198.

A double dovetailed slot is cut in the vulcanite plate, one broad end being away from the tooth, the other being towards the palatal aspect of the plate. Into this slot the hickory wedge is placed. For forcing the premolars backwards, wedges of hickory wood are also useful.

Wedges of rubber may also be used. Cone-shaped holes are drilled in the plate, the base of the cone being towards the tooth to be moved. A loop of rubber is fixed in each hole, the free ends passing through the apical portion of the cone on the palatal surface. Rubber makes a more powerful wedge than hickory wood, but its action is not so gradual, and it is more likely to cause pain by forcing the teeth forward too quickly.

Wedging may be carried out by the aid of vulcanite pegs. Cone-shaped holes are drilled in the plate, and in place of the rubber a vulcanite peg is inserted and is left sufficiently long to prevent the plate being forced at once into place. The peg is also arranged with a sloping surface so that at first it presses on the tooth near the cutting edge, and as the plate is driven up into place by the lower teeth so the tooth is forced forwards. It is important that the lower incisors should occlude with the plate and so increase the force transmitted to the teeth to be moved.

(iii.) **The inclined plane** is most usefully employed when it

is necessary to force forwards three or four maxillary incisors. For this purpose, a plate is made capping the lower teeth, and to this an inclined plane is fixed so that when the mouth is closed the teeth to be moved impinge on the sloping surface and are thus driven forward. The inclined plane must be used with care, as it may force the teeth forward too quickly and so injure the soft tissues.

(iv.) **Elasticity.**—The force obtained from the elastic properties both of rubber and metals, especially the latter, is most useful for mechanical regulation of teeth.

(*a*) *Rubber.*—This material is generally used in the form of small bands. There is always some difficulty in retaining the bands in position on the teeth, the tendency being for them to slip towards the neck and cause inflammation. This can be overcome by cementing to the teeth metal bands with hooks attached. The rubber bands require frequent renewal, and are somewhat uncertain in their action. (Rubber in the form of wedges has already been referred to.)

FIG. 199.

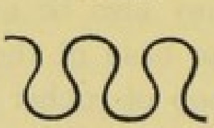

FIG. 200.

(*b*) *Pianoforte Wire.*—This is a most useful material, light, strong and inexpensive, and in skilful hands it is capable of being utilized to produce any movement, *i.e.*, pulsion, traction, or torsion of a tooth. Moreover it is constant in its action and can be easily controlled. The wire used should be thin (gauges No. 14 to 17). The disadvantage of the wire is the tendency to oxidize in the vulcanizer, but this can be overcome by tinning the wire. The following method is suggested by Mr. Coysh.[1]

" After cleaning the wire thoroughly it is dipped into chloride of zinc solution, and then for an instant into melted tin, which must not be too hot and the surface of which must be quite

[1] *Dent. Rec.*, vol. xi, p. 109.

clear. Upon removal from this the surplus molten tin is quickly shaken off and the spring cooled in cold water."

Pianoforte wire is used to the best advantage when curved or coiled; in this way greater springiness is obtained. The twist given may be similar to that shown in fig. 199, or to that seen in fig. 200. For the manipulation of pianoforte wire, the pliers

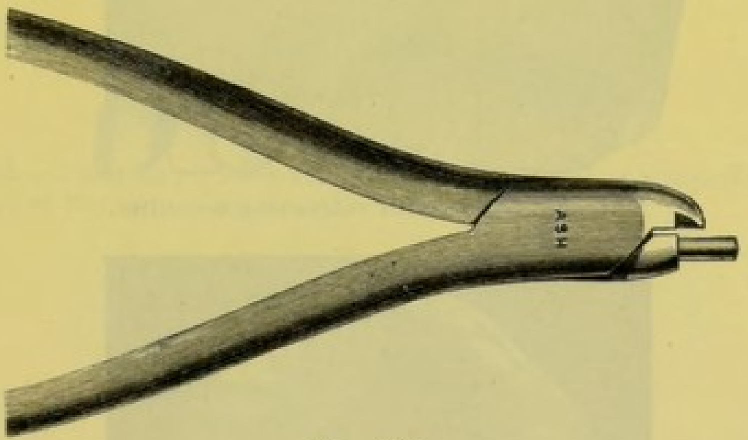

FIG. 201.

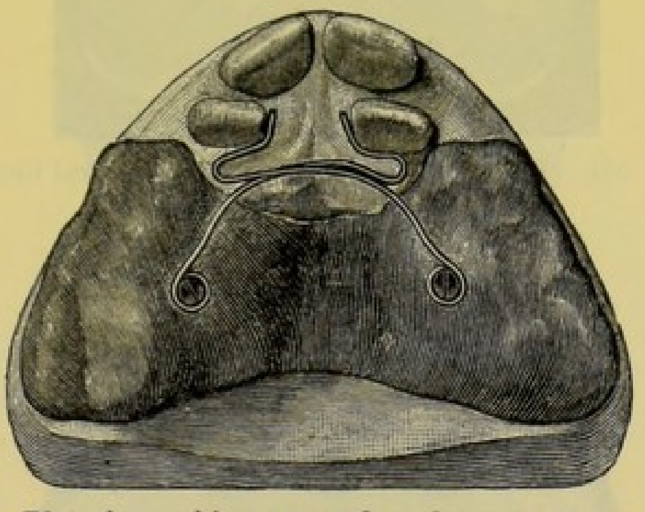

FIG. 202.—Plate for pushing outwards and rotating lateral incisors.

designed by Mr. Northcroft and shown in fig. 201 will be found most useful. In twisting up the wire, anything approaching an angular bend must be avoided. Care must be taken to arrange that the force of the spring acts in the direction in which the tooth is to be moved. A bend should be made in the wire at the free end where it impinges on the tooth. This will permit the wire to be more easily adjusted in the direction

required. It is also important that the coil or turn which gives the spring should be in a plane parallel to the direction of force required. In the figures (202 to 209) some methods of employing pianoforte wire are shown.

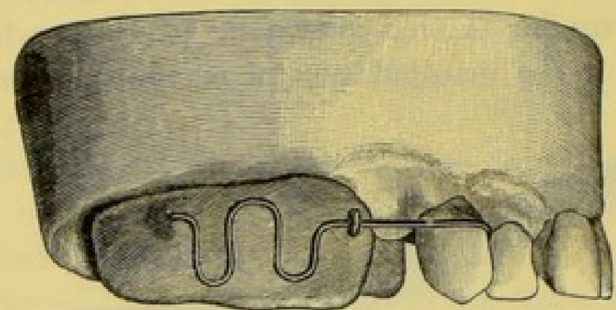

FIG. 203.—Plate for retracting a canine.

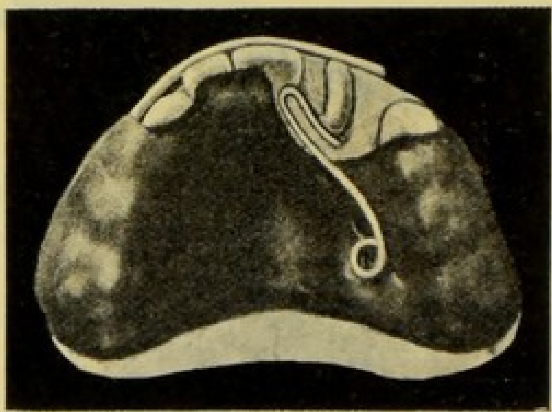

FIG. 204.—Plate for rotating a maxillary central incisor.

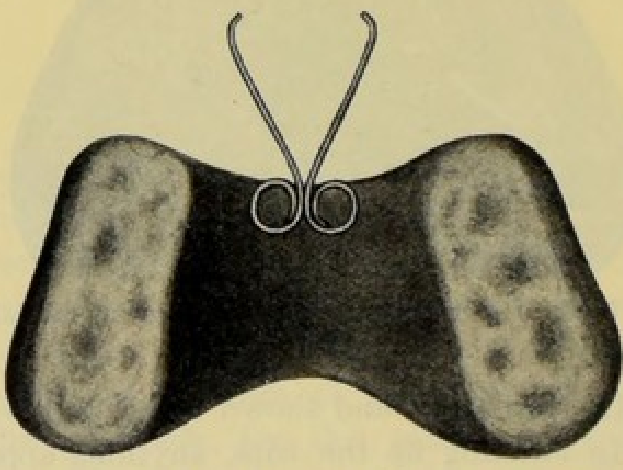

FIG. 205.—Plate for drawing together central incisors.

(c) *Gold wire* can be used in place of pianoforte wire for regulating. It may be made fairly springy by gentle hammering, but the peculiar elasticity of the steel wire cannot be obtained.

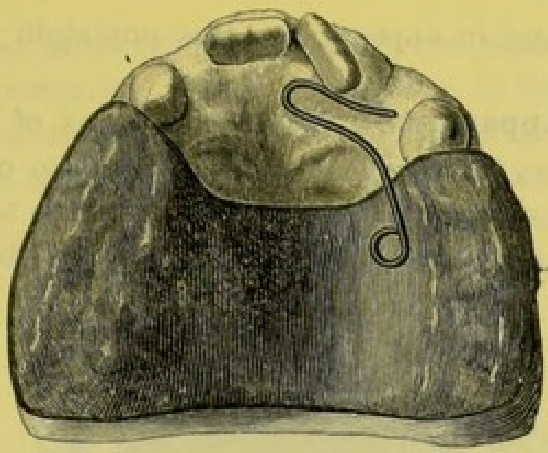

FIG. 206.—Plate for pushing outwards the distal side of a maxillary central incisor, and at the same time slightly rotating it.

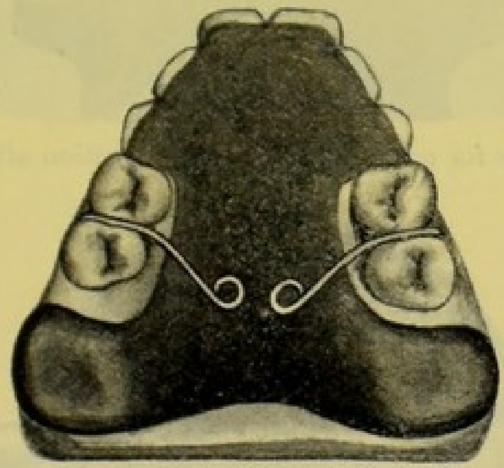

FIG. 207.—Plate for retracting premolars.

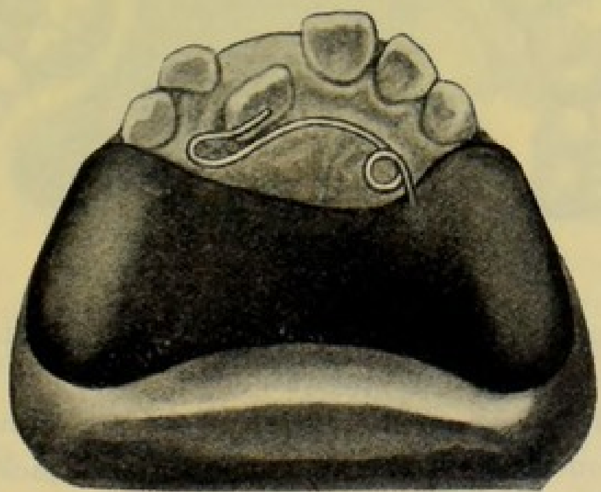

FIG. 208.—Plate for pushing forwards a maxillary incisor.

Gold wire is neater in appearance, does not stain the teeth, and does not oxidise.

(*d*) **Fixed Apparatus.**—With fixed forms of apparatus the "point of delivery" is obtained by banding two or more of the posterior teeth, and fixing to the band the force to be employed. The bands should always be fastened to the teeth with oxy-

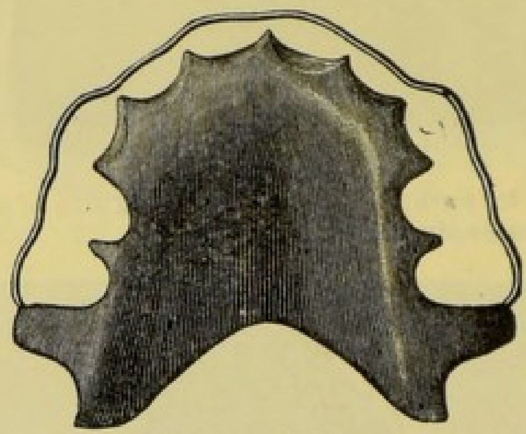

Fig. 209.—Plate for retaining the teeth in position after regulation.

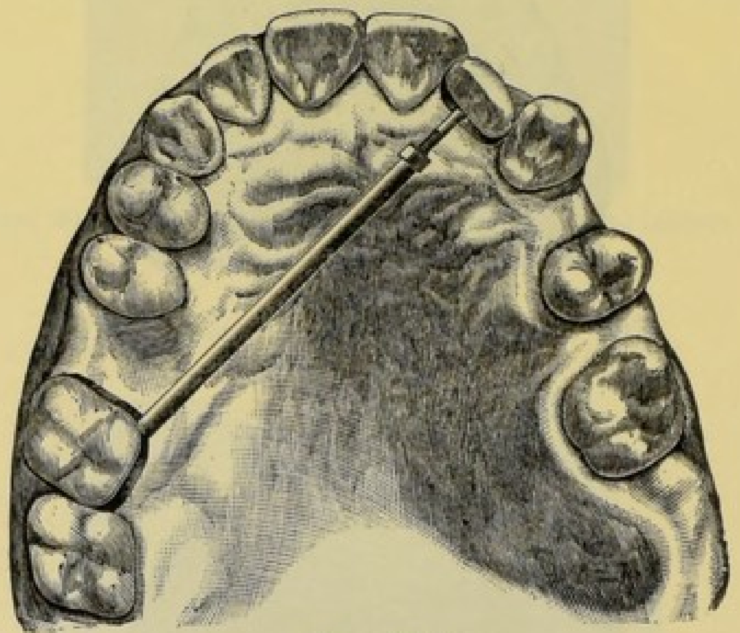

Fig. 210.[1]

phosphate cement. Various forms of fixed regulating apparatus are shown in the following illustrations.

In fig. 210 is seen a method (Angle's) for moving a lateral incisor in an outward direction by means of a jack screw. The

[1] From "Malocclusion of the Teeth," by E. H. Angle.

tooth chosen as anchorage is as nearly as possible in a direct line with the movement desired to be given to the lateral incisor.

A method of employing pianoforte wire is shown in fig. 211. The twist given to the wire is generally known as "Talbot's coil."

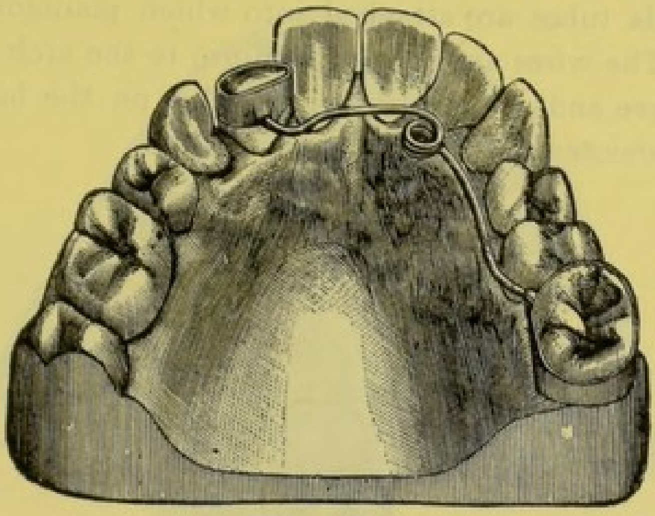

FIG. 211.[1]

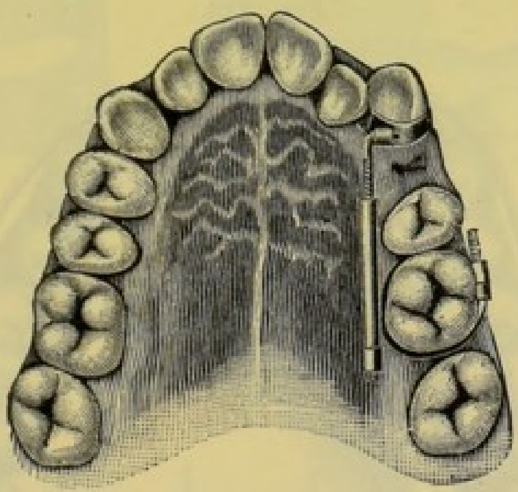

FIG. 212.[2]

Fig. 212 shows a method suggested by Angle for retracting a canine. The anchorage tooth and the tooth to be moved are banded. The two bands are connected by a traction screw.

A method of producing rotation, also from Angle, is shown in fig. 213. The tooth to be rotated is banded. Anchorage is obtained from the second premolar, the resistance being increased

[1] From "Text-book of Operative Dentistry" (Kirk).

[2] From "Malocclusion of the Teeth," by E. H. Angle.

by the bar shown in the figure. The teeth are then connected by pianoforte wire.

A method of moving forward incisor teeth, designed by Goddard, is shown in fig. 214. The first molars are banded, and to the bands tubes are attached into which pianoforte wires are inserted. The wires are bent to conform to the arch of the teeth, and their free ends are inserted into tubes on the labial surfaces of bands cemented on the teeth to be moved.

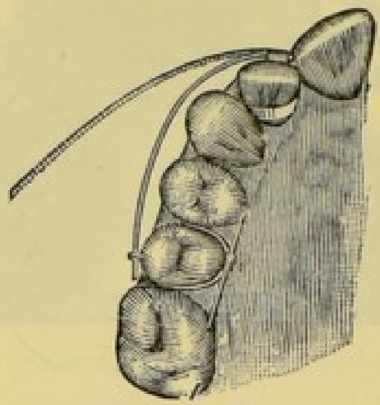

FIG. 213.[1]

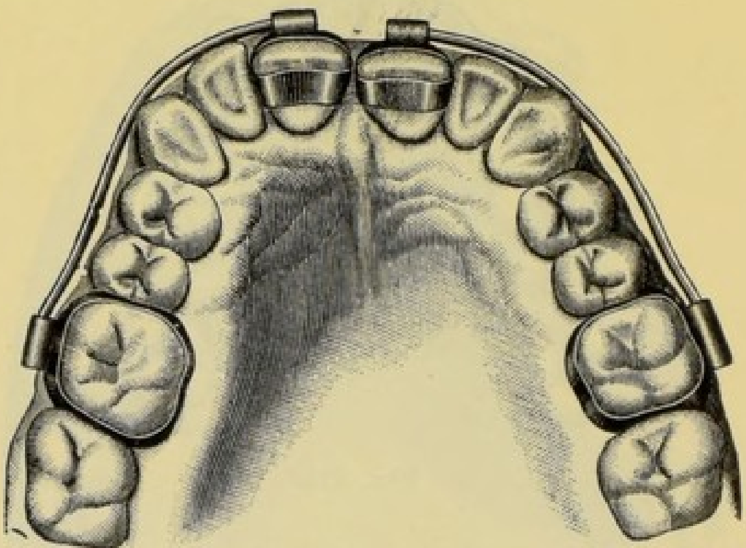

FIG. 214.[2]

A method of retracting a central incisor is shown in fig. 215.

In the appliance known as the Siegfried spring, the force of the wire is potentially raised by being wound in the form of a spiral. The fulcrum of the force is in the teeth contiguous to

[1] From "Malocclusion of the Teeth," by E. H. Angle.

[2] From "Text-book of Prosthetic Dentistry" (Essig).

the tooth to be moved. The latter is banded, a metal pin is attached to the band, and the spring is adjusted on the pin (see fig. 216). The Siegfried spring is useful for the correction of instanding and outstanding incisors.

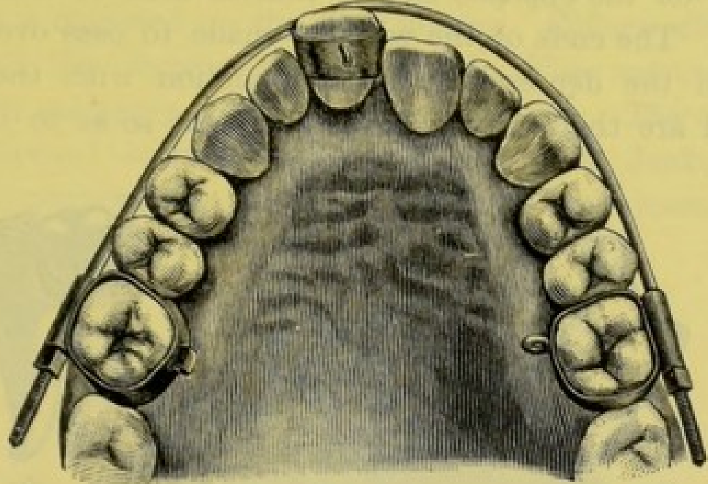

FIG. 215.[1]

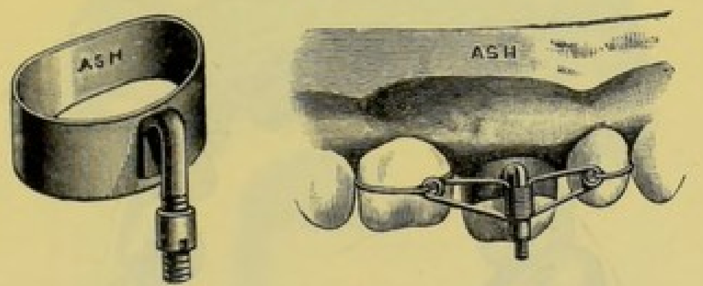

FIG. 216.[2]

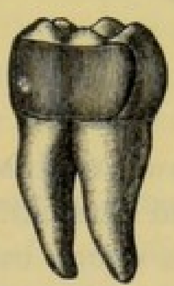

FIG. 217.

FIG. 218.

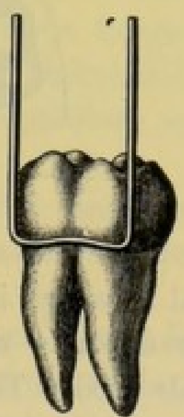

FIG. 219.

In the type of appliance advocated by Dr. Jackson the anchorage is obtained by spring clasp attachments supporting

[1] From "Text-book of Operative Dentistry" (Kirk).

[2] By permission of Messrs. Ash, Sons & Co.

a base wire, to which any form of spring can be added. The clasp is made by bending a thin piece of plate-metal to fit the labial or palatal aspect of the tooth (fig. 217). A piece of spring wire about No. 21 (American gauge) is fitted around the neck of the tooth on the opposite side to that covered by the thin metal (fig. 219). The ends of the wire are made to pass over the arch, resting on the depressions at the junction with the adjoining teeth, and are then curved down and bent so as to rest on the

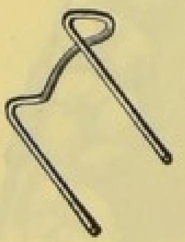

FIG. 220.[1]

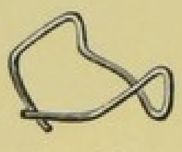

FIG. 221.

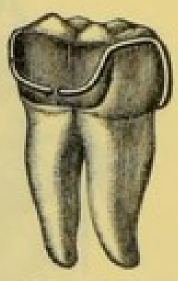

FIG. 222.

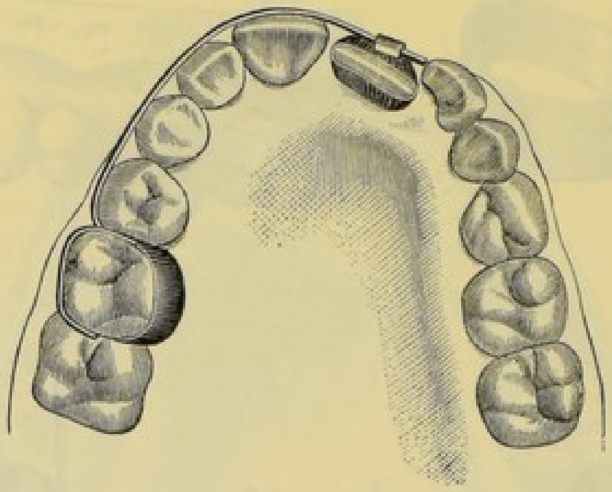

FIG. 223.

metal to which it is soldered. The grasping power of this attachment depends upon the elastic properties and strength of the metals used. The spring clasps are united by a strong base wire, and to this wire are attached the various spring wires required. (See figs. 217 to 222.)

In fig. 223 is shown a method of moving an incisor outwards.

[1] For the use of figs. 217 to 224 I am indebted to Messrs. Lippincott, the publishers of "Orthodontia," by W. H. Jackson.

The spring clasp is attached to the second deciduous molar, and retruding from this is a spring wire passing over the labial surface of the tooth, and extending to a tube soldered to a collar cemented on the incisor.

Fig. 224 illustrates a method of moving incisor teeth outwards. Anchorage is obtained on the first molars. Collars with lugs are attached to the incisors to be moved. The moving force is obtained by soldering a spring to the base bar. The loop of the spring is opened every three or four days. Dr. Jackson claims that his appliances are simple, occupy but little room, and can be easily removed and adjusted.

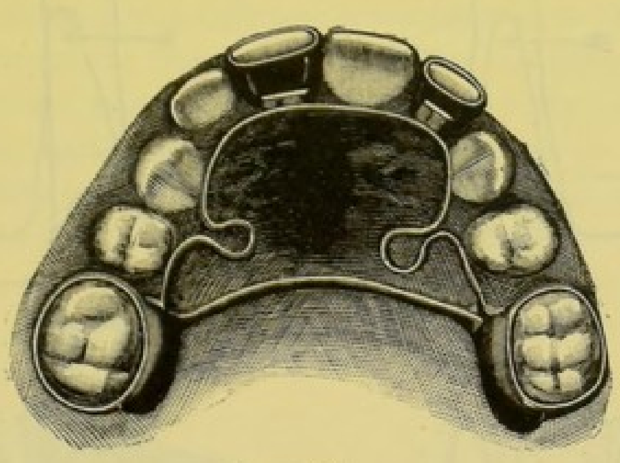

FIG. 224.

The foregoing examples of mechanical appliances are intended to illustrate the range of application of the various forces used for the mechanical movement of teeth. Each individual case must be treated on its merits, and the design of appliance worked out by the surgeon.

The works of Farrar, Angle, Talbot, Guildford, and Jackson contain full accounts of various forms of apparatus favoured by those authors.

Choosing between the Use of Removable and Fixed Apparatus.—In deciding upon the particular apparatus to be used the peculiarities of the case to be treated must of course be considered. There is, however, a distinct point in favour of removable apparatus, inasmuch as both the apparatus and the mouth can be easily kept clean. Moreover, with fixed apparatus the adjustment of the bands to the teeth must necessarily entail

some damage to the gingival margin even in the most skilful hands, a point of importance in relation to periodontal disease.

Changes in the Tissues Produced by Mechanical Movement

The position which a tooth assumes when acted upon by mechanical appliances depends largely upon the manner in which force is applied.

With the majority of appliances, a movement similar to that shown in fig. 225 takes place. The force P, which is applied

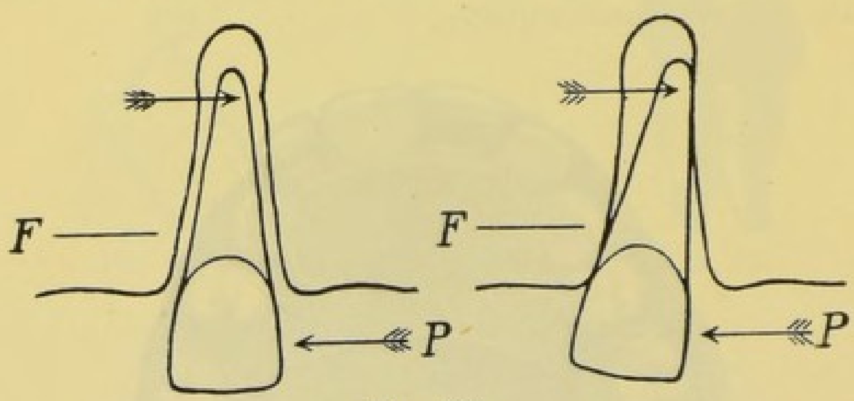

FIG. 225.

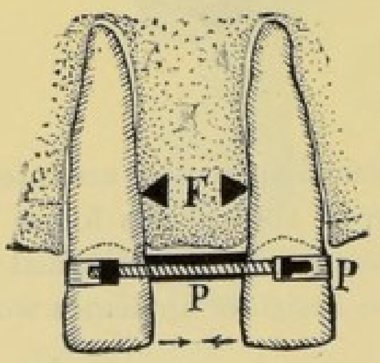

FIG. 226. (Farrer.)

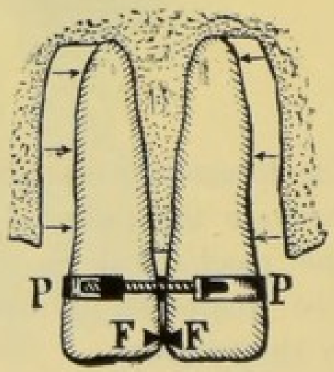

FIG. 227. (Farrer.)

to the crown, is transmitted to the opposing portion of the alveolar process F, and in proportion to the resistance here met with, the apex is moved in the opposite direction. The movement of the apex is probably only slight, and for practical purposes **the tooth may be said to move in the arc of a circle,** the centre of which is represented by the apex of the tooth.

Under certain conditions it is possible to apply force so as to move both crown and apex in the same direction.

The diagrams (figs. 226 and 227) illustrate one method by which this movement may be produced. If a clamp band is attached to two separated central incisors, the immediate result of applying force will be to approximate the mesial angles and cause the apical portions of the roots to diverge. When the mesial angles come into contact, the fulcrum will be shifted from the alveolus to the point of contact in the crowns, and the continued application of force will cause the teeth to approximate throughout their whole length until they become parallel (see fig. 227). It will be noticed that, whilst the alveolar process forms the point of resistance, the apices tend to move in directions reverse to the crowns, but directly the fulcrum is transferred to the crowns the apices commence to approximate. This creation of a static fulcrum on some portion of the crown near the occluding surface, and the application of force as high up on the tooth as possible, are the fundamental principles underlying all appliances which claim to move the roots of the teeth bodily.

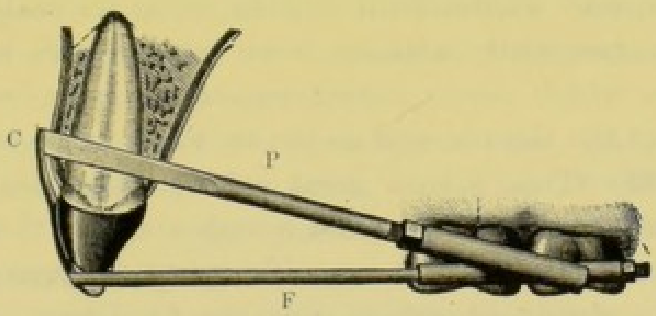

FIG. 228.[1]

The method introduced by Dr. Case, of Chicago, is ingenious. The tooth is banded, and to the band an upright bar, C, is soldered (see fig. 228). To the lower end of C a traction bar, F, is fixed, this bar being united to the point of delivery. Force is applied by connecting the upper part of the bar C with the point of delivery by means of a bar, P. By adjusting the screws connected with the bars P and F, the root or the entire tooth can be moved backwards or forwards as required.

When pressure is applied to a tooth, the alveolar wall, against which the pressure is indirectly applied, undergoes absorption; when the tooth has been moved into the position required, and

[1] From "Text-book of Operative Dentistry" (Kirk).

is retained there firmly by suitable means, a fresh deposition of bone takes place and a new socket is formed. The rapidity with which this fresh bone is deposited depends upon (1) the recuperative powers of the patient; (2) the retention or non-retention of the tooth firmly in its new position by suitable means during the period the tissue is forming; (3) the amount of local disturbance caused by the operation.

Complications and Sequelæ of Mechanical Movement of the Teeth

The mechanical regulation of teeth may be attended by certain complications or sequelæ.

(*a*) **Periodontitis.**—Injury of the periodontal membrane may result from the application of too great a force to the tooth or from direct impingement of the force on the membrane through faulty adjustment. The inflammation of the periodontal membrane may spread to the pulp and so cause its death. Chronic periodontitis frequently attacks teeth which have been moved. The changes which occur during regulation may tend to lower the vitality of the tissues, and so render them liable to attack.

(*b*) **Caries.**—This is to a great extent an avoidable sequela. The more clean the apparatus and mouth are kept the less will be the liability to caries. The movable types of apparatus have in this respect a strong advantage over the fixed ones. The mouth and all mechanical appliances must be carefully cleaned after every meal. Before inserting the plate an alkaline mouth wash[1] should be used, and it is also advisable to run a little of the fluid over the surface of the plate where it comes in contact with the teeth and gums.

[1] The following is suggested :—

℞	Mag. Carb. Levis	ʒiv.
	Aq. Rosæ	℥vi.
	Aquam. ad	℥xii.

M. Shake before using.

After the mouth has been thoroughly cleansed, a tablespoonful is to be taken and moved about in the mouth between the teeth. The magnesia, which is only in suspension, clings about the necks of the teeth and neutralizes any acid. Ordinary solutions of alkalies have only a transient effect upon the oral secretions.

(*c*) **Permanent Enlargement of the Alveoli.**—This condition is due to inadequate re-formation of bone after the tooth has assumed its new position. There may be a lack of recuperative power on the part of the individual from general causes. Growing tissues are more likely to recuperate than fully developed ones; hence it is that permanent enlargement of the alveoli is frequently met with in cases of regulation in adults. The enlargement of the alveoli may be the result of inflammatory changes in the tissues due to want of care in regulating. Teeth which have been moved should be retained firmly in their new position, otherwise permanent enlargement of the alveoli may result from undue movement in the socket.

(*d*) **Injury of the Gums.**—In cases where the regulation has been too rapidly carried out, inflammation of the gums frequently occurs. Inflammation may also arise from want of care in cleansing the plate. The application of a little tincture of iodine, powdered tannic acid, or some other suitable astringent will speedily remove the trouble. If, however, the inflammation increases, the application of force must be postponed until the gums return to a normal condition.

If, owing to defective adjustment, the plate presses on the gums and not on the teeth, sloughing of the soft tissues may occur. Under these conditions the regulating appliance must be immediately abandoned, and must not be used again until the tissues have assumed a healthy condition.

(C) THE MOVEMENT OF TEETH BY SURGICAL METHODS

Within the last few years the practice of regulating teeth by surgical methods has been more frequently adopted.

In a communication to the Odontological Society,[1] Mr. Sidney Spokes showed some cases of instanding incisors and canines which he had treated by immediate methods. The method pursued is as follows: The deciduous teeth are extracted and their permanent successors are then grasped with forceps and forcibly advanced over the edges of the lower teeth. Where there are neighbouring teeth, a silver wire interlaced is sufficient to hold the advanced tooth in its new position. In the ten cases shown,

[1] *Trans. Odonto. Soc.*, vol. xxvii, p. 180.

four central incisors and six lateral incisors had been regulated and were in good position.

When last seen by Mr. Spokes, the pulps in every instance had responded to the thermal test. Of three cases of canines treated, only one was a success. The accidents which may occur are (1) loss of the permanent tooth through injury to its pulp, or by unintentional extraction; (2) fracture of portion of the tooth.

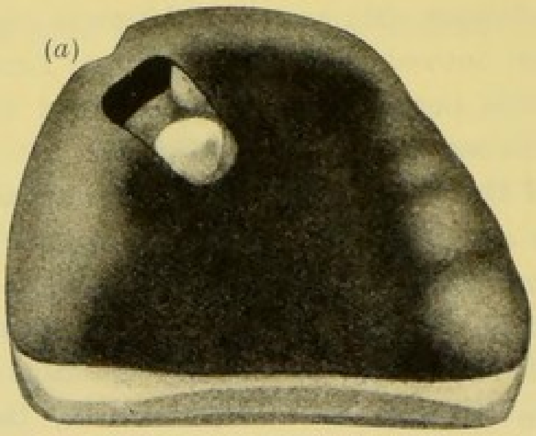

FIG. 229.

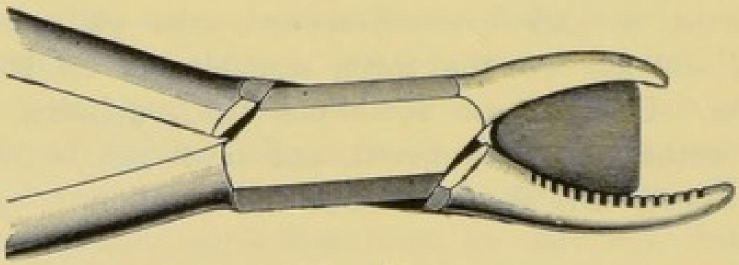

FIG. 230.

Dr. Bryan adopts a different method. He suggests that in a case similar to that shown in fig. 229 it would be well to take a model of the case and saw through the plaster cast on each side of the tooth to be regulated. This section, which should be broken out as far up as the root of the tooth goes, should be fitted and secured with the crown in the place it will occupy when in line and the model properly articulated with the lower teeth. This done, a wax plate should be fitted over the whole palate. From the wax, a space should be cut out sufficient to accommodate the inner blade of the forceps. The forceps should then be placed in the position they will occupy during the opera-

tion, and a depression (*a*) forced in the wax with the outer blade of the forceps. This depression will prevent the outer blade slipping during the operation. The vulcanite at this part should

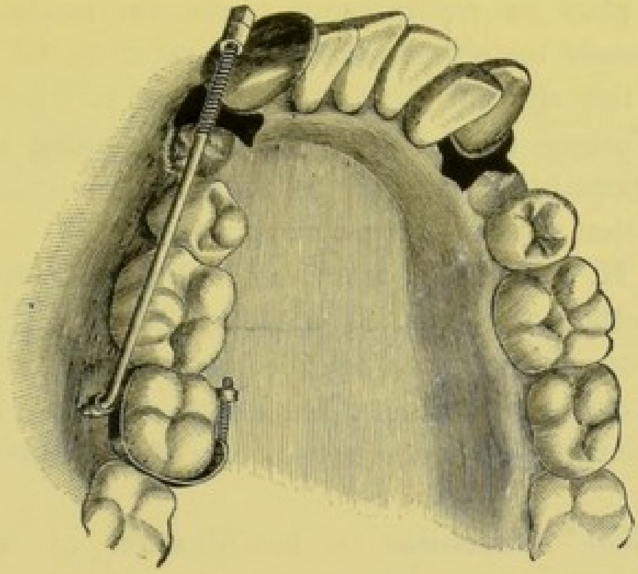

FIG. 231.[1]—Method of retracting a mandibular canine.

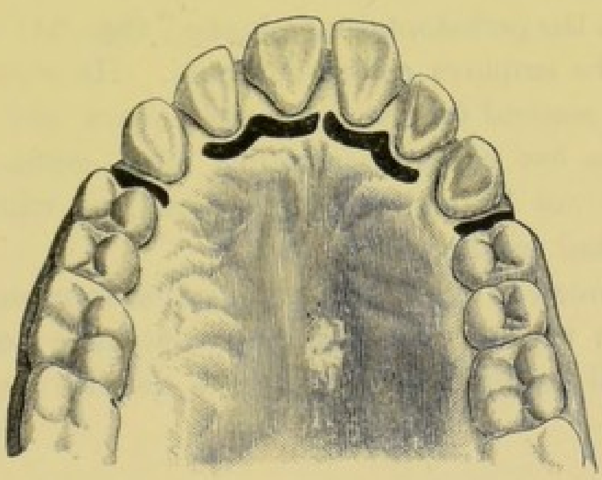

FIG. 232.[1]—Method of treating a case of superior protrusion.

also be strengthened with a strip of metal. A plate of this character, he maintains, forms a thoroughly stable fulcrum.

The forceps recommended by Dr. Bryan are shown in fig. 230.

Mr. Cunningham, in a paper read before the World's Columbian

[1] From *Dental Cosmos*.

Dental Congress,[1] has applied the method of regulating somewhat extensively, in one instance five teeth having been moved at one sitting. The paper, which records several cases and is fully illustrated, is well worthy of perusal.

In the plan he recommends, cuts are made through the alveolar process on either side of the tooth to be moved. The tooth with the anterior part of the socket is then brought forward with forceps similar to those recommended by Dr. Bryan. Antiseptic precautions should be taken. The tooth is fixed in its new position with a ligature or splint.

Mr. W. H. Dolamore,[2] who has had considerable experience with this method of regulating, attaches great importance to the proper fixation of the tooth after correction and adopts a metal splint fitted over the tooth and fixed with cement. In preference to the circular-bladed saw, he uses one somewhat like a Hey's, only thinner.

Dr. Talbot[3] advocates a combination of surgical with mechanical treatment. His method consists in removing the osseous tissue in "the line of travel of the tooth to be moved, leaving a small amount of process about the root of the tooth, holding intact the periodontal membrane" (figs. 231 and 232). For this purpose he employs coarse-cut burs. He states that he has practised the method for over seventeen years, and that although he has had a few cases of infection, such contingencies in his opinion need not be seriously considered, as with proper precautions no bad results will follow.

There is much to be said for and against immediate regulation, but until the various methods employed have been more fully tested, it will be difficult to express a definite opinion as to its value.

[1] Vol. i, p. 129.

[2] *Trans. Odonto. Soc.*, vol. xxxii, p. 42.

[3] *Dental Cosmos*, vol. xxxviii, p. 909.

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CHAPTER VII

Abnormalities in Position of the Teeth Associated with Normally Developed Jaws

(1) MAXILLARY INCISORS

Separation of the Central Incisors

Causes.—Separation of the maxillary central incisors is usually due to the attachment of the frænum of the lip to the muco-periosteum posterior to the tooth, but occasionally this irregularity can be traced to the presence of a supernumerary tooth ; while in rare instances a persistent frænum and a supernumerary tooth are both present. That the frænum acts as a cause of divergent centrals is often overlooked, but that such is the case will be easily seen by an examination of irregularities of this class. In a few cases the cause is obscure, separation being apparently the result of growth of bone at the median suture. Slight rotation often accompanies separation of the central incisors.

Treatment.—Should the cause of the irregularity be removed before the eruption of the canines, the space between the central incisors will, as a general rule, become lessened without mechanical treatment, as the canines in erupting will exert lateral pressure sufficient to bring the incisors into proper position. Supernumerary teeth should therefore be removed, where necessary, at the earliest opportunity, and the frænum should be cut.

The operation of dividing the frænum is easily performed as follows : The free edge of the frænum is seized with a pair of artery forceps and drawn forward ; a V-shaped piece is then removed from it with a sharp pair of scissors, care being taken to cut the part away where it blends with the gum (a point of great importance). The part between the teeth should also be removed. A strip of lint moistened with boracic acid lotion should be kept between the cut surfaces until the wound has

healed, an antiseptic mouth wash also being given. Cases treated by division of the frænum are shown in figs. 233 to 236. No mechanical treatment was adopted. Division of the frænum, if carried out before the eruption of the canines, will be found to

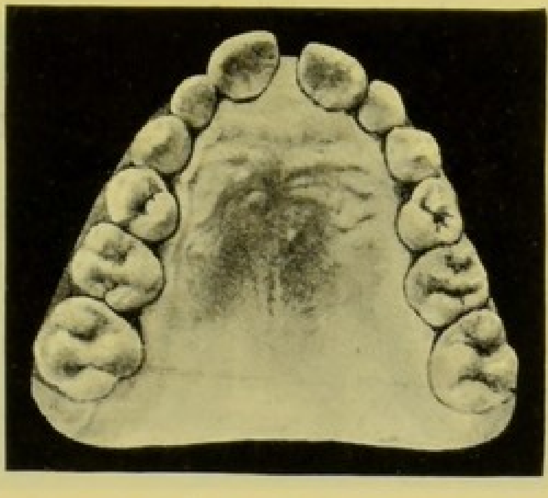


FIG. 233.—Case 1. Before treatment.

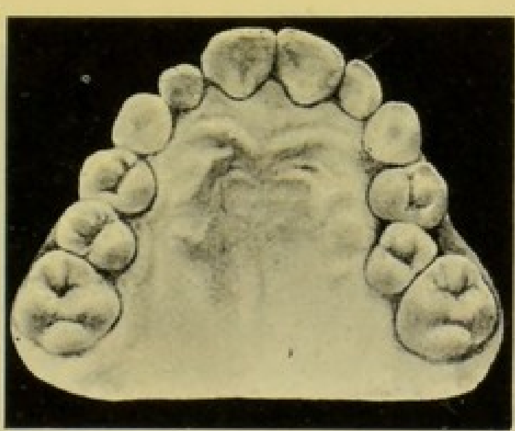


FIG. 234.—Case 1. After treatment.

lead to excellent results, but in cases treated after the eruption of these teeth the benefit is not marked, although the space will tend to close slightly. Should the removal of the cause not prove sufficient to correct the deformity, the teeth can easily be approximated by mechanical methods.

A plate of the form shown in fig. 205 will be found useful. After the teeth have been brought together, it will be necessary to retain them in position by suitable means.

Displacement External or Internal to the Arch

Causes.—The displacement of an incisor external or internal to the arch may be due to the persistence of the deciduous predecessor (see p. 135). In cases where a maxillary incisor erupts

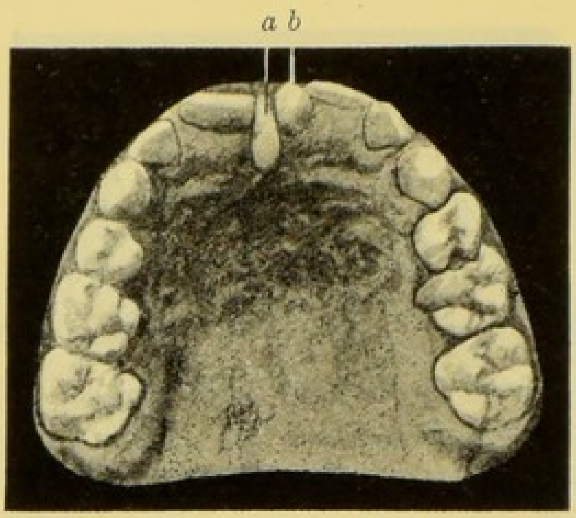


FIG. 235.—Case 2 (semi-diagrammatic). In this patient the separation of the centrals was due to (*a*) the frænum, and (*b*) peg-shaped supernumerary tooth.

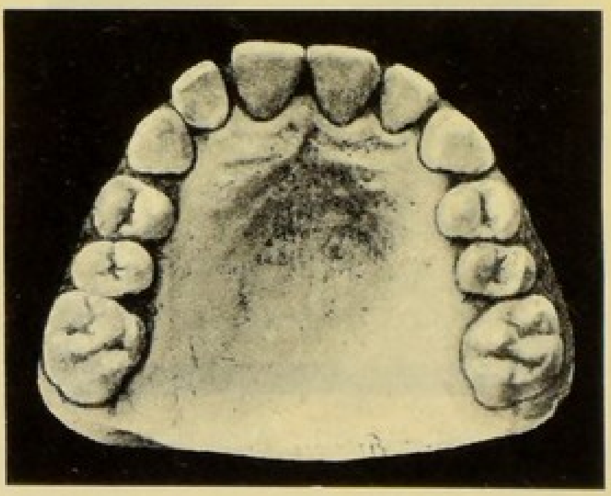


FIG. 236.—Case 2. After treatment.

so far out of line as to be outside the lower lip, the pressure of the lip will tend greatly to increase the amount of projection. The protrusion of a maxillary incisor may be due to irregularity of the lower teeth.

Thumb- or finger-sucking, if persisted in, will lead to protrusion of the incisors. In this habit, the palmar surface of the

thumb is placed against the palatal surfaces of the central incisors, the mandibular teeth being closed on the dorsal surfaces. The pressure exerted causes the central incisors to protrude so that the lower lip passes behind them, and aggravates the protrusion when the mouth is at rest. In a few cases, the thumb or finger is inserted between the teeth, causing the teeth to impinge on the lateral surfaces. Under such conditions the maxillary lateral incisors and also the canines are forced outwards and frequently upwards, producing a type of "open bite."

In a few instances, the protrusion is traceable to the habit of constantly sucking the lower lip or tongue. The prolonged use of the baby comforter or "dummy" also leads to protrusion of incisors (see pp. 138 and 328). Some of the most troublesome cases of displacement are due to the presence of supernumerary teeth. An example of this is shown in fig. 48. The supernumerary teeth invariably develop on the palatal aspect of the arch and cause a displacement of the incisors forwards and at times outwards.

Treatment.—Teeth that erupt internal to the arch may be treated either by an upper plate with wires or wedges (see fig. 202), or by a lower plate with an inclined plane. The latter method is particularly useful where the maxillary teeth do not afford a firm hold for a plate.

In teeth which show signs of erupting external to the arch, it is usually sufficient to remove the deciduous teeth and leave the natural forces to complete the process of correction. If, however, the tooth falls outside the lower lip, mechanical measures must be resorted to. After correction, it will be necessary to retain the teeth in position for from three to six months.

In cases where a supernumerary tooth is the disturbing influence, the tooth should be removed as soon as its presence is detected.

When all the incisors are prominent the teeth should be retracted slowly and retained in their corrected positions until they show no tendency to relapse.

Rotation.

Causes.—Rotation of an incisor may arise from the persistence of a deciduous tooth, or from the presence of a supernumerary tooth. A slight tilting of the lateral incisors may

often be traced to the canine developing in a slightly abnormal position. The frænum of the lip, in addition to causing separation of the central incisors, may be the cause of slight rotation of one or both teeth. The amount of rotation of the incisors may vary from an eighth to half a turn.

Treatment.—In treatment, the first step is to remove the cause, if that is possible. The actual rotation of the tooth may be accomplished either by *immediate* or by *gradual torsion.*

Immediate torsion consists in turning the tooth with forceps; **gradual** in rotating the tooth by mechanical methods. The points in favour of immediate torsion are the saving of time and the avoidance of a plate. Against the immediate method the main points are:—

(1) Liability of the tooth to leave the socket completely during the operation.

(2) The risk of death of the pulp from strangulation of the vessels at the apex.

(3) Fracture of portions of the enamel from pressure of the forceps.

(4) Fracture of the root in cases where the end is twisted.

As a rule, immediate torsion should not be resorted to after the root of the tooth is complete, which usually occurs about the age of ten. Prior to that age, the apical foramen is large, and there is less danger of twisting the vessels. Cases are recorded where torsion has been performed at the ages of 12, 14, or even later, and although many of these operations proved successful, some were failures. If the failures amount to only 5 per cent., it is a question whether it would be justifiable to subject patients even to that risk, when by gradual torsion the irregularity can be remedied by a safer, if slower, method.

In cases where the root may be considered fully formed, or there is any reason to suspect that it may be twisted, a radiograph should be obtained with the object of ascertaining the shape of the root.

In cases of immediate torsion, a model should be taken prior to the operation, the tooth being cut off the model and refixed in the position it will occupy after rotation. To the corrected model, a thin tin splint should be made to cover the lower third of the tooth to be operated on as well as the approximal teeth

This splint is applied by first drying the teeth and then fixing the splint in position with osteoplastic cement.

The operation of twisting the tooth should be performed with a pair of forceps which fits the tooth accurately. The blades should be covered with some such substance as thin lead foil, lint, or cotton-wool. Mr. Dolamore recommends the use of india-rubber between the blades at their division as shown in fig. 230, the elasticity of rubber exerting a force in an upward direction. The tooth should be grasped firmly, and slowly rotated, steady pressure in an upward direction being maintained during the process of turning in order to overcome the tendency of the tooth to leave the socket. It is advisable to turn the tooth slightly more than is required. Immediately the operation is completed, the splint should be applied and retained in place for about a week. An antiseptic mouth wash should be prescribed.

Before the operation is performed it is obviously essential to obtain sufficient space to allow of the necessary movement of the tooth. At times it is difficult to gauge the precise amount of space that will be necessary, and the direction of the root of the tooth to be turned should always be taken into account, as the tooth will not necessarily occupy the whole space.

Should the accident of complete removal of the tooth from its socket occur, the tooth must be cleansed in an antiseptic solution and replaced. Such teeth frequently remain alive.[1]

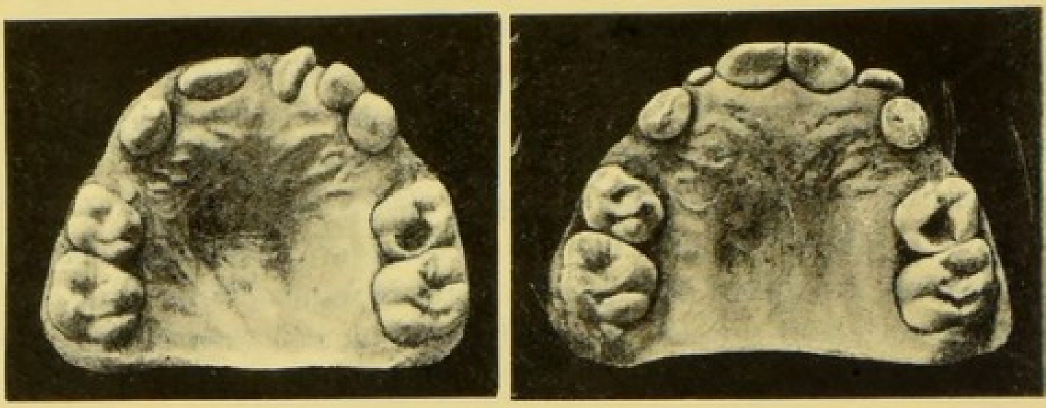
If the tooth after rotation shows signs of pulpitis, the gum should be painted with a counter-irritant, but if this fails to bring relief, and the symptoms become aggravated, the pulp cavity should be opened and the pulp removed. It is inadvisable to delay the removal of the pulp, as timely interference may prevent discoloration of the tooth substance, or, what is more serious, suppuration, which may eventually lead to loss of the tooth.

A case of immediate torsion is shown in fig. 237.

The gradual or mechanical torsion of a tooth can be carried out in a variety of ways, all of which depend upon the

[1] An interesting example of this was recorded by Mr. A. S. Underwood in the *Trans. Odonto. Soc.*, vol. xviii, p. 98.

principle of two forces working in opposite directions. A favourite method is to fix to the tooth a band with soldered hooks at the mesial and distal angles. Elastic bands are stretched from the hooks to attachments in the vulcanite plate. Other methods might be enumerated, but they all depend upon employing two forces acting in opposite directions.



(*a*) (*b*)

Fig. 237.—(*a*) before treatment; (*b*) after treatment. The rotated tooth was held in position for three weeks by a tin splint made as suggested in text.

Elongation

Cause.—**Elongation** of an incisor is usually the result of an accident.

Treatment.—In cases where the elongation is but slight, the tooth may be cut down by means of carborundum wheels, care being taken to polish the cut surface thoroughly. In more severe cases, an endeavour may be made to force the tooth into the socket if it is desirable from an æsthetic point of view.

Displacement Upwards of an Incisor

Causes.—This irregularity is generally the result of injury, but it may be the result of mal-development.

Treatment.—In all cases, a radiograph should be obtained to ascertain the shape of the root of the tooth. If the root is normally developed and it is considered advisable to correct the deformity, treatment may be carried out:—

(*a*) By reducing the length of the approximal teeth.

(*b*) By forcibly bringing the tooth into place with forceps.

(c) By mechanical appliances.

The first method, which may be adopted when the displacement is but slight, is more suitable for the treatment of centrals than laterals. With the former, a symmetrical appearance can be obtained by grinding down the cutting edge or rounding off the angles of the fellow tooth. With the lateral incisor, reduction of the length of the approximal teeth will naturally give an asymmetrical appearance to the mouth. This may of course be overcome by treating the lateral, central and canine on the other side of the mouth in a similar manner, a plan seldom advisable.

The second method of treatment may be adopted in cases of forcible displacement upwards, which are seen at an early date after the accident.

Treatment by mechanical appliances may be accomplished by the plan shown in fig. 238, the suggestion of Dr. C. L. Goddard.

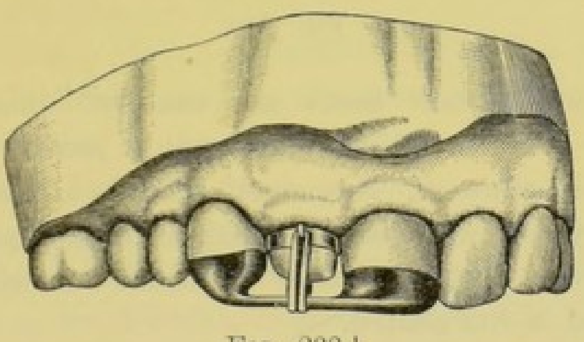


FIG. 238.[1]

Caps connected by a wire are attached to the teeth approximal to the one to be regulated. To the latter tooth a band is adjusted, hooks being soldered to the labial and lingual surfaces. Traction force is obtained by an elastic band arranged as shown in the illustration.

In cases where the root of the tooth is abnormal in direction, the first form of treatment only should be adopted.

Total Displacement of the Incisors

Incisors may be transposed, that is, occupy a position in the arch which should be held by another tooth. For instance, the central and lateral may change positions, or the lateral may

[1] From "Text-book of Operative Dentistry" (Kirk).

occupy the position of the canine. Cases of transposition do not call for treatment. The incisors may be completely displaced, as shown in fig. 239, and it is needless to say that the only treatment for such abnormalities is extraction. Occasionally the incisors erupt high up in the alveolar arch with the cutting edges

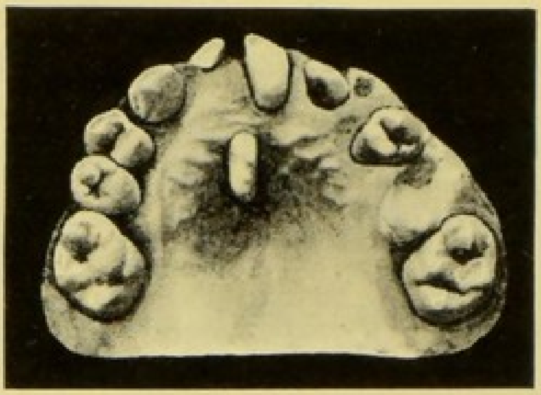


FIG. 239.

directed forward. Such teeth are usually "dilacerated," and endeavours to bring them into place would prove futile. Extraction is the only remedy. Niemeyer[1] records a case in which the right maxillary central incisor erupted through the lip in a woman about 60 years of age, and Salter[2] mentions one where the lateral incisor erupted in the nostril.

In cases of cleft palate complicated by hare-lip, the incisors adjacent to the fissure are often misplaced, and may erupt into the nasal cavity. As a rule, it is inexpedient to attempt their regulation, the roots of such teeth being usually curved and twisted. If the condition produces great disfigurement, the teeth can be removed and a denture inserted.

(2) MANDIBULAR INCISORS

The mandibular incisors may erupt internal or external to the arch. These conditions are usually produced by persistence of deciduous teeth, and when this is the case the obstructing tooth should be removed and the case left alone. The tongue on the one hand and the lips on the other are usually sufficient to bring

[1] *Deutsche Monatsschrift für Zahnheilkunde.*

[2] "Dental Pathology and Surgery," S. J. Salter, p. 51.

the tooth into line. In a few cases, the lower tooth may be outside the upper incisors; under these conditions the lower tooth must be retracted or the upper tooth pushed out. Total displacement of the lower incisors is very rare.

(3) MAXILLARY CANINES

The eruption of the maxillary canine external to the arch may be associated with persistence of the deciduous tooth, but as a rule it is the result of lack of space arising from the forward movement of the premolars and molars. The early extraction of the second deciduous molar may be followed by a forward movement of the first permanent molar, and the second premolar in erupting forces forward the first premolar. If, however, the canine erupts before the second premolar; the first premolar is driven back by the canine, and the second premolar erupts in a misplaced position.

Eruption of the canine internal to the arch is uncommon.

For the methods of treating the above irregularities, see p. 216.

Partial eruption of the canine occurs occasionally. An effort may be made to force the tooth to erupt. An appliance for this purpose is figured by Essig.[1] A band is cemented to the first premolar. To this band a tube is soldered. Into this tube a piece of wire is fixed which extends across the space and under the cutting edge of the lateral incisor. A stud is fixed into the canine tooth and traction applied by means of elastic.

Success is by no means certain, and in one case under treatment the tooth resisted every effort to regulate it. In all cases where a permanent canine erupts late, a radiograph should be obtained, and if there is no indication that the tooth is coming into correct position, or the root shows signs of being twisted, the tooth should be removed and the deciduous canine retained.

Complete Displacement.—The maxillary canine is more frequently "transposed" than any other tooth, that is, occupies the normal position of another tooth. It may be found usurping the place of the lateral incisor, or of the first premolar and occasionally of the second premolar. In the maxilla shown in fig. 240, the right and left canines are transposed. This

[1] "Text-book of Prosthetic Dentistry."

specimen also shows complete displacement of the right first molar. The canine is totally displaced from the arch more often than any other tooth. In figs. 241 and 242 are shown some

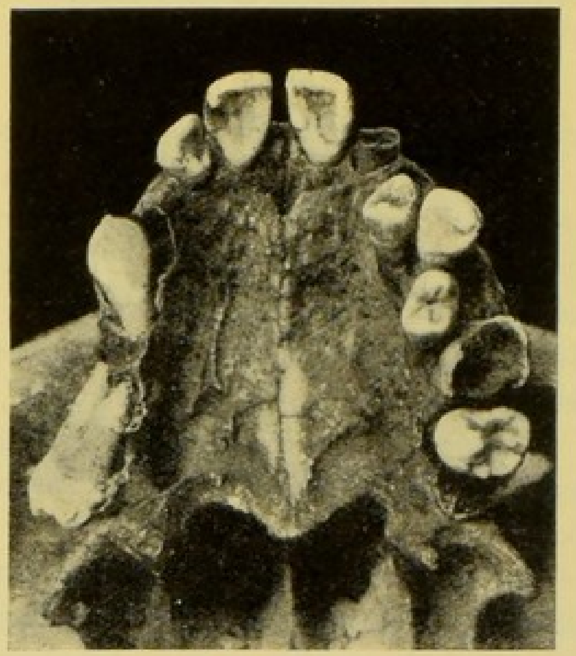


Fig. 240

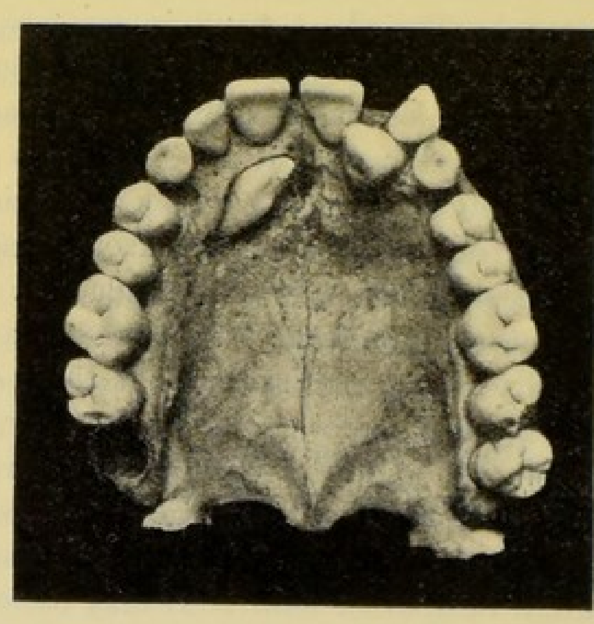


Fig. 241.

specimens illustrating these irregularities. The misplaced tooth in these cases often lies dormant and causes no inconvenience, but should it erupt extraction is the best remedy. A unique

case in which a deciduous canine was developing within the left orbit has been recorded by J. W. Cousins.[1] The patient was two years of age and there was a hard swelling located just

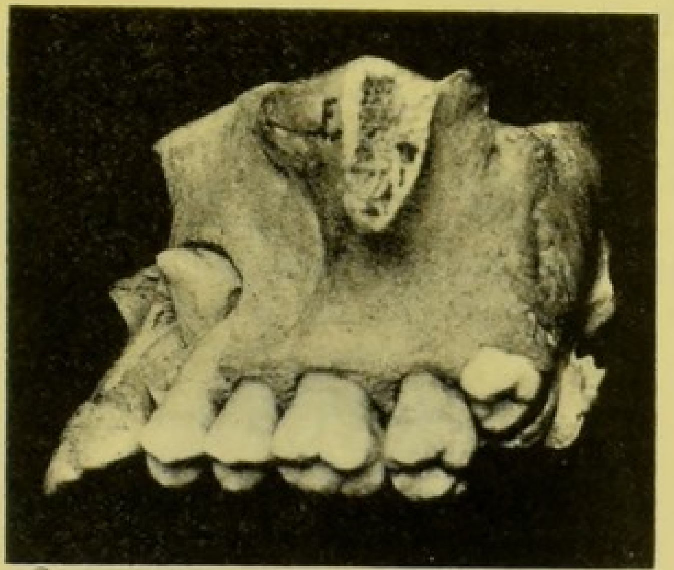


FIG. 242.

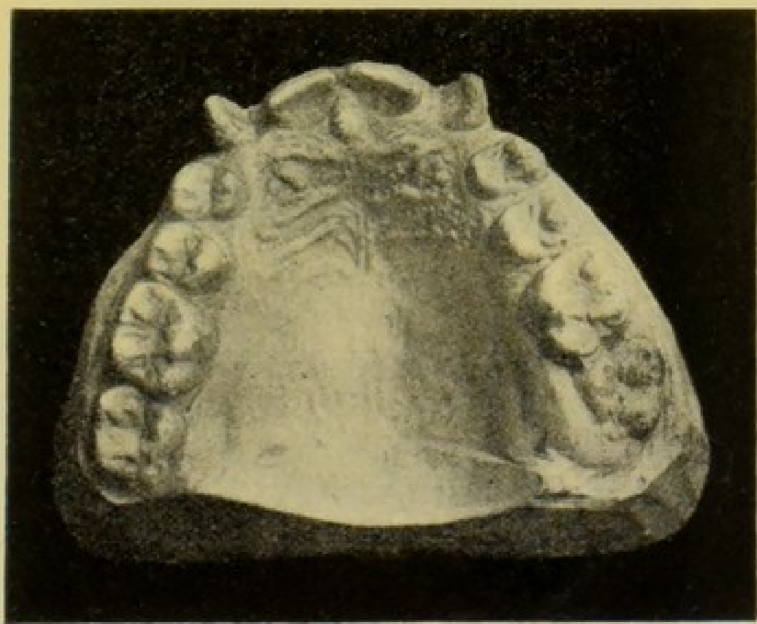


FIG. 243.

within the left orbit. On the growth being detached from its surroundings, the crown of a deciduous canine was found enclosed

[1] *Journ. Brit. Dent. Assoc.*, vol. viii, p. 294.

in a sac, the root of the tooth being attached to the orbital plate by fibro-cartilage.

Misplaced canines may lead to troublesome irregularity of the teeth present in the arch. An example of this is shown in fig. 243. The lateral incisors have been rotated and tilted owing to the pressure of the canines. Under such conditions, the canines must be removed, and correction of the misplaced teeth carried out.

(4) MANDIBULAR CANINES

Irregularities of the mandibular canines from causes other than crowding are rare. In the case shown in fig. 244, the

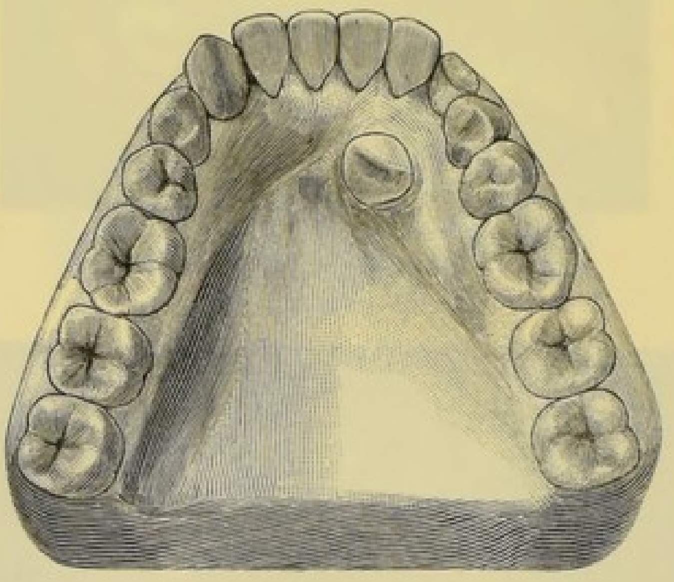


FIG. 244.

deciduous canine is in position and the permanent canine has erupted internal to the arch. The treatment consisted in the removal of the misplaced tooth.

An interesting example of a misplaced mandibular canine was recorded by Mr. C. Truman.[1] The tooth appeared under the chin, the presence of a sinus having apparently caused the deviation. After its removal, a premolar made its appearance in the same position. A similar case is recorded by Mr. D. Whittles.[2]

Complete displacement of the mandibular canine is rare.

[1] *Trans. Odonto. Soc.*, vol. xxiii, N.S., p. 34.
[2] *Journ. Brit. Dent. Assoc.*, December, 1901.

(5) PREMOLARS

Abnormalities in the position of the maxillary and mandibular premolars are usually the result of early extraction of the second deciduous molar. The first premolar erupts in correct position with the second premolar misplaced internal to the arch. More rarely, both the teeth are involved in the irregularity, as seen in fig. 245. Irregularly placed premolars are best treated by extraction, provided that both the approximal teeth are savable. If, however, one of the approximal teeth is unsavable then it should be removed and the misplaced premolar trained into position. In a case similar to that shown in fig. 245, one of the premolars

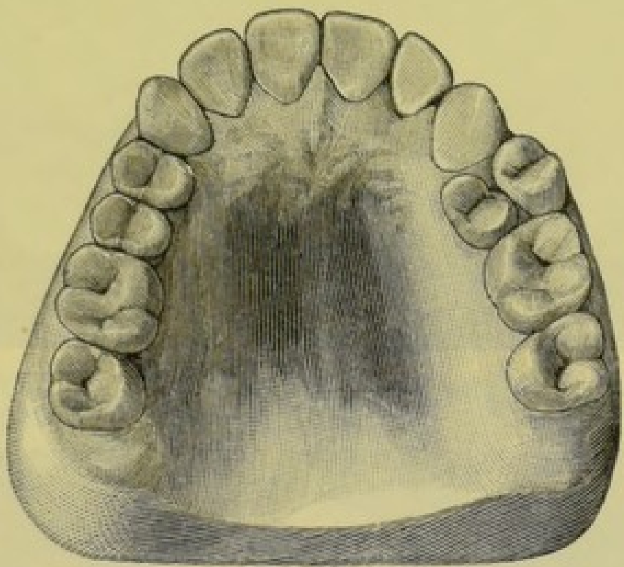


FIG. 245.

should be removed, and, in choosing between them, the judgment should be guided by their relation to the opposing teeth and to the degree of rotation.

Misplacement of the premolar may be associated with persistence of the second deciduous molar, but this may rarely occur, an example is seen in fig. 245A. The cause of this irregularity is obscure, but there is reason to think that it is due to a developmental defect, and in this connection it is interesting to note that the displacement of a premolar is often met with in monkeys.[1] The specimen shown in fig. 246 is a Patas monkey, and in this animal

[1] See "Irregularities of Teeth in Animals," *Brit. Med. Journ.*, November 23, 1907, p. 1505.

all second premolars had erupted external to the arch, and well up in the alveolar process.

FIG. 245A.

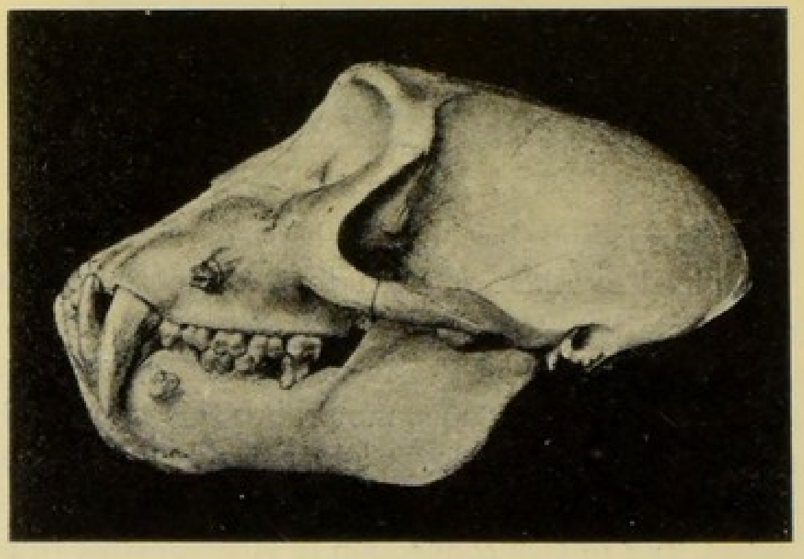


FIG. 246.[1]

Transposition of the maxillary canine and first premolar may occur. Complete displacement of the premolars from the arch is rare.

[1] From *Trans. Odonto. Soc.*

(6) MOLARS

Maxillary.—Of the maxillary molars, the third is occasionally misplaced. This tooth may erupt obliquely or horizontally towards the cheek (fig. 247), or it may be in a posterior direction

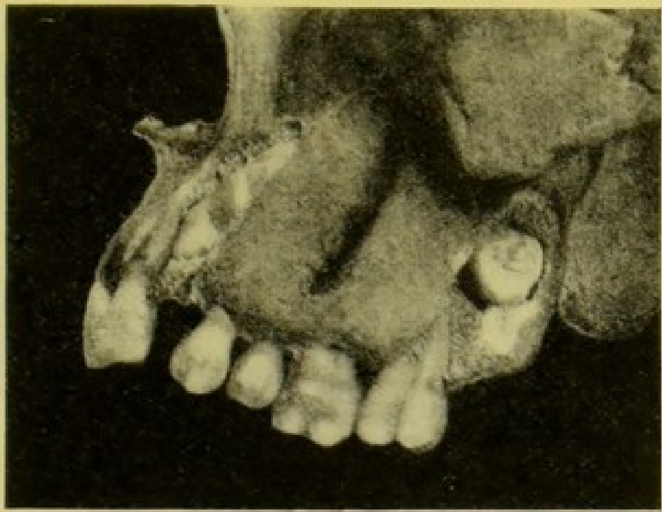


FIG. 247

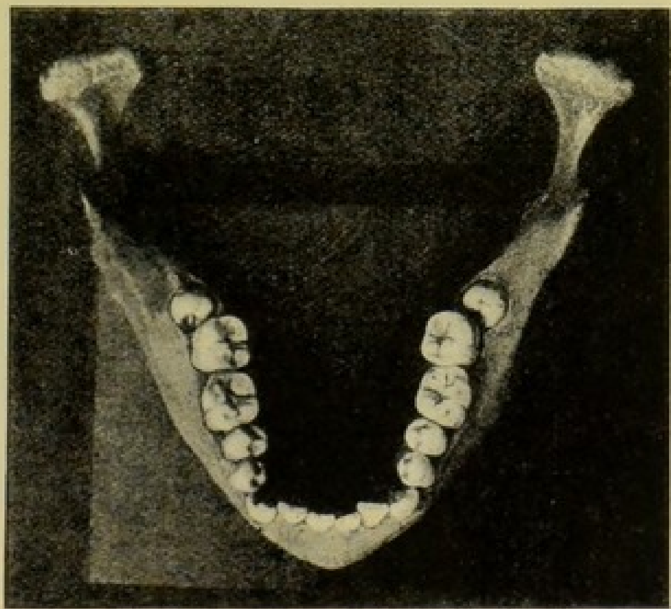


FIG. 248.[1]

towards the hamular process. Complete misplacement of this tooth may occur; for example, it may be caught by the roots of the second molar, as seen in fig. 59. In a specimen in the

[1] From *Trans. Odonto. Soc.*

Royal College of Surgeons the third molar has erupted in the median line of the palate.[1]

Mandibular.—The third molar is frequently misplaced. Among the conditions which have to be treated in practice there are few which demand more thought and care than a misplaced

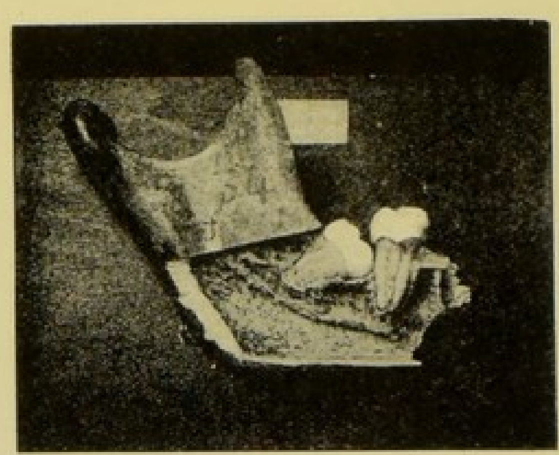


FIG. 249.[1]

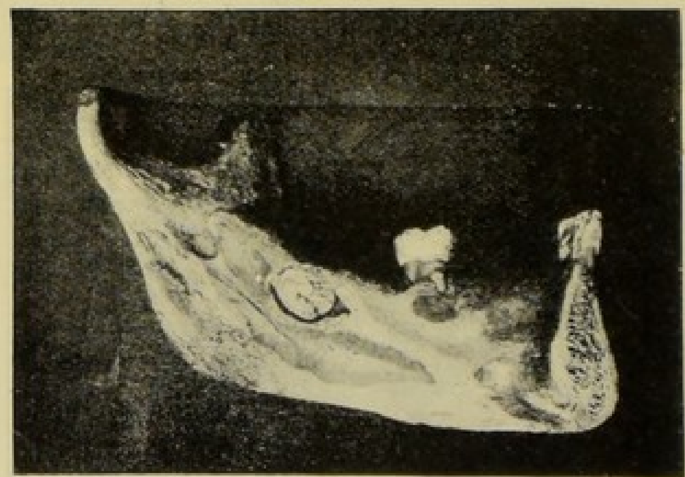
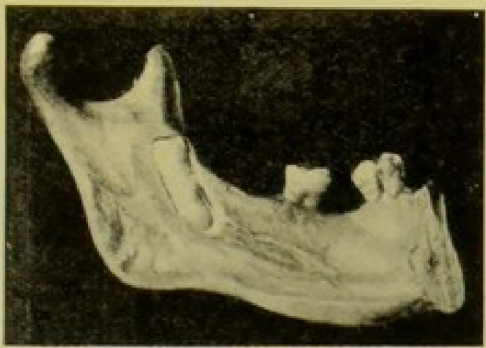


FIG. 250.[1]

third mandibular molar that is causing trouble. The tooth may be only slightly tilted forward (fig 248); or it may be placed horizontally, the occluding surface of the crown impinging on the posterior root of the second molar (fig. 249). In some instances, the tooth may be so placed that the occluding surface faces downwards and inwards (fig. 250). An examination of specimens

[1] From *Trans. Odonto. Soc.*

exhibiting the third mandibular molar misplaced will demonstrate very clearly that the roots are to a greater or less extent covered by the ascending ramus of the mandible. This is well shown in fig. 249. Other points brought out in this specimen are the close proximity of the root of the tooth to the mandibular canal, and



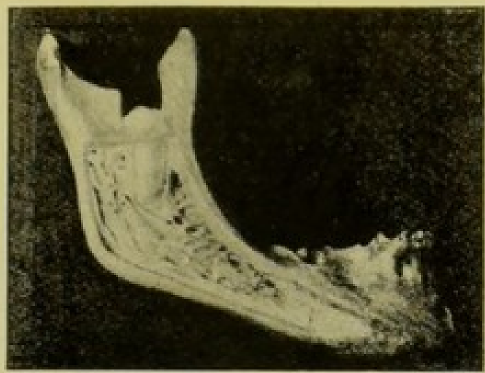


FIG 251.[1]

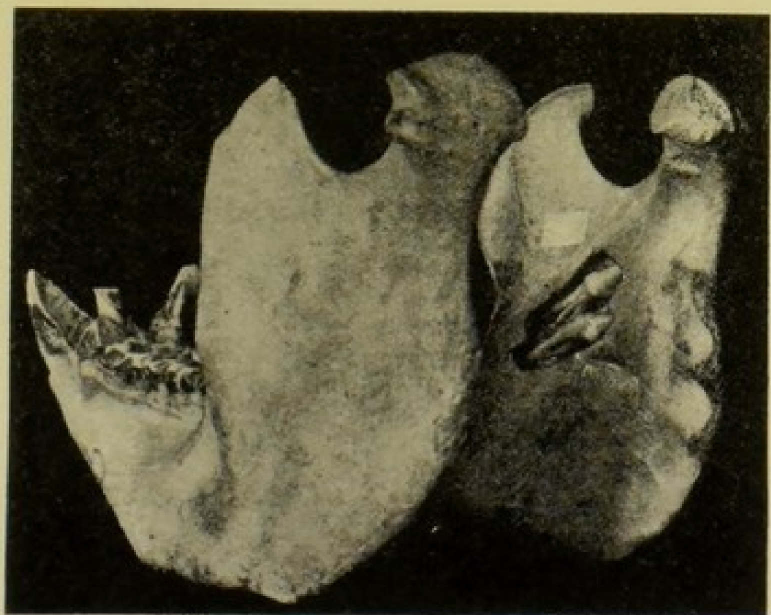


FIG. 252.[1]

the small amount of bone existing at the posterior aspect of the second molar.

By far the most interesting specimen of misplaced third molars

[1] From *Trans. Odonto. Soc.*

is that shown in fig. 251. The right third molar is situated in the centre of the upper part of the ascending ramus. The tooth is placed vertically, the crown being but little below the sigmoid

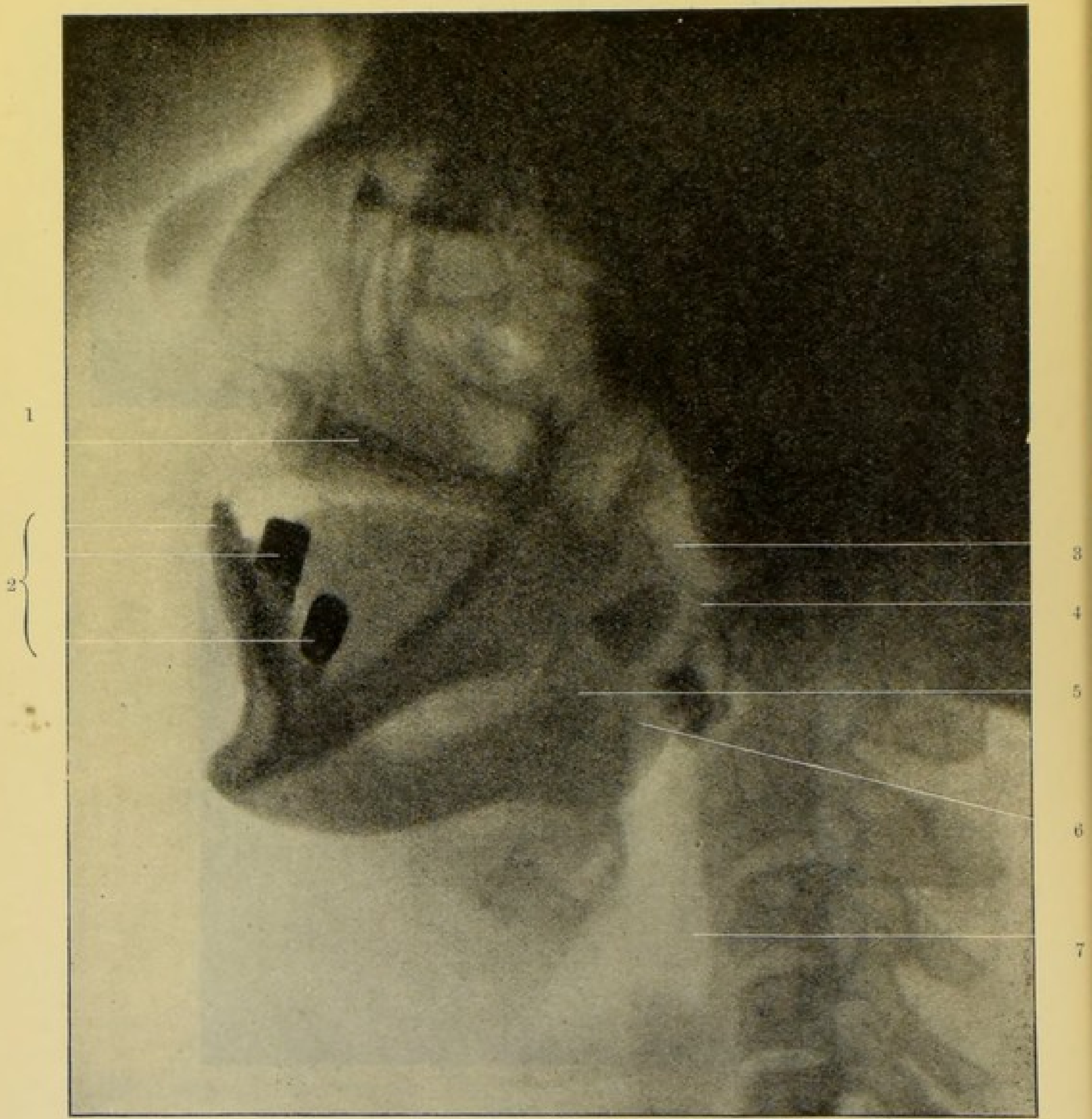


FIG. 253.[1]—(1) Hard palate; (2) teeth and crowns in mandible; (3) sigmoid notch; (4) third molar; (5) sinus leading from mouth; (6) mandibular canal; (7) trachea.

notch. The left third molar is also misplaced, and rests in the anterior portion of the ascending ramus. Both teeth, as might be expected, lie above the mandibular canal.

[1] From *Brit. Dent. Journ.*

The specimen shown in fig. 252 seems to throw some light upon the foregoing pathological treasure. The specimen represents the mandible of a gorilla, in which two cone-shaped teeth are imbedded in the ascending ramus; one of these teeth is triple-rooted and one single-rooted. The full number of premolars and molars are in place on the mandible, and the cone-shaped teeth must therefore be regarded as supernumerary teeth. It will also be noticed that they lie above the mandibular canal.

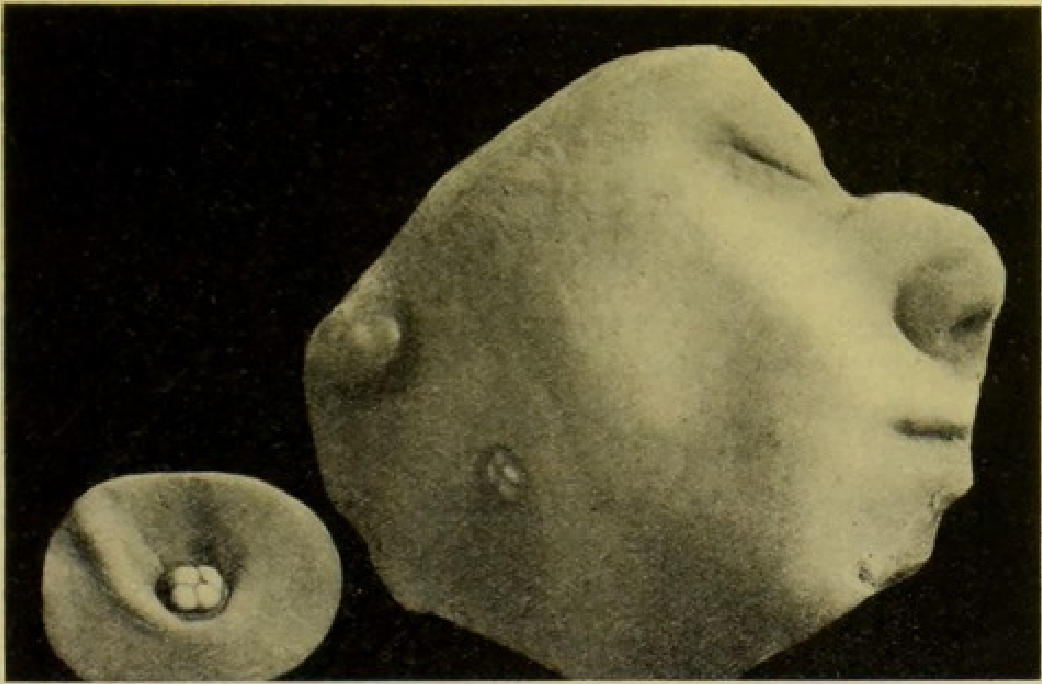


FIG. 254.

The condition seen in figs. 252 and 253 is probably due to some aberration of the "tooth band." It seems not unlikely that the abnormalities are the result of the "tooth band" passing too far back, and that the misplaced third molar is but a partial manifestation of a condition which finds its full expression in the specimen illustrated in fig. 251.

An aberration of the "tooth band" may similarly be responsible for the curious temporal teeth found in horses, for it must be remembered that the first visceral arch assists in the formation of the mandible, as well as of the bones of the middle ear.

Mr. J. J. Andrew[1] has recorded a case in which the left mandibular third molar was misplaced high up in the ascending ramus, but with the apex towards the sigmoid notch (see fig. 253). In this patient, a woman aged about 55, suppuration had occurred in connection with the tooth, necessitating its removal. "An obtuse-angled incision was made along the posterior border of the ramus, and the angle of the jaw and the masseter temporarily displaced; the bone just below the sigmoid notch was removed by means of a trephine and the tooth exposed and removed."

In a case under the care of Mr. Craigie the third molar erupted at the angle of the jaw. (See fig. 254.)

[1] *Brit. Dent. Journ.*, vol. xxx, 289.

CHAPTER VIII

Abnormalities in Position of the Teeth, associated with Abnormally Developed Jaws

General Crowding.

In general crowding of the teeth the irregularity varies between a slightly crowded arrangement involving all the teeth and the extrusion from the arch of one or several teeth. The causes of the condition are to be found in those factors which, acting subsequent to birth, tend to retard the growth of the jaws, and so diminish the space available for the teeth when erupted. The position which the teeth assume depends upon several contingencies, which may now be conveniently referred to.

Of these, one of the most important is *the position of the teeth in their crypts.* It has already been shown that, even under normal conditions, the permanent teeth are arranged in their crypts in an irregular manner, and it necessarily follows that the irregularity of their position will become more marked as the space available for their development diminishes; the lateral incisors will perhaps be placed more inwards and the canines more outwards. The direction which a tooth takes in erupting is probably in the same line as the long axis of the tooth in the crypt, and herein, perhaps, lies the explanation of the frequent eruption of the lateral incisors and the premolars internal, and the canines external, to the arch in cases of crowded mouths.

The Order of Eruption is an important factor in determining the character of an irregularity, and this is clearly shown in cases of early loss of the second deciduous molar. When the teeth appear in normal order, the canine erupts subsequent to the second premolar; hence, if there is insufficient room in the arch, the canine will be the principal disturbing factor. If there is a fair interval between the lateral incisor and the first premolar, the canine will force its way into the arch, causing disturbance in the

position of the incisors, but if the interval is slight the result will be the exclusion of the canine which will erupt in all probability external to the arch. The pressure of the canine will also, in many cases, force the incisors into irregular positions.

Should the canine erupt before the second premolar, the disturbance in the position of the anterior teeth will be less noticeable. The incisors, canine, and first premolar will erupt in a fairly regular manner, the premolar being forced towards the first molar. If the space between these latter teeth is but slight, the second premolar will erupt internal to the arch and cause but little disturbance. On the other hand, if the interval is nearly normal, the second premolar in erupting will, in all probability, cause displacement inwards of the first premolar and so produce a type of saddle-shaped arch.

The type of irregularity also varies with the cause interfering with the growth of the jaw. In cases where "adenoids" have been present before the age of six, the interference with the growth of the premaxillæ will lead to crowding of the lateral and central incisors, the roots of the laterals lying with their apices directed towards the median line. The canine, also, owing to the want of development of the anterior nares, will lie too near to the median line, with the result that, when erupted, the root will cover a small portion of the upper part of the lateral root. This point is of practical importance when the treatment of crowded incisors is under consideration.

In cases where the main interference in the growth has occurred in the molar region, the incisors will generally erupt in a regular curve, and the principal irregularity will be posterior to the premolars and canine.

Treatment.—In considering remedial measures for the treatment of crowding of the teeth, there are one or two points which should influence us in our choice of method.

In the first place, we must not lose sight of the prevalence of **caries of the teeth.** All methods, therefore, which assist the lodgment of food and increase the difficulty of keeping the mouth clean should, if possible, be avoided.

Again, the increasing liability to lose the teeth from **chronic periodontitis** is a reason for avoiding mechanical methods, in the use of which damage to the gingival margin is so likely to occur.

The main point, however, constantly to be borne in mind is that the **crowding of the teeth is the direct result of interference with the growth of the bone,** and that the "arch" is too small to contain the normal number of teeth. Hence it follows that—

The jaws must be stimulated to grow, or the number of the teeth must be reduced.

The latter method can easily be carried out by extraction; but are there any means by which the former can be accomplished? Let us consider this question. It has already been shown that the jaw grows in a backward direction, and that the only change in the bone after it is formed is a slight addition from the periosteum, and that that growth is interfered with by lack of proper stimulation. If stimulation is restored, growth continues normally, but this growth does not occur in the region where the bone is deficient, namely, that anterior to the molar. Indeed, it is difficult to see how any increase in this part can occur without interstitial growth, and there is no evidence to show that such growth occurs.

There are, however, some who maintain that the jaw can be stimulated to grow, and they adopt that method of treatment known as "expansion of the arch." This operation was first suggested by Dr. Coffin, and consists in moving all the teeth, or a proportion of them, in an outward direction. On a previous page the question of the movement of teeth, when treated mechanically, was discussed, and it was shown that, with the majority of appliances, the tooth, for all practical purposes, may be considered to swing on its apex. In expansion the crowns are made to occupy a greater arch, but the apical portions remain in much the same crowded condition. There is, therefore, no true relief to the crowding, and hence a relapse frequently takes place.

It is claimed, however, that, if the crowns are kept in normal apposition, the roots will follow, and that the movement of the teeth and alveoli stimulates the growth of the under-developed jaw, and, indeed, of all the bones of the face, and with them the nasal and accessory cavities. It is extremely difficult to understand how this can occur, and the evidence so far advanced by its advocates has not been of an entirely satisfactory character, seeing

13

that the improvement claimed to have been made could quite possibly have been the result of natural causes.

It is urged against "expansion of the arch" that considerable derangement of the occlusion may result, but those who advocate this method maintain that if derangement occurs it is due to faulty manipulation.

With rapid expansion a separation of the maxillæ at the median suture may occasionally occur. Dr. C. E. Quinby[1] records the case of his own child, in whom he spread the arch with a jack-screw. One day the child complained of a swelling in the roof of her mouth, saying it felt like a cut. Examination of the mouth showed that the bones had separated, and with the rhinoscope it was seen that the septum had slipped into its proper position between the maxillary bones and was perceptibly straightened. The operation also resulted in the child becoming a nasal instead of a mouth-breather. Dr. R. Landsberger[2] also records a case, illustrated with radiographs, in which a separation of the maxilla apparently occurred.

The first step adopted by those who advocate expansion of the arch is to determine what should be the normal arch for the individual under treatment. A method of ascertaining this has been suggested by Dr. Hawley,[3] and he has worked on the data of the late Dr. Bonwill. As a result of many observations on living persons and skulls, Dr. Bonwill established, as a standard, an arch constructed upon an equilateral triangle, the base representing the distance between the condyles and the apex resting between the central incisors at the cutting edges. In this ideal arch "the six anterior teeth are arranged in an arc of a circle, the radius of which is determined by the combined width of the central, lateral and canine teeth. From the distal point of the canine the premolars and molars are arranged in straight lines, passing to the extremities of the base of the triangle, the points of the buccal cusps being cut by the line."

[1] Discussion on a paper, "Theories made Facts," by Dr. E. A. Bogue.

[2] "Anatomical Alterations in the Osseous Tissue of the Palate during Maxillary Orthopædic Treatment." Translated from *Correspondenz-Blatt für Zahnärzte*, in Ash's *Quarterly Circular*, July, 1909.

[3] *Dental Cosmos*, May, 1905, p. 541.

The method adopted by Dr. Hawley for obtaining this arch is as follows: From the combined widths of the central, lateral, and canine as a radius, draw a circle A—D—C (fig. 255). Measure

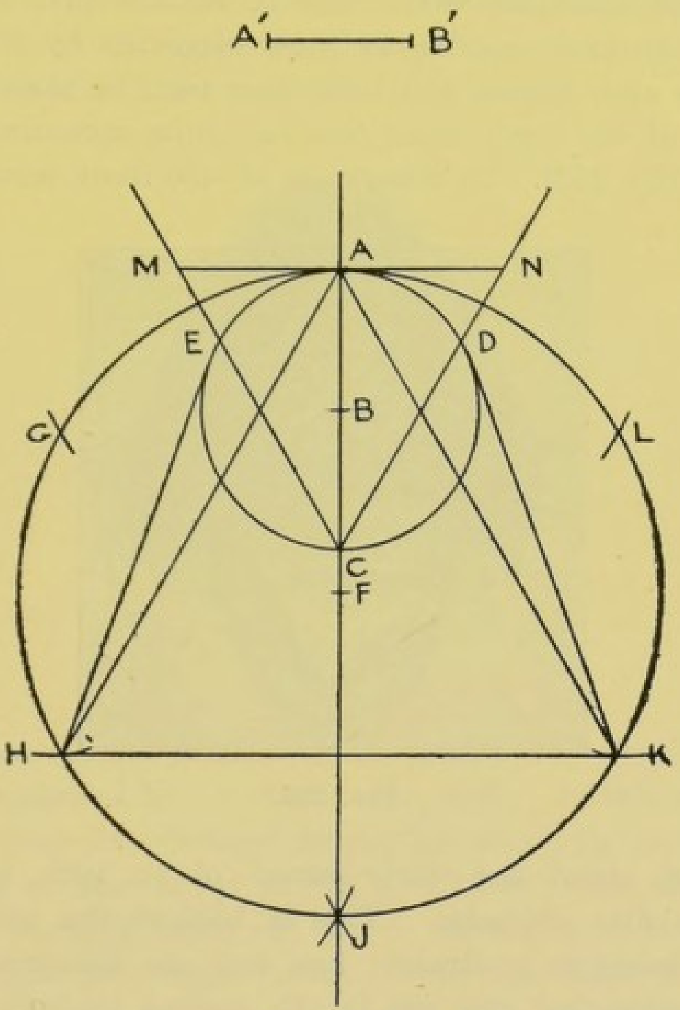


Fig. 255.

the radius upon the circumference of the circle at E and D, marking the distal points of the canines. From C, the end of one of the radii of the circle, drawn through A and B, draw the lines C—N and C—M through E and D, extending them indefinitely. Draw a tangent to the circle at A, cutting these lines at M and N, forming the equilateral triangle C—M—N. Take one side of this triangle as the radius of a circle passing through A, with the centre F upon the extension of the line A—C. From A mark off the radius of the circle upon the circumference six times at G—H,

J—K—L, and A, and draw the inscribed triangle H—A—K. Draw the lines H—E and K—D. We have now an arch based upon and arranged with an equilateral triangle, but proportional to the widths of the three front teeth, or the radius A—B.

By these measurements it will be noticed that Dr. Hawley constructs an arch similar to that suggested by Dr. Bonwill. Having the arch drawn, the teeth may then be sketched in full, the width of the teeth being obtained from measurements from the mouth (fig. 256). In measuring off the front teeth there is a

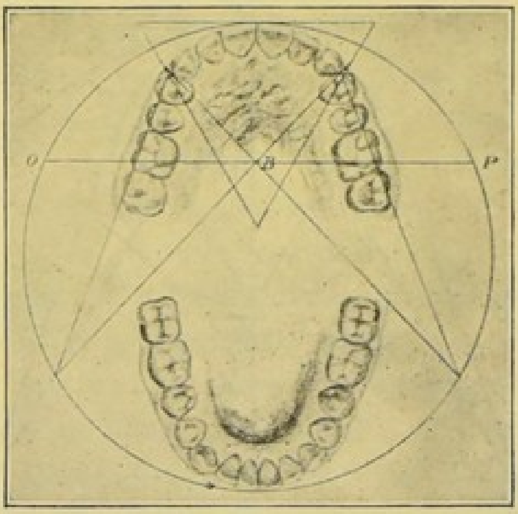


Fig. 256.[1]

small space, about one thirty-second of an inch, between the canine and first premolar. This is because the widths of the teeth are taken in a straight line and are measured off on a curve. Notice that the line O—P, passing through B parallel to the base of the triangle, passes through the crest of the disto-buccal cusps of the first molars. This Dr. Hawley has found true of every case that he has drawn.

The second molars are turned slightly towards the median line. The lower arch is drawn from measurements of the lower teeth.

The drawings obtained are kept as standards for the comparison of measurements as the case proceeds. The arches are expanded to the required size by any method selected. In the mandible the premolars are raised and the incisors lowered if

[1] From *Dental Cosmos.*

conditions require it, and the lower teeth brought into correct occlusion.

The value of this method is open to criticism, and there are no grounds for assuming that by the geometrical processes suggested the curve of the normal arch can be determined, and that the size of the arch can always be correctly derived from the measurement of the incisors and canines.

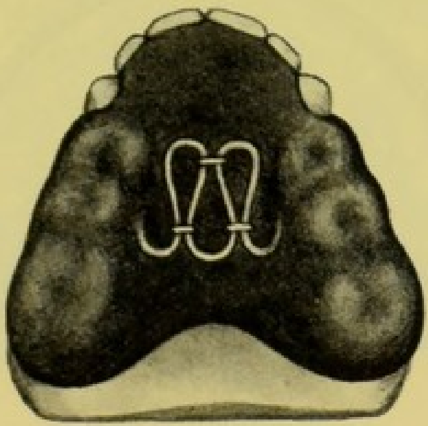


Fig. 257.

Expansion of the arch may be carried out by the method originally suggested by Dr. Coffin (fig. 257). In this method the expansion force is obtained from the elasticity in pianoforte wire, acting on the halves of the split plate. The plate should be inserted without being cut down the centre, and should be worn for about forty-eight hours. This will allow the plate to adjust itself thoroughly to the mouth, and, when subsequently cut down the centre, it will work more satisfactorily. A plate of similar design is used for the lower.

The method suggested by Dr. Angle is a favourite with many. The expansive force in this method is obtained from the elasticity of a wire adjusted to the labial aspects of the teeth. The apparatus is shown in fig. 258, and in fig. 259 its method of application to the maxillary and the mandibular teeth. The bands are fixed to the first molars, and the expansion wire bent to the form of the ideal arch, and to this the teeth are ligatured by means of wires, which are occasionally tightened. The pressure on the teeth may be assisted by blocks of rubber.

The majority of those who favour expansion recommend that treatment should commence soon after the eruption of the incisors.

It will readily be seen that expansion entails a long period of mechanical treatment, and this is most undesirable from the point of view of the hygiene of the mouth.

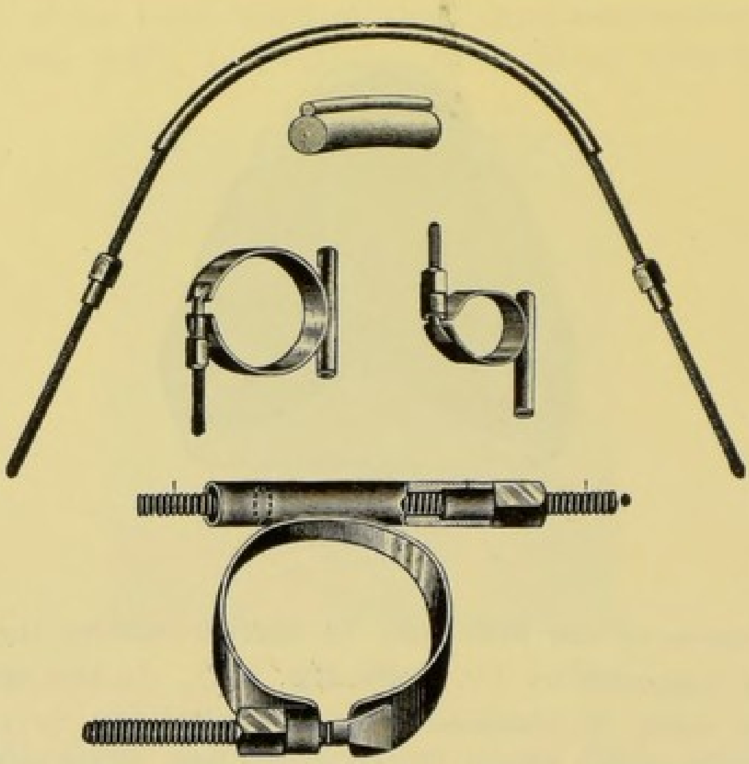


Fig. 258.[1]

A disadvantage of expansion is that the results are often not permanent, the teeth tending to relapse into their original positions, owing to the fact that the apical portions of the roots still remain in a crowded condition although the crowns of the teeth are brought into a regular arch. It is claimed that, with the attainment of ideal occlusion, the facial expression is improved and that extraction mars the features; but this is purely a matter of opinion, and in many of the illustrations, showing the result of treatment by expansion, the expression has lost rather than gained.

In considering the alternative treatment for crowded arches,

[1] From "Mal-occlusion of the Teeth," by E. H. Angle. Seventh Edition.

namely, extraction, the following points can be urged in its favour :—

(*a*) Room is gained not only for the crowns but also for the roots of the teeth.

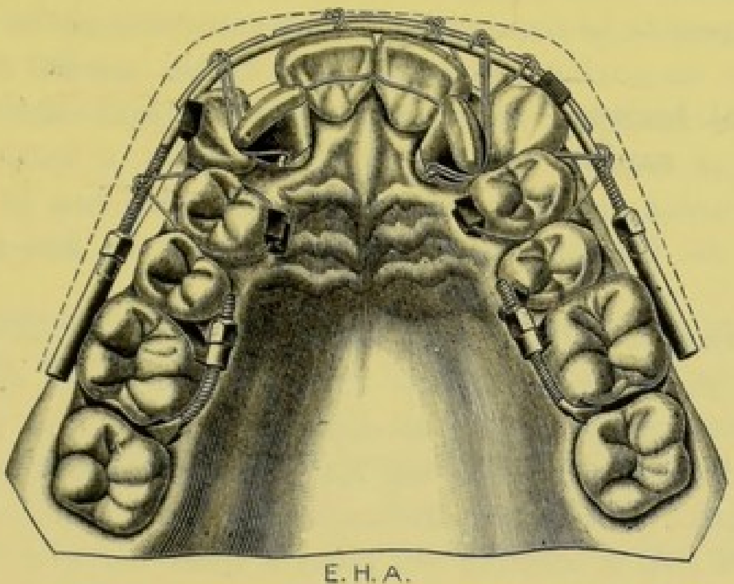


FIG. 259.[1]

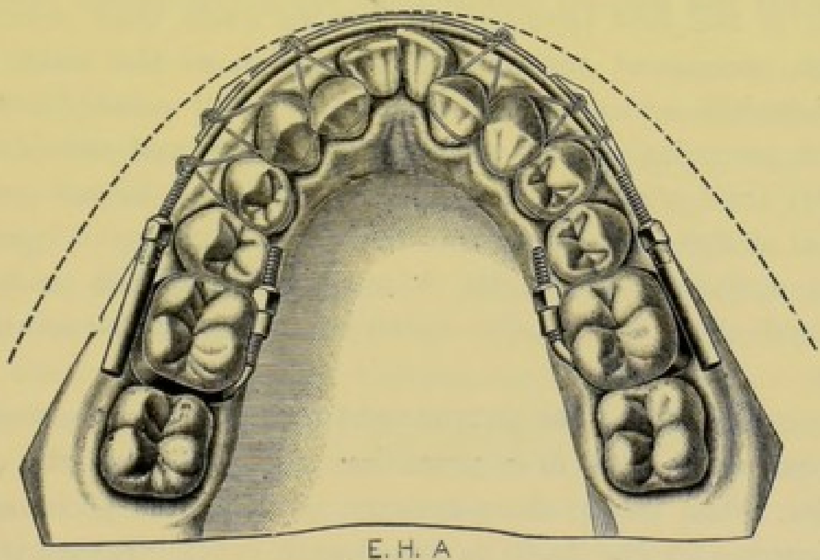


FIG. 259.[1]

(*b*) Mechanical treatment is minimized, and in many cases dispensed with.

(*c*) Isolation of the teeth is often obtained, which is a point of therapeutic importance in the prevention of caries.

[1] From "Mal-occlusion of the Teeth," by E. H. Angle. Seventh Edition.

(*d*) The occlusion is but little deranged, provided the extraction is judiciously carried out.

(*e*) The teeth invariably assume better directions.

In the large majority of cases extraction is far preferable, and would appear to be more rational than expansion of the arch.

When employing extraction, it is rarely needful to remove **a central incisor**. Occasionally, the removal of the **lateral incisors** or **canines** is necessary. Generally, a tooth posterior to the canine can be removed, and a choice has to be made between the first and second premolars and the first permanent molar.

The removal of the **first premolar** has the advantage of relieving the crowding of the anterior teeth more easily than the removal of either the second premolar or first permanent molar. Its removal causes but little disturbance of the occlusion of the teeth. If, however, the amount of room required is slight, there is a risk of creating too great a space between the canine and the second premolar.

Extraction of the **second premolar** provides less room than removal of the first premolar, but more room than removal of the first permanent molar. The occlusion of the teeth is but little disturbed, and any space that may result would be between the first premolar and first permanent molar, and would be less unsightly than a space between the canine and second premolar. Removal of the second premolar has the advantage of freeing the anterior surface of the molar, which will lessen the tendency to caries and allow any caries which may exist to be more easily treated.

Removal of the **first permanent molar** gives less room than the removal of the first premolar, or, probably, the second premolar. The treatment necessary is also more prolonged, and the occlusion of the teeth is frequently much disorganized, the second lower permanent molars tilting, and the premolars, both upper and lower, rotating. As an organ of mastication, the first permanent molar is most important. It possesses the largest area of crown surface, and is situated in that part of the arch where the muscles of mastication work to greatest advantage. Its importance as an organ of mastication is so great, and the disturbance to the articulation caused by its removal so marked,

that only when the tooth is unsavable should it be removed for the relief of crowding. Under all other circumstances, the choice should be made between the first and second premolars; if both teeth are free from caries, the first should be removed if the crowding is marked; if but little space is required the choice should fall on the second premolar.

A combination of extraction with expansion is occasionally useful in cases where the amount of crowding cannot be wholly overcome by expansion, and yet expansion is to some extent desirable.

Treatment of Cases coming under Observation before the Premolars and Canines have Erupted.—In mouths where crowding is inevitable, treatment should be commenced at an early age. For simplicity of description this question will be considered under two headings: (i.) Cases where the first permanent molars are unsavable; (ii.) cases where the first permanent molars are savable.

(i.) Cases where the First Permanent Molars are Unsavable

In these cases good results accrue from a line of treatment somewhat similar to the following: The first permanent molars are filled or treated in the manner best calculated to retain them until the second permanent molars have erupted. The crowding of the upper and lower incisors is then relieved by the removal of the four deciduous canines. If the teeth erupt in the normal way, the first and second premolars will come into good position, and we shall then have the following condition: the four incisors and the four premolars will be in a regular arch, with a greater or less space between the lateral incisors and the first premolars, so that the canines erupt just external to the arch; in other words, we shall have to deal with a fairly simple irregularity, namely, the canines high in the arch. To make room for the canines, the first permanent molars should be removed directly the second permanent molars are fairly through the gums. A plate to hold back the second molars should then be inserted. This plate (fig. 260) is made to cover the palate in such a way that it comes in contact with the palatal surfaces of the incisor teeth, while to the back of it are fixed half-round gold wires

which pass around the anterior and buccal surfaces of the second molars, the plate being quite free of the premolars. This form of plate retains the second molars in position, and prevents them from moving forward, while at the same time it allows the premolars to fall back, partly by the action of the bite and partly by the pressure of the canine tooth, so that many cases require no

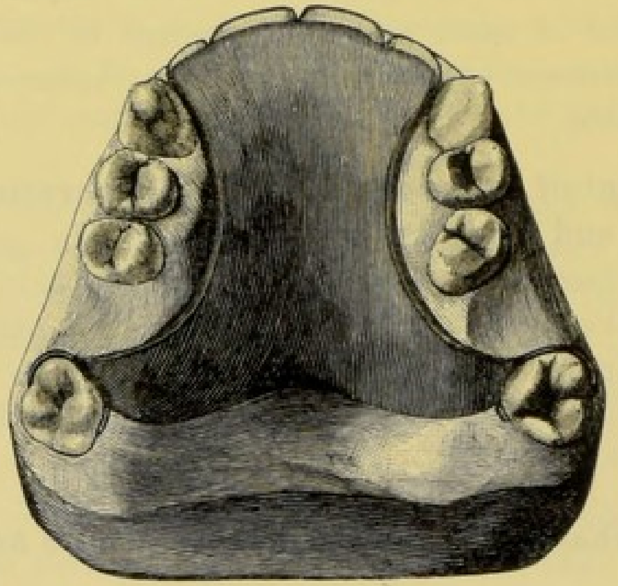


Fig. 260.

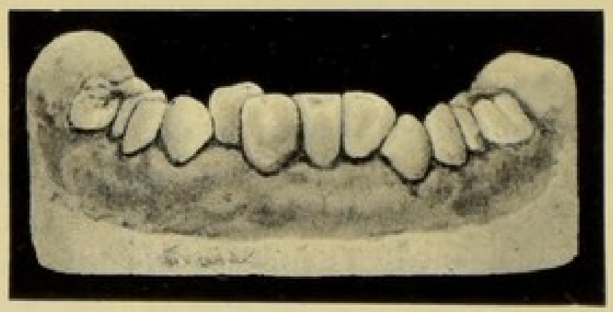


Fig. 261

further mechanical treatment—a point of no small importance. Obviously, this line of treatment will not apply in all cases. In some patients, the lower front teeth are so crowded at an early age that extraction of at least one of them becomes necessary. A good example of this is seen in fig. 261. Here the first permanent molars are quite unsavable, and the crowding of the lower incisors is excessive. This condition is due to pressure

from the canines, and removal of the first permanent molars will not sufficiently relieve the pressure to allow the laterals to assume anything approaching a normal direction. If left untreated, the lower canines will, in all probability, erupt in a plane anterior to the laterals. Removal of the right central incisor, however, will relieve the crowding and allow the remaining teeth to assume good directions. The result of treatment is seen in fig. 262.

Another example, which could hardly be carried out on the general principles just indicated, is to be found in cases where, at an early age, it is clear that the maxillary permanent canine will erupt over the position of the lateral. Under such circumstances, the lateral is forced much internal to the bite, or is twisted and turned in some very abnormal position. The lateral incisors must

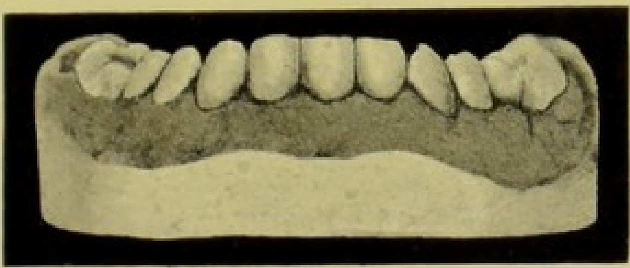


FIG. 262.

be extracted, and this should be done before the canines erupt. The first permanent molars should be removed before the eruption of the second permanent molars, in order that the latter may move well forward, and so fill up the gap caused by the extraction of the first permanent molars. This will prevent undue spacing between the anterior teeth, which would be unsightly.

(ii.) Cases where the First Permanent Molars are Savable

Attention here should, in the first instance, be directed to the first permanent molars, and these teeth should be filled in as permanent a way as possible. The probable position of the permanent canine should next be determined. If the incisors are in a fairly regular line, or if the lateral has its mesial angle tilted forward, it may be assumed that the canine will erupt posterior to the lateral. If, on the other hand, the distal edge of the lateral is projected forward, and the apex of that tooth is directed towards the median line, we may conclude that the canine will, in all

probability, erupt over the situation of the lateral, and the same may be assumed if the lateral is placed much internal to the bite, and the deciduous canine lies close to the central.

In cases where the canine shows signs of erupting posterior to the lateral, the treatment must depend upon the degree of crowding. If the crowding is slight, the deciduous canine should be removed and further treatment delayed until the permanent canines show signs of erupting. Either the first or the second premolar should then be removed, the choice depending upon the amount of space required for the erupting canines.

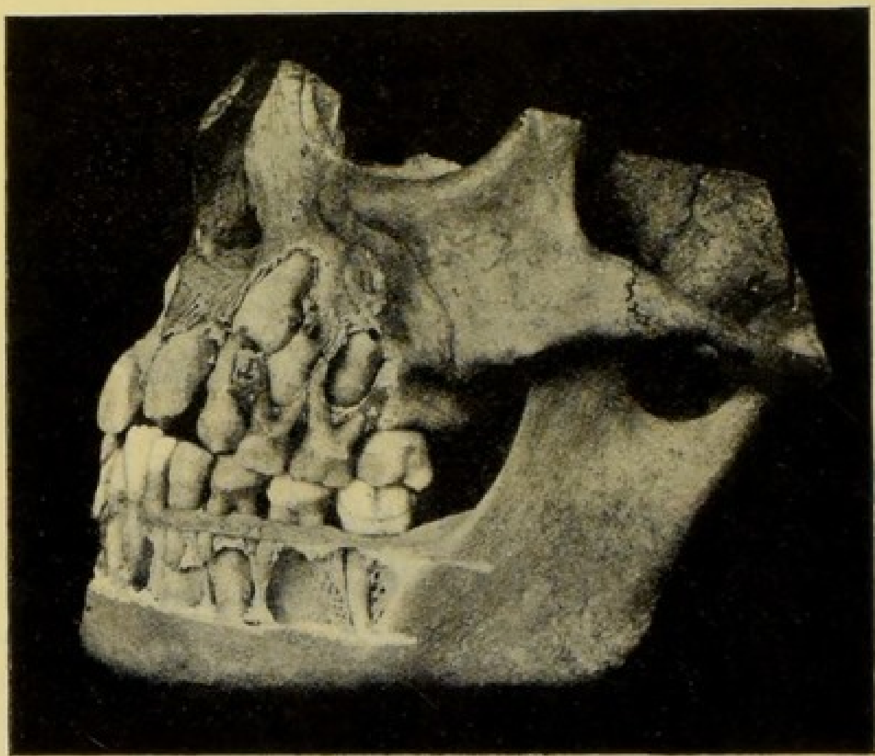


FIG. 263.—In this specimen the lateral incisor is placed internal to the arch with the canine partially covering the labial surface.

If, however, the crowding of the incisors is marked, the unerupted first premolar should be removed. This operation permits the permanent canine to move backwards and so relieves the pressure on the anterior teeth (see fig. 263).

It may be argued that extraction of the deciduous canine would suffice to remedy the condition of the lateral, but, if the dried specimen be carefully studied, it will be noticed that the

removal of the deciduous canine will not provide room for the permanent canine.

In performing this operation, an anæsthetic should always be given, as the removal of the premolar is frequently difficult.

FIG. 264.—Case 1. Upper, before treatment.

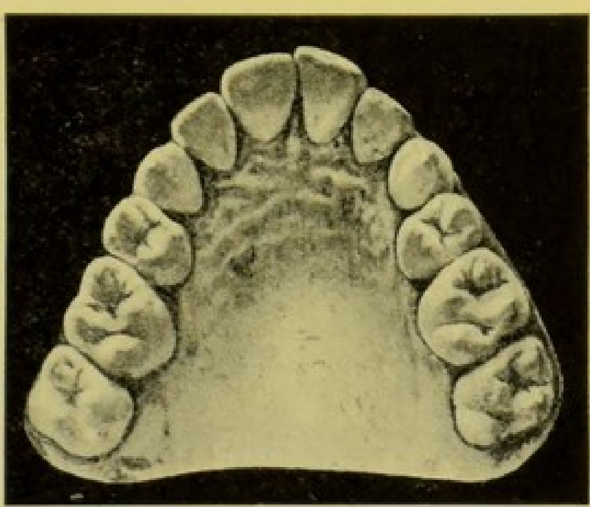


FIG. 265.—Case 1. Upper, after treatment.

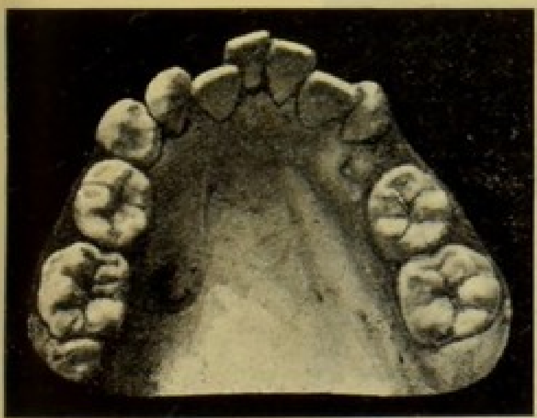


FIG. 266.—Case 1. Lower, before treatment.

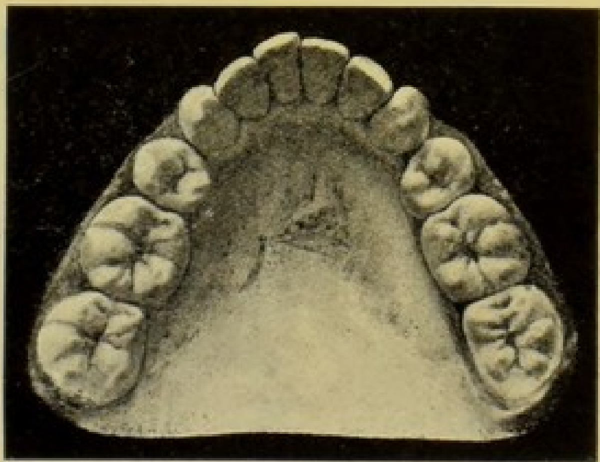


FIG. 267.—Case 1. Lower, after treatment.

Nitrous oxide, administered in the usual way, is quite sufficient if the operation is confined to one side of the mouth; but a longer period of anæsthesia must be obtained if it is necessary to remove both premolars at one sitting. The most suitable instrument for the removal of the teeth is a pair of upper root forceps with rather long blades. The deciduous molar is first removed. In

attempting the removal of the premolar, the inner blade of the forceps must be kept well inwards, the blades being thrust well upwards and extractive force made in an inward direction. The occluding surface of the erupting premolar is directed slightly inwards, and, unless the precaution suggested is taken, the inner

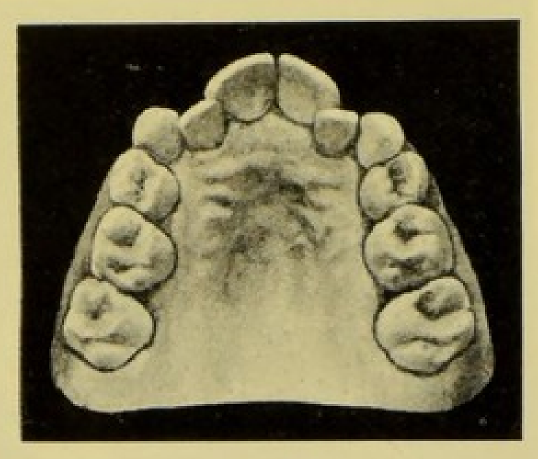


FIG. 268.—Case 2. Before treatment. (In this case the lateral incisors had to be pushed forward over the lower teeth.)

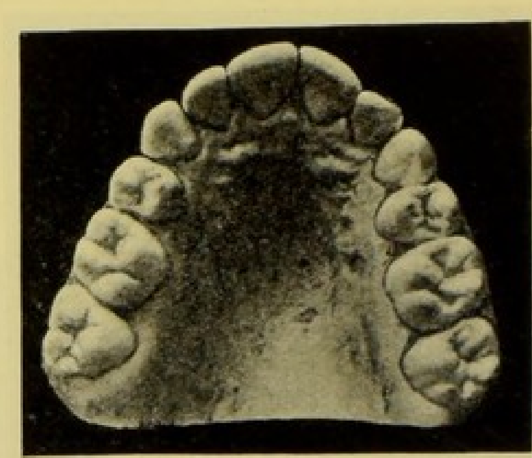


FIG. 269.—Case 2. After treatment.

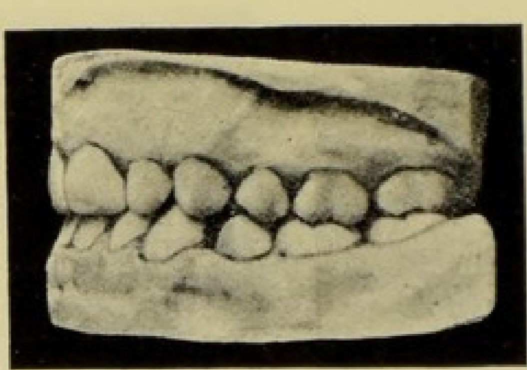


FIG. 270.—Case 2. Side view, showing occlusion of premolars and molars after treatment.

blade of the forceps impinges on the occluding surface and does not grip the inner aspect.

The after-treatment of the wound consists in the use of an antiseptic mouth-wash.

Crowded mouths treated in this manner give excellent results. The canine moves into the space previously occupied by the premolar. Pressure on the front teeth is relieved, a good arch is

obtained, and, what is most important, the teeth will be in excellent direction. In addition, mechanical treatment is avoided, and the occlusion of the molars and premolars remains good. (Figs. 264 to 273 are examples of this form of treatment.) At times, the space in the arch between the lateral incisor and the

FIG. 271.—Case 3. Before treatment.

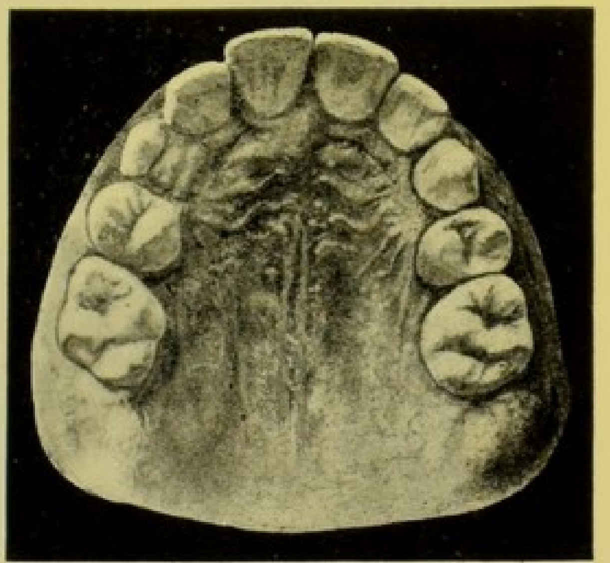


FIG. 272.—Case 3. After treatment.

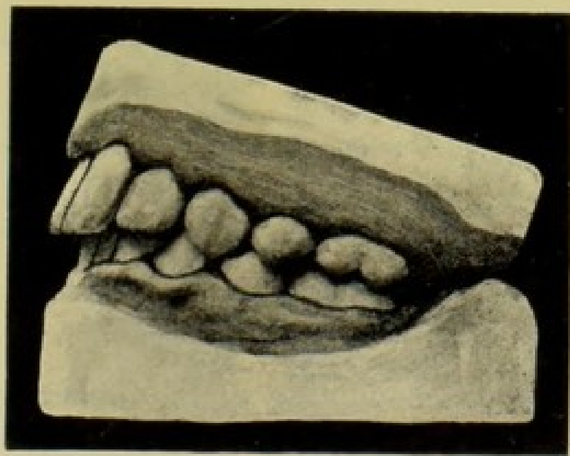


FIG. 273.—Case 3. Side view, showing occlusion of premolars and molars.

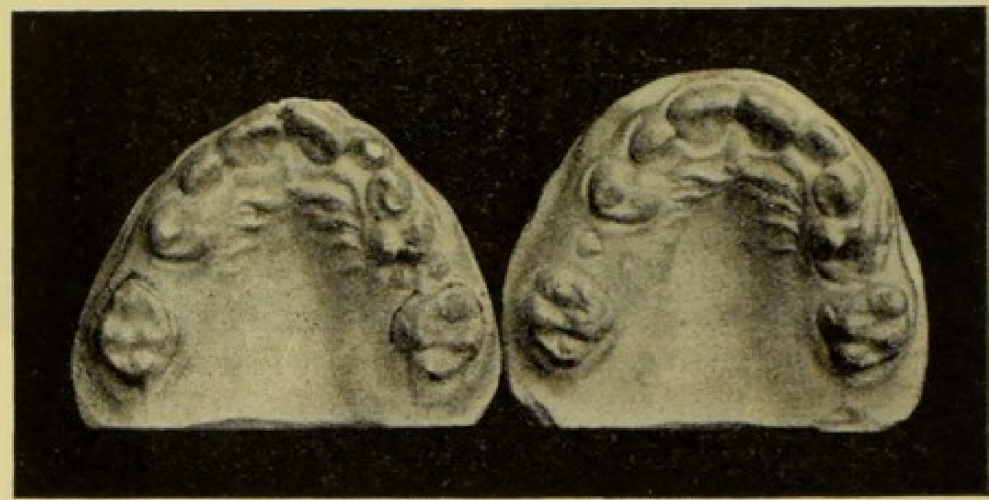
first permanent molar is insufficient even for two teeth, a condition shown in fig 274. In these circumstances, the molar should be retracted until there is room for the canine and one premolar, The molar should then be retained in its new position and the first premolar extracted.

The advantages of the early extraction of the premolars, where a severely crowded mouth is in the future inevitable are :—

(1) Pressure on the front teeth being relieved, any irregular position they may have assumed is easily rectified.

(2) The canines and premolars come down in a good direction and form a regular arch.

In cases where the canines show signs of erupting over the situation of the laterals, but little advantage is gained by the removal of the premolars, and such cases are treated much more



(a) (b)

FIG. 274.—(a) before retraction of the first molar; (b) after retraction of the first molar.

satisfactorily by removing the lateral incisors. This should be done before the canines erupt. Cases treated in this way are shown in figs. 275 to 278.

Treatment of cases coming under observation after the premolars and canines have erupted :—

(i.) Cases of Crowding complicated by Disease of a Central Incisor.—In considering the treatment of such cases, our decision must depend upon—

(*a*) The prospects of permanently retaining the affected tooth.
(*b*) The degree of crowding.
(*c*) The sex of the patient.
(*d*) The age of the patient.

If the pulp of the tooth died subsequent to the completion of the root, and no periodontal mischief supervenes, or, if present, is only slight, there is a reasonable prospect of permanently saving the root and affixing a crown. Under these conditions, the

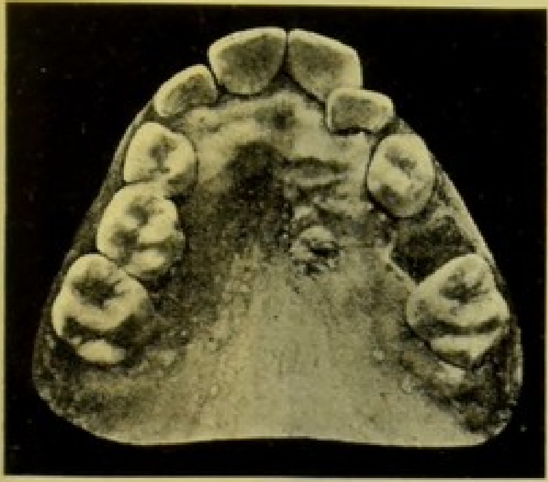


FIG. 275.—Before treatment.

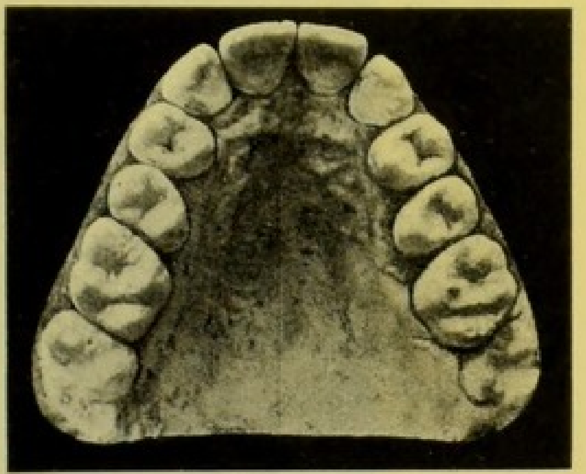


FIG. 276.—Case shown in fig. 275. After treatment.

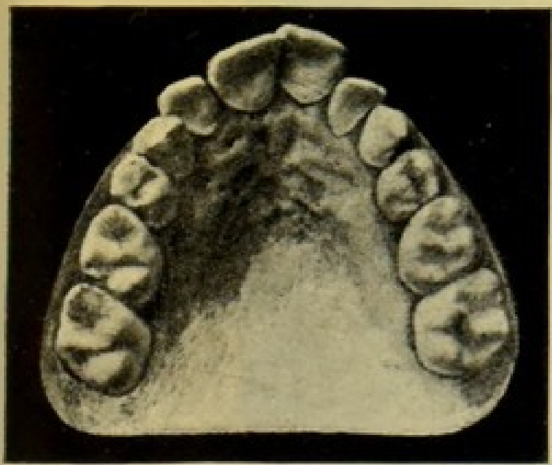


FIG. 277.—Before treatment.

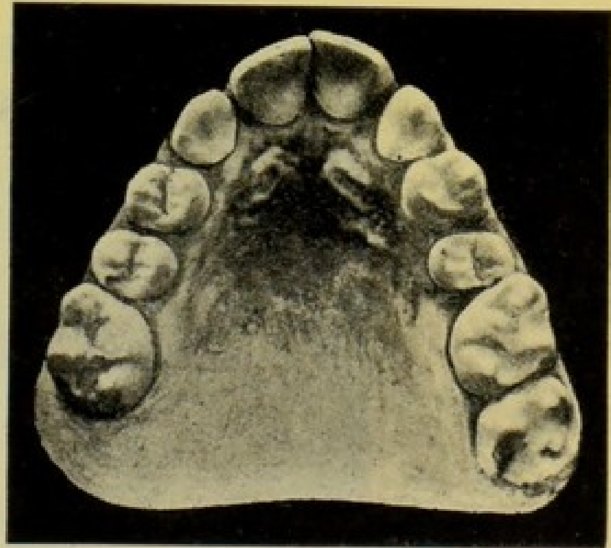


FIG. 278.—Case shown in fig. 277. After treatment.

central incisor should be saved, and the crowding treated by the removal of a posterior tooth.

If, however, it seems probable that the pulp died prior to the completion of the root, and the chronic periodontal trouble is

extensive, the chances of permanently retaining the tooth will be remote, and in most cases it would be advisable to remove it.

In deciding whether the space left by the removal of the tooth should be allowed to close up or be kept open, we must be guided by the merits of each case. With a boy, especially if there is considerable crowding as shown in fig. 279, the space should be

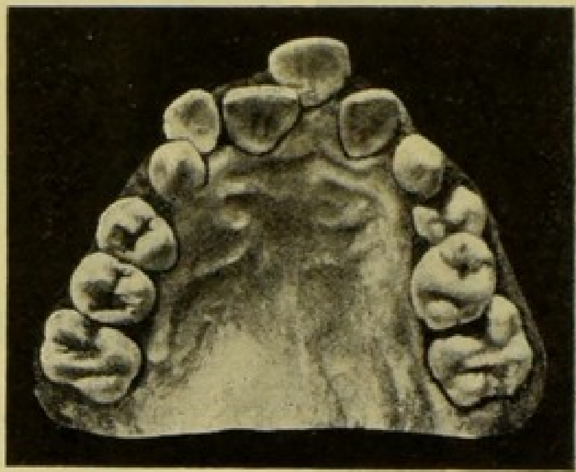


Fig. 279.

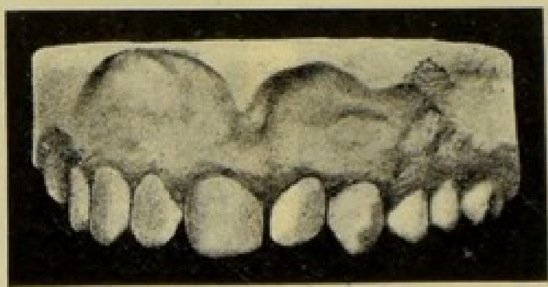


Fig. 280.

allowed to close up, thus avoiding the necessity for an artificial denture, a point of importance as far as the hygiene of the mouth is concerned. The unsightliness could usually be hidden to a great extent by a moustache in later life. With a girl, the disfigurement arising from allowing the space to close up is of more serious import, and the space should therefore be retained by suitable means, an artificial denture being subsequently inserted.

(ii.) Crowding resulting in the Protrusion of a Central Incisor.—An example of this irregularity is shown in fig. 281. The patient was aged 21. The arch was expanded by means of

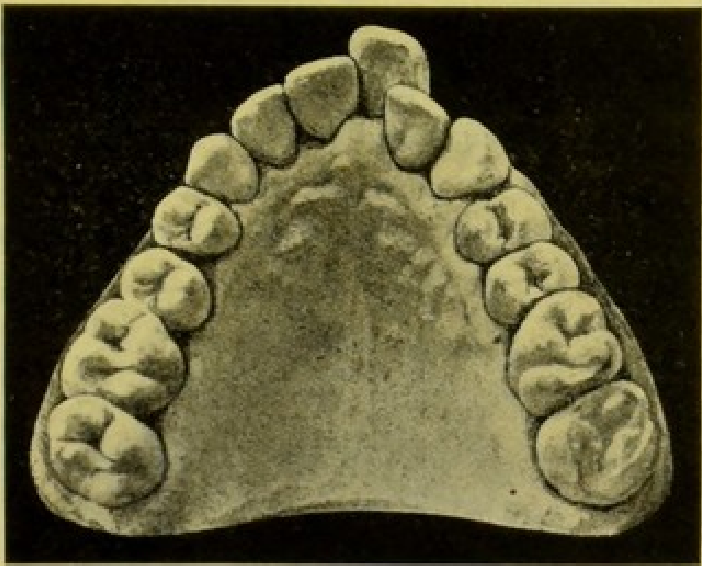


Fig. 281.

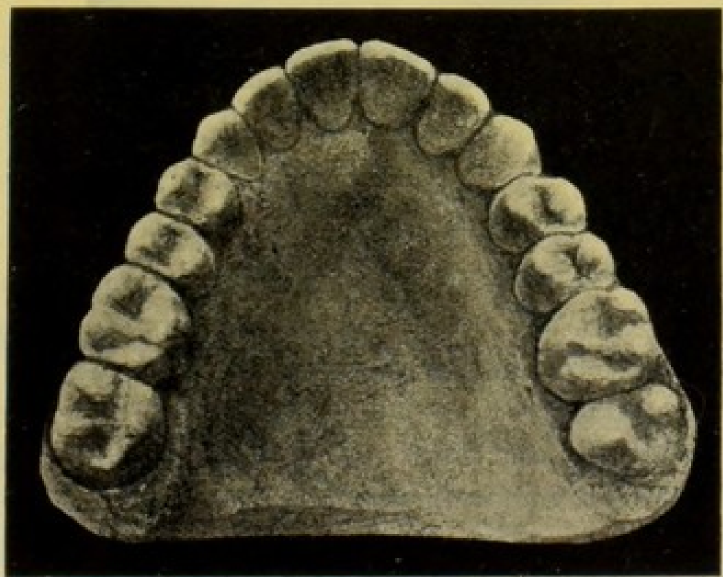


Fig. 282.

a plate similar to fig. 257. A half-round gold wire was fixed to the outer side and made to impinge upon the projecting incisor, the plate being cut away upon the palatal surface to allow the

tooth to move inwards. The result of the treatment is shown in fig. 282.

(iii.) Crowding resulting in the Exclusion of Laterals from the Arch.—The advisability of sacrificing a lateral incisor in the treatment of crowding is constantly disputed, some practitioners even going so far as to maintain that, under no circumstances, is such a course desirable. The principal argument urged against the removal of this tooth is that the canine erupts next to the central and produces an unsightly appearance. It is true that a lateral in correct direction has a better appearance than a canine

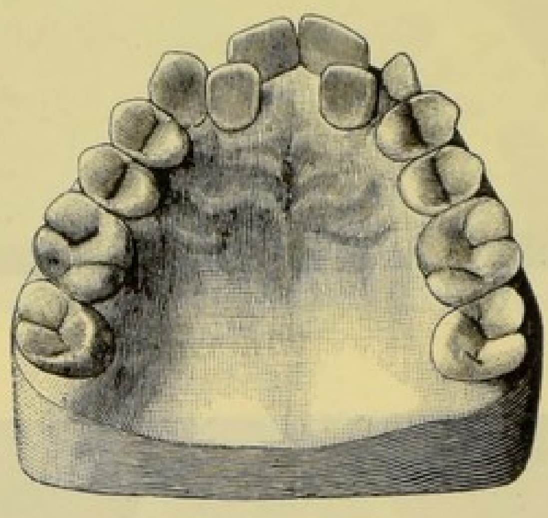


Fig. 283.

next to the central, but in cases where the extraction of a lateral is in question, the problem to be solved may be put in this way: Is it better to have a canine in correct alignment next to the central and the premolar in apposition to the canine, or a lateral in a mal-direction, with, possibly, its cutting edge tilted forward and the canine sloping towards the median line, and, in all probability, short. Take as an example the case shown in fig. 283. The laterals are displaced inwards to a considerable extent and are in a vertical direction, the canines being but slightly external to the arch. An examination of the roots of the teeth shows the canines to be sloping towards the median line, while the roots of the first premolars take the same direction. Extraction of the laterals will effect a remedy without mechanical treatment; the canines will come down in good direction, the centrals will fall

back and assume a more correct position, while the premolars will move forward also into a vertical position.

If an attempt were made to treat the case by extraction of the first premolar, the result obtained would, in all probability, be far from satisfactory. Even with a fairly good result, and with the teeth brought approximately into a normal curve, the difference in the slope of the teeth would produce anything but a pleasing appearance. The central would be forced more outward, the lateral

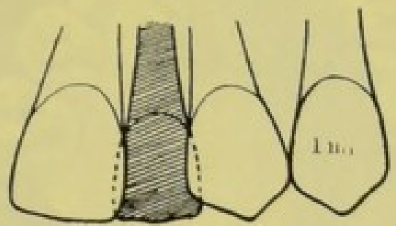


FIG. 284.—Case before treatment, showing positions of incisors and canine.

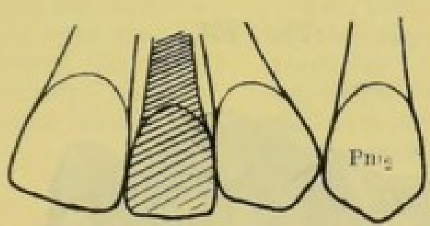


FIG. 285.—Result of treatment after removing the first premolar.

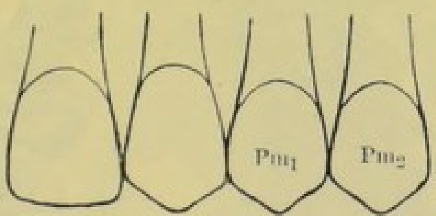


FIG. 286.—Result of treatment after removing the lateral incisor.

would have its cutting edge directed forward, that is to say, the neck would be in a plane well posterior to the central, the cutting edge of the canine would be above the level of the lateral and the slope would be considerable. Further, this operation would entail prolonged mechanical treatment with all its attendant troubles.

A row of teeth in correct alignment with the canine next to the central is more sightly than a row of teeth in bad alignment with the lateral next to the central; and, moreover, it must not be forgotten that the public do not view the teeth with the

professional eye of the practitioner. Diagrams illustrating these points are shown in figs. 284 to 286.

A case calling for the removal of the laterals is shown in fig. 287.

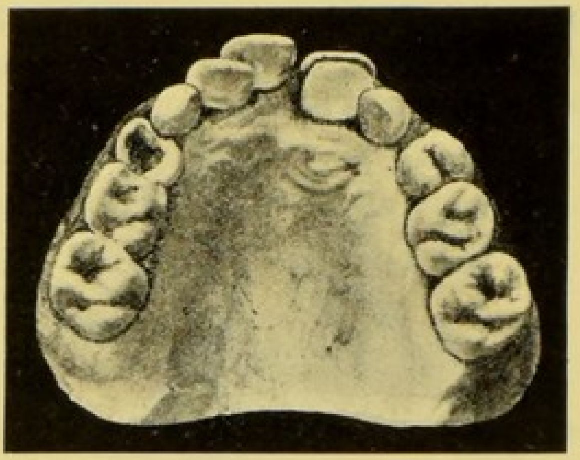


Fig. 287.

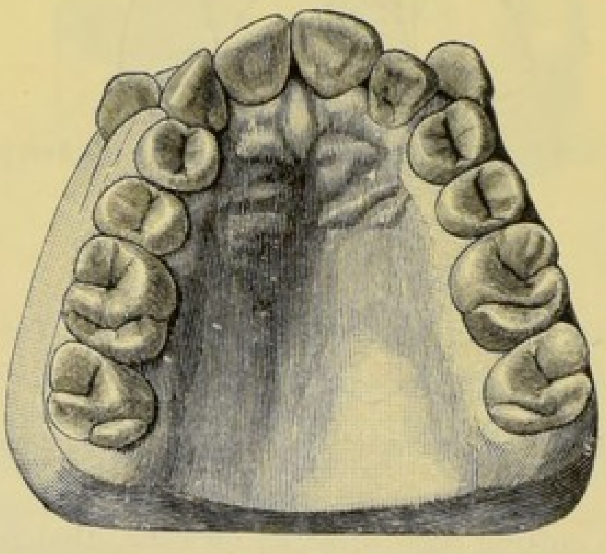


Fig. 288.

The cases, however, which test the judgment most are those where the root of the canine is directed only slightly towards the median line and there is a possibility of the tooth coming into good direction if the premolar is removed. Under these conditions, the removal of the premolar would be the wiser course, especially if the patient is a girl.

Cases are sometimes met with where the laterals are misplaced to such an extent that their extraction is imperatively called for and the first permanent molars are also quite unsavable. Under such conditions, the molars must be removed, and this should be effected if possible before the second permanent molars

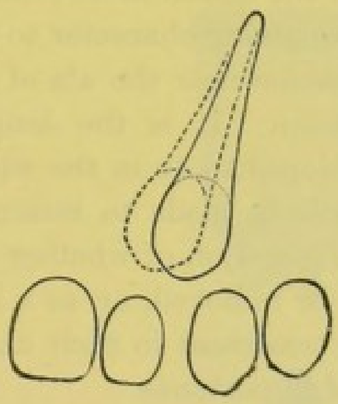


FIG. 289.—Showing the root of the canine lying over the premolar. The dotted lines represent the direction the canine will take if the lateral is extracted.

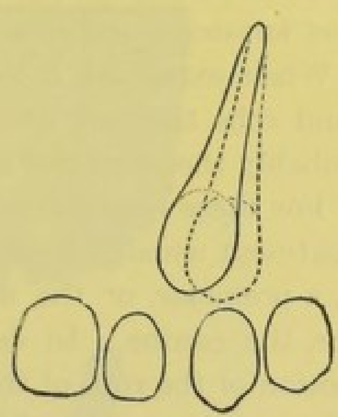


FIG. 290.—Showing the root of the canine lying over the premolar. The dotted lines represent the direction the canine will take if the premolar is extracted.

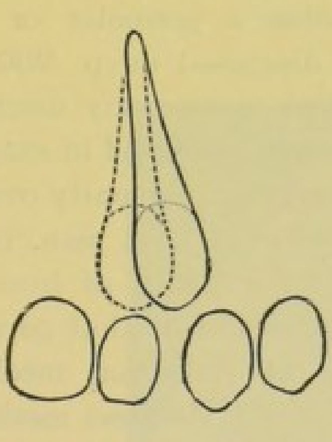


FIG. 291.—Showing the root of the canine lying over the lateral. The dotted lines represent the direction the canine will take if the lateral is extracted.

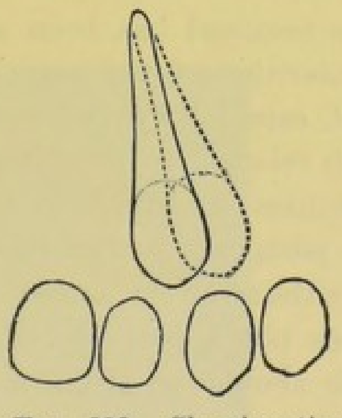


FIG. 292.—Showing the root of the canine lying over the lateral. The dotted lines represent the direction the canine will take if the premolar is extracted.

erupt. The latter will then come forward and, in a great measure, prevent a backward movement of the premolars, which would probably leave unsightly spaces between the front teeth.

(iv.) **Cases of Crowding in which the Canine is displaced External or Internal to the Arch.**—The displacement of a canine external to the arch is the commonest result of a crowded condition of the teeth. A typical example is shown in fig. 288.

In considering this irregularity, it should be remembered that the canine is the most important tooth in the dental arch, forming a kind of keystone, and in a great measure giving character to the face. When extracted, it leaves a depression near the ala of the nose, and robs the face of much expression. It is the longest and probably the strongest and best developed tooth in the whole arch. For these reasons endeavours should be made to retain it. The treatment usually depends upon the question of whether the lateral, a premolar, or the molar should be removed, or, as a last resource, the canine. In deciding upon treatment in such cases, the position of the root of the canine is of importance.

If the root has a direction forward, it is useless to remove a posterior tooth, as the canine, when it erupts, will slope very much backwards and look extremely ugly; whereas, if the lateral is extracted, the canine would erupt fairly straight, and give a much better appearance. The accompanying figures 289 to 292 illustrate this point. The question whether a premolar or molar should be removed has been already discussed on p. 200.

Irregularities of the canines seldom require any mechanical treatment, especially if judgment has been exercised in extracting teeth with relation to the bite. Nature will frequently overcome the difficulties unaided, and it is therefore a good plan, in most cases, to postpone further treatment for a period of from three to six months after extraction. If at the end of that period the tooth does not appear to be moving into position, mechanical assistance should be given, and one of the simplest methods in vogue is that shown in fig. 203.

In removing a premolar for the relief of a crowded canine, attention must be given to the position of the corresponding lower premolar, for the latter may be placed in such a position as to prevent the upper canine from coming correctly into line. In certain cases, however, extraction of the canines is quite justifiable, especially in cases where, with the arch regular and the occlusion good, the laterals are close or fairly close to the premolars, and the canines erupt outwards almost at right angles, as seen in fig. 293.

(v.) Cases of Crowding resulting in Displacement of Premolars.—Displacement of the second premolar internal to the bite frequently results from crowding. When this occurs, the premolar has erupted after the canine. Fig. 294 is an

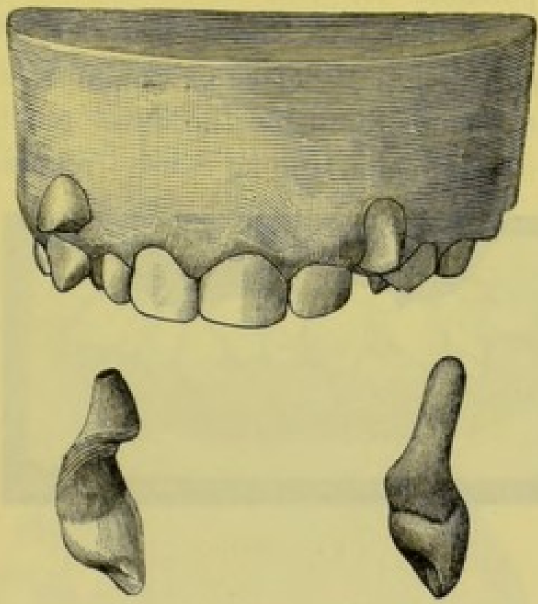


Fig. 293.

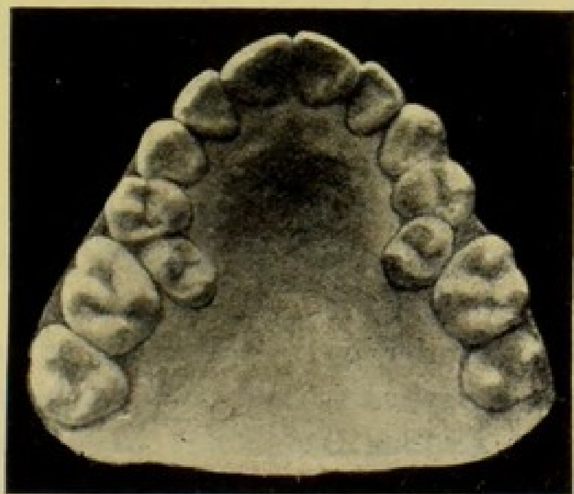


Fig. 294.

excellent example of this type of irregularity. The treatment of such a case would be the removal of the abnormally placed premolars. If, however, the molars are unsavable, it would be

necessary to remove them and bring the premolars into the line of the arch.

(vi.) **Crowding resulting in the Displacement of a Mandibular Incisor.**—An irregular arrangement of the mandibular incisors caused by crowding is frequently met with, the canines being mainly responsible for this condition. The canines are normally developed external to the incisors, the crowns often slightly overlapping the labial surface of the laterals ; in instances where there is insufficient room for the development, the canines encroach on the incisor region and so cause irregularity.

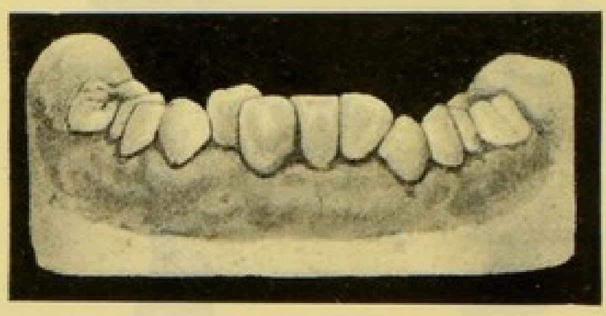


Fig. 295.

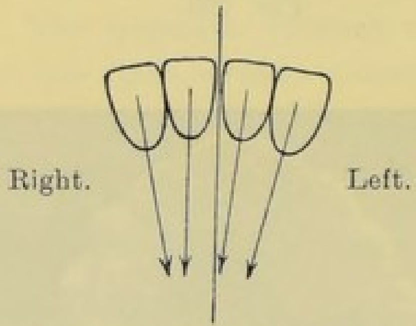


Fig. 296.—Diagram showing directions of the roots of the incisors.

Crowding of the anterior lower teeth is not so important from an æsthetic point of view as crowding of the upper. The most effective method of treating these cases when the crowding is severe is to remove an incisor. In selecting from the four incisors, the following points should influence a decision :—

(*a*) A central should, if possible, be extracted in preference to a lateral, for the reason that the symmetry of the mouth will be to a certain extent maintained, the laterals being adjacent to the canines with the single central between them. If a lateral incisor

be removed, the canine on one side will be adjacent to a central, and on the other side to a lateral.

(*b*) An outstanding tooth should be removed in preference to one instanding, as the latter will be more easily brought into correct line, the pressure of the tongue being more powerful than that of the lower lip.

(*c*) The direction of the roots of the different teeth must be considered. The tooth selected should permit of the remaining incisors assuming a vertical direction. For instance, in the case shown in figs. 295 and 296, removal of the right central incisor would permit the remaining teeth to assume vertical directions, but removal of the left central incisor would result in the right central incisor assuming a distinct slope.

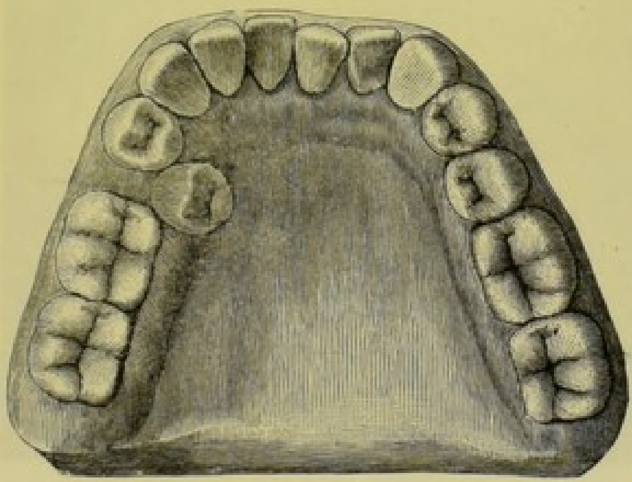


Fig. 297.

(**vii.**) **Mandibular Canines.**—Displacement external and internal to the arch may occur, the former being more common. The principles of treatment are similar to those for maxillary canines.

(**viii.**) **Mandibular premolars** placed external or internal to the arch, as shown in fig. 297, require removal.

General Crowding—Treatment of Cases involving the Mal-position of Several Teeth.—In cases of general irregularity of the teeth, the treatment will depend, to a great extent, upon the condition of the teeth. If the first molars are unsavable, their removal is indicated, but opinions differ as to the correct time to remove these teeth in order to obtain the best results.

An examination of mouths in which this operation has been performed would appear to show that the best results are obtained when these teeth are removed prior to the eruption of the second permanent molars, and subsequent to the eruption of the premolars. Under such conditions, good spacing between the anterior teeth is obtained, and there is far less tilting of the second lower molars (fig. 298). A strong objection to removing the first permanent molars at this period in crowded mouths is that the second permanent molars (especially the upper) move forward

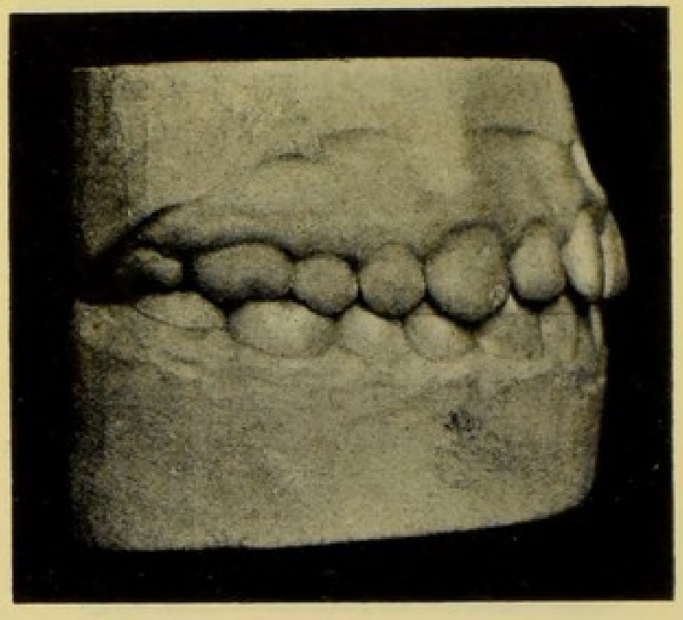


FIG. 298.—Models of a case in which the first permanent molars were removed for caries before the eruption of the second molars.

and encroach on the space required for the backward movement of the anterior teeth. In crowded mouths, removal of the teeth should not be carried out until the appearance of the second permanent molars. Many practitioners hold that the operation should be delayed until the latter teeth are fully erupted and in good occlusion, on the ground that a great amount of the tilting of the second lower molars is avoided. A disadvantage of waiting until this period is that the irregularity of the anterior teeth becomes more pronounced and the teeth more firmly implanted, so that the crowding is less easily remedied. It therefore seems advisable to remove the first permanent

molars directly the second molars are sufficiently through to allow of their being held back by mechanical means (fig. 299). In this way, the crowding can be overcome at an earlier period, and the tilting of the second molars, to a great extent, prevented.

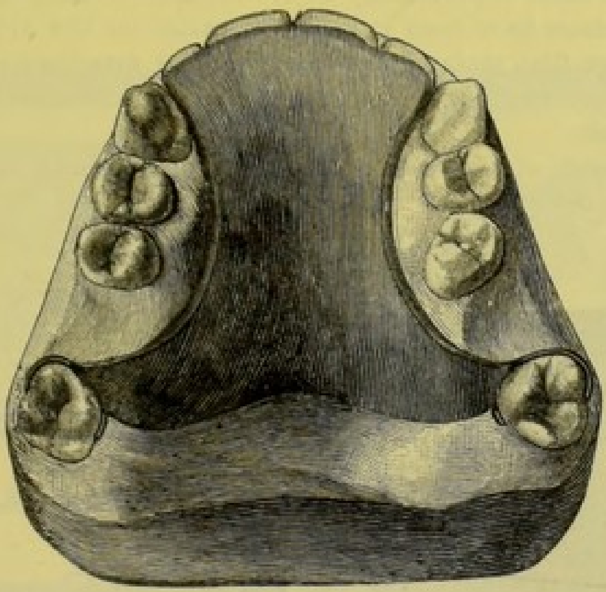


FIG. 299.

FIG. 300.—Before treatment.

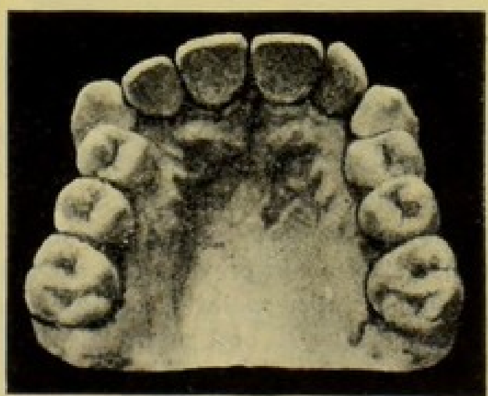


FIG. 301.—After treatment.

The disadvantage of removing the first molars before the second molars erupt is seen in figs. 300 and 301.

A certain number of cases come under treatment in which the mandibular first molars have already been removed and no

attention has been directed to the maxillary teeth. The following case is instructive:—

Owing to the removal of the lower first molars a year previously, the second permanent molars have travelled forward and partly articulate with the first upper molars; the upper left second premolar is displaced inwards, but otherwise there is practically no crowding (see figs. 302 to 308). Some of the upper incisors have been attacked by caries on the approximal surfaces. The left upper first molar has a cavity on the masticating surface, while in the right upper first molar a cavity has been successfully treated on the anterior surface.

The occlusion of the teeth on the right and left sides is diagrammatically shown in figs. 303 and 304.

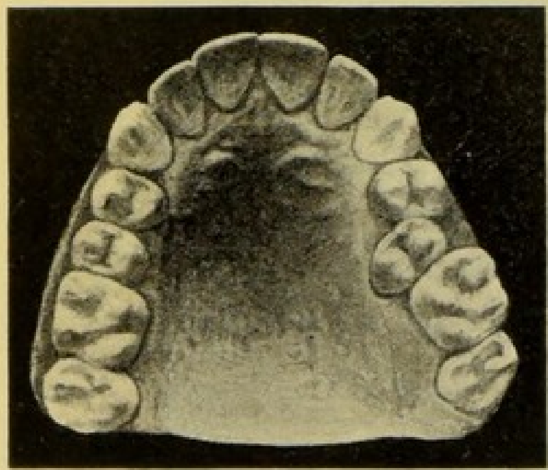


Fig. 302.

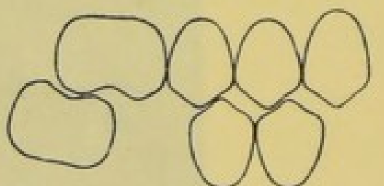


Fig. 303.—Right side.

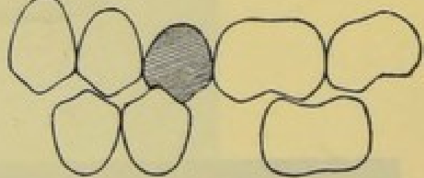


Fig. 304.—Left side.

On the left side it will be noticed that the second upper premolar is internal to the arch. The articulation between the first upper premolar and the lower premolars is not good. The upper first molar is prevented from moving forward by the second premolar and is only half opposed, while its posterior cusps prevent the second lower molar from moving forward. The second upper molar is erupting, hence a posterior force is present. Extraction of the second premolar will allow the first upper molar and the second lower molar to move forward, and so lead to an improvement in the articulating surface. On the right side, it will be seen that the anterior plane of the first upper premolar only partially articulates with the posterior plane of the corresponding lower tooth, and not at all with the anterior plane of the second lower premolar as it should do. Only half the anterior plane of the second upper premolar is used. The first upper molar is only partially in occlusion

[1] The following cases are fully described with a view of showing the various points to be considered when adopting extraction for the relief of crowded conditions of the mouth.

with the second lower molar, and this prevents the latter moving forward. The upper second molar is erupting. Extraction of the second upper premolar would permit the first upper premolar to move backwards and articulate correctly with the lower premolars. The first upper molar and second lower molar would move forward and the articulation would be improved. The upper second premolars were removed, and the result is seen in figs. 306 and 308.

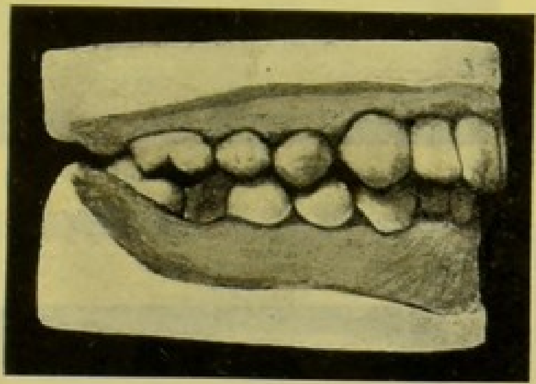


Fig. 305.—Before treatment. Right side.

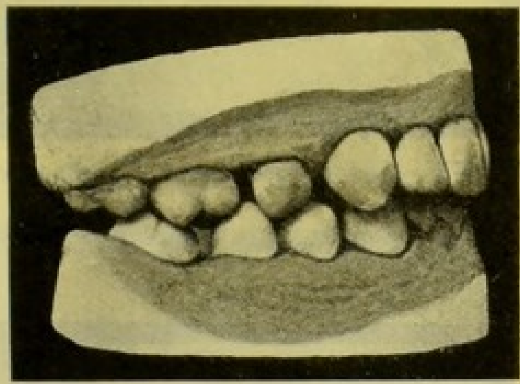


Fig. 306.—After treatment. Right side.

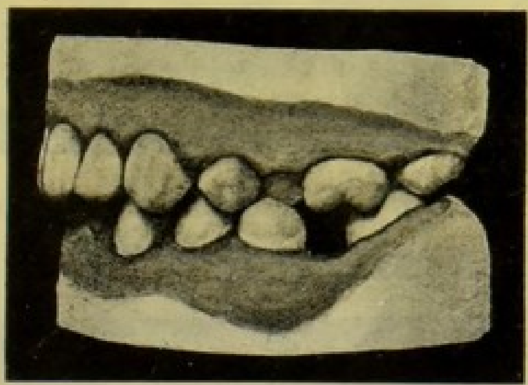


Fig. 307.—Before treatment. Left side.

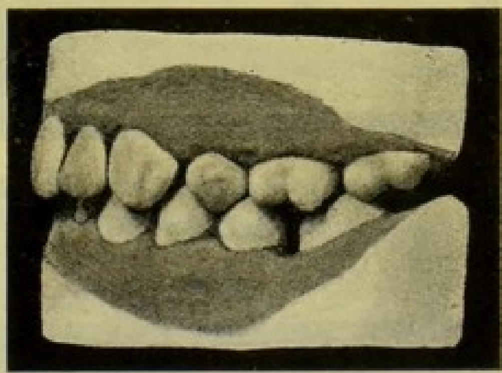


Fig. 308. After treatment. Left side.

In cases where there is marked crowding in the maxilla, with the maxillary first molars savable and the mandibular unsavable, the best results are to be obtained by removal of the mandibular first molars before the eruption of the second molars. The latter will then come forward and articulate well with the upper teeth. The first maxillary premolars should be removed, if possible, before the canines erupt. In this way, the crowding of the upper teeth can be correctly overcome and a good articulation obtained. A case thus treated is shown in figs. 309 to 311.

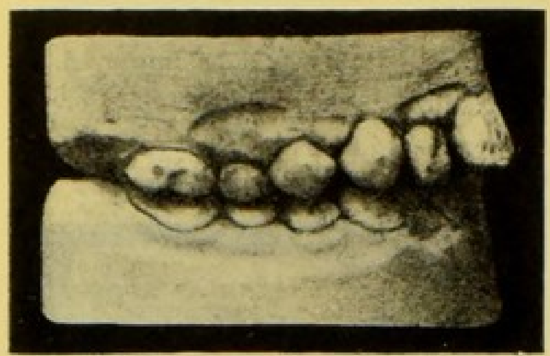


FIG. 309.—Before treatment. Right side.

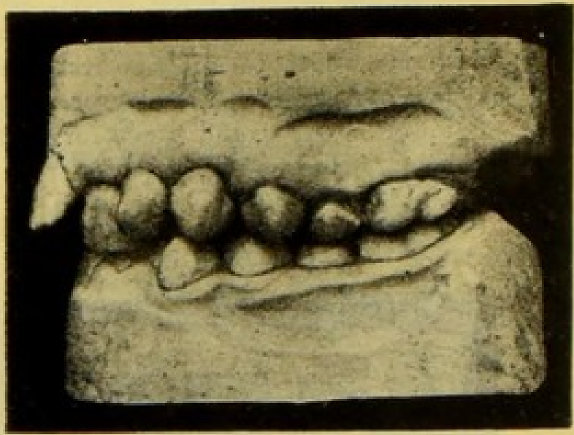


FIG. 310.—Before treatment. Left side.

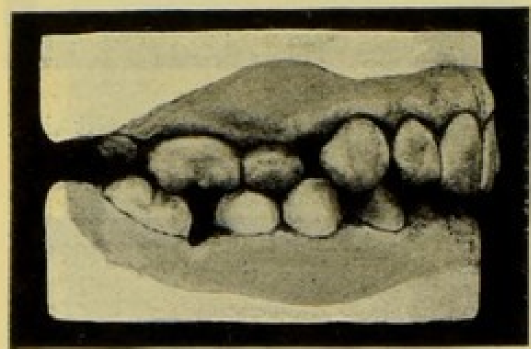


FIG. 311.—After treatment. Right side.

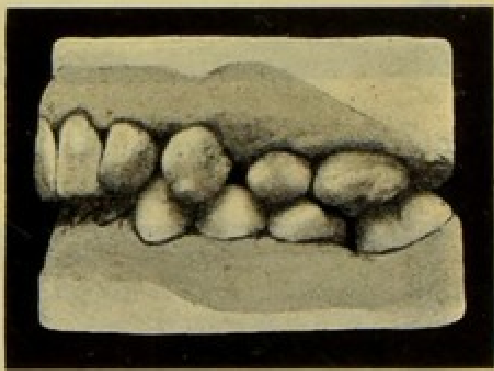


FIG. 312.—After treatment. Left side.

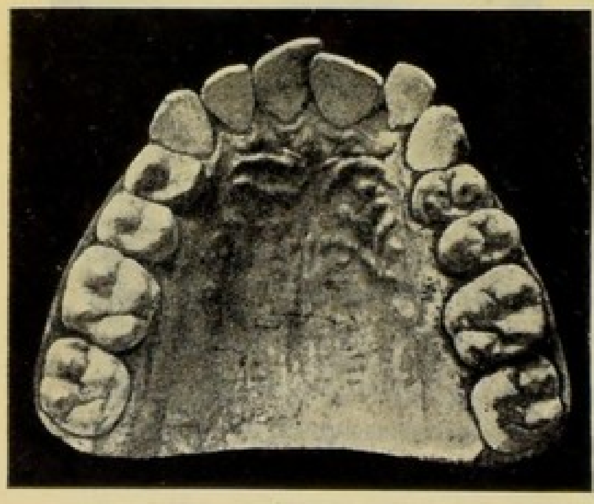


FIG. 313.—Before treatment.

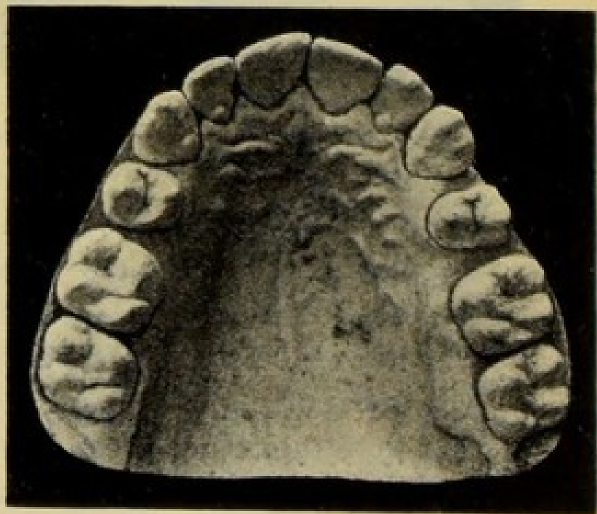


FIG. 314.—After treatment.

Second premolars should, as a rule, be removed in cases where the crowding is not great. Should a space remain, it will not be so noticeable as if the first premolar had been extracted. Removal of the second premolars is indicated in cases where caries is present on the anterior approximal surfaces of the first molars.

The following is an instructive case requiring the removal of the second maxillary premolars:—

The patient was a girl aged 15. The upper front teeth were crowded and irregular (fig. 313). The lower teeth presented a good arch. An examination of the premolar and molar occlusion on the right side showed that only

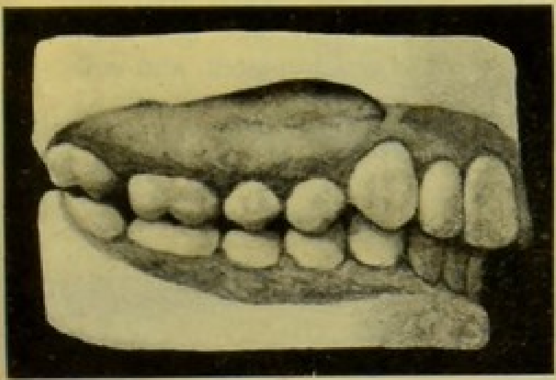


Fig. 315.—Before treatment.

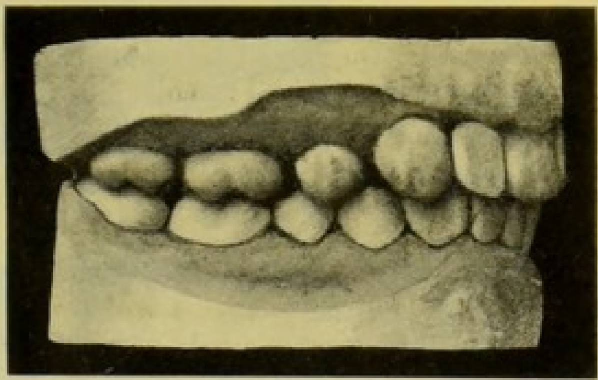


Fig. 316.—After treatment.

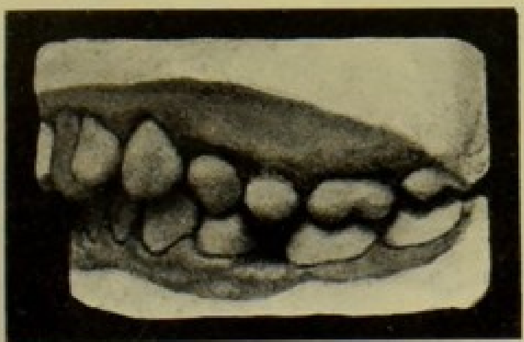


Fig. 317.—Before treatment.

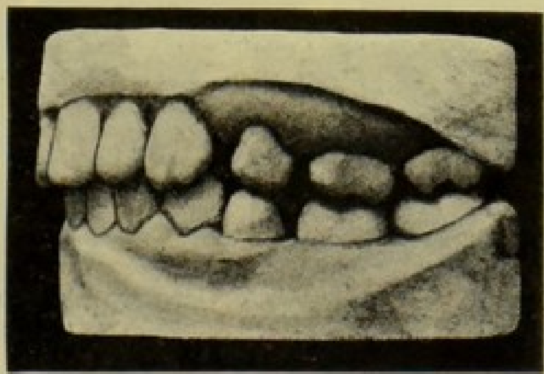


Fig. 318.—After treatment.

portions of the posterior planes of the first and second premolars were in contact with the lower teeth (fig. 315). This is diagrammatically shown in fig. 319. Removal of the first upper premolar would allow the second premolar to come forward and occlude with both lower premolars, and at the same time allow room for the canine to move backwards, but the second premolar on this side was carious. With removal of the second premolar, the

first premolar could be brought back and made to articulate satisfactorily with the lower premolars, and the crowding of the front teeth would be overcome. On the left side (fig. 317) the second lower premolar had not erupted, and there were no signs of its presence. The second upper premolar, therefore, formed but a small portion of the masticating area, and was consequently the tooth to remove.

The treatment consisted in the removal of the second upper premolars. The first premolars were then brought back by mechanical means. A vulcanite plate capping the molars and premolars was made, half-round gold wires being attached to the sides and arranged so as to bring pressure on the mesial angles of the right central and the left lateral. Opposite the palatal aspect of the left central, a wedge of compressed wood was inserted and the tooth brought forward. By a similar arrangement, the distal angle of the right central was driven forward. A retention plate was used for twelve months. The result is seen in figs. 314, 316, and 318. A regular arch has been obtained. The occlusion of the teeth on the right side has been improved. On the left side, the occlusion has not been impaired, and will be improved when the molars move forward.

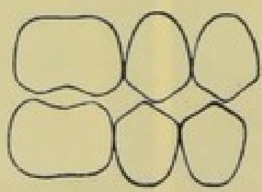


FIG. 319

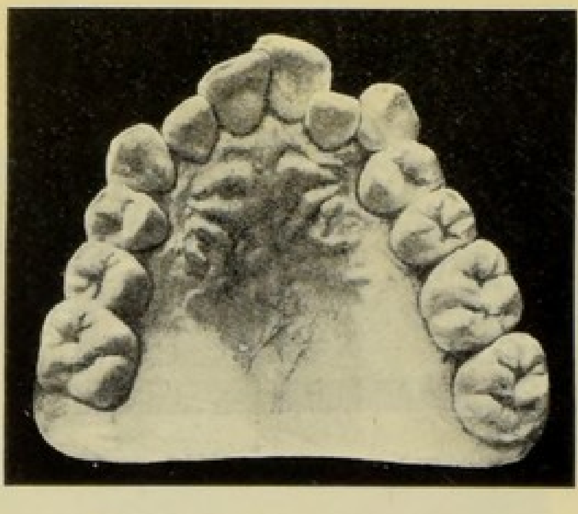


FIG. 320.—Before treatment.

FIG. 321.—After treatment.

In a few cases, the removal of a lateral incisor on one side and a premolar on the other may be necessary. The following is an example :—

In this patient, a girl, the anterior upper teeth were crowded, the lateral incisor on the left side being internal to the arch (fig. 320). In the lower, the arch was regular, but the lower central incisors were absent. The teeth were free from caries. An examination of the roots of the left central and lateral incisors and canine showed that the root of the central sloped in a backward direction, and was placed in a plane anterior to the root of the lateral and also overlapped that of the right central. The direction of the canine root was very slightly backward, and was also in a plane anterior to the lateral. The positions of the three teeth are shown in fig. 322. The occlusion of the premolars and molars was good (fig. 323). On the right side, the root of the

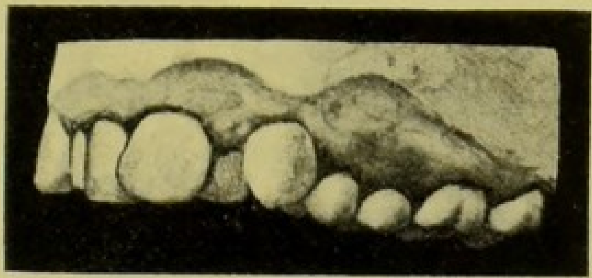


FIG. 322.

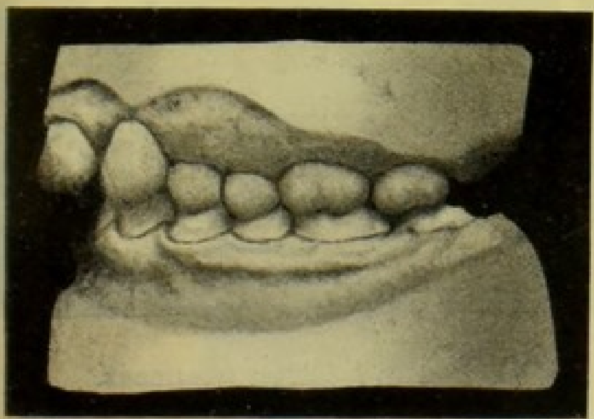


FIG. 323.—Left side. Before treatment.

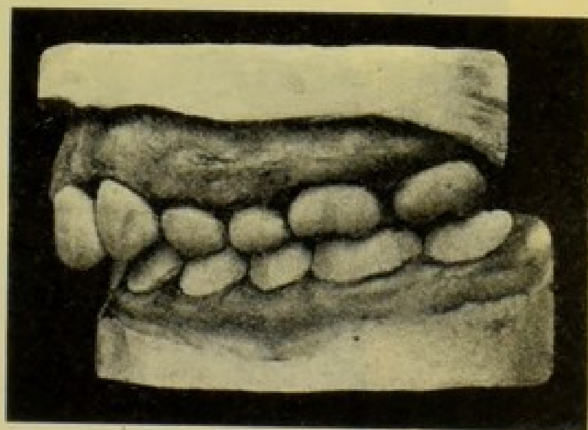


FIG. 324.—Left side. After treatment.

canine was directed backwards, and the crowding of the central and lateral incisors was slight. The relation of the upper to the lower premolars and molars is shown in fig. 325. In considering the treatment of this case, the main difficulty was the marked crowding on one side and the slight crowding on the other. On the left side, two courses were open: (*a*) the removal of the first premolar, or a tooth posterior; (*b*) the removal of the lateral incisor. If removal of the first premolar were carried out, the canine would need to be retracted and the lateral incisor pushed out. This operation would probably result in the canine assuming a very sloping direction and being short, the lateral having its cutting edge tilted forward, while the central would be driven still more across the median line. In addition, the treatment would require the prolonged use of a plate, and there would be a constant tendency

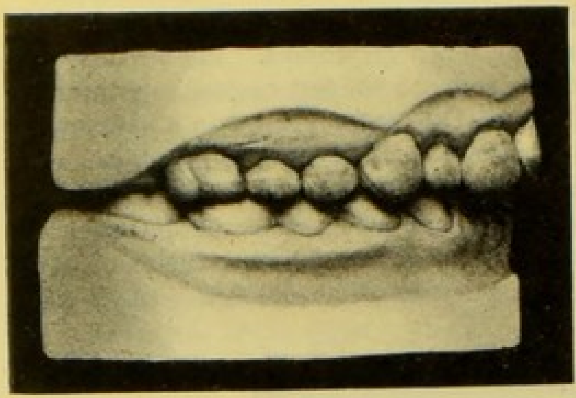


FIG. 325.—Right side. Before treatment.

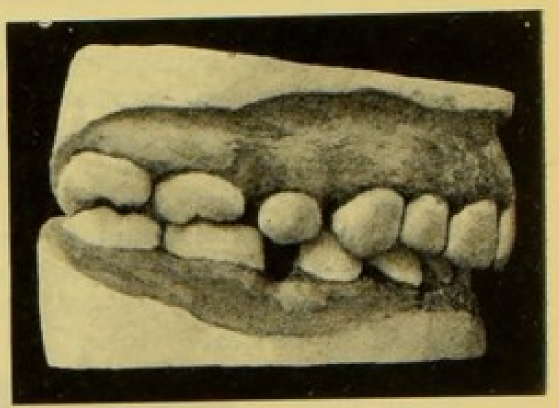


FIG. 326.—Right side. After treatment.

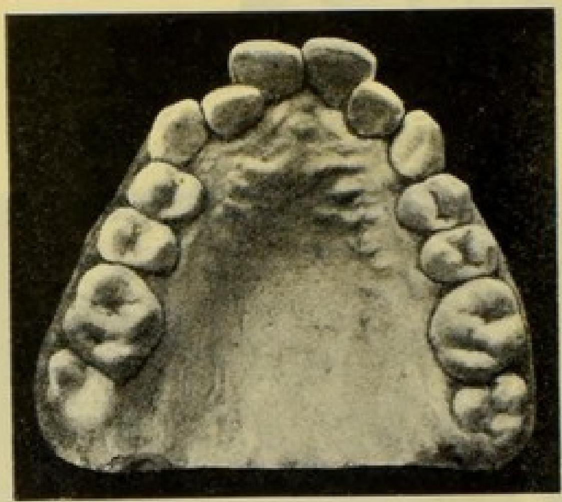


FIG. 327.—Before treatment.

FIG. 328.—After treatment.

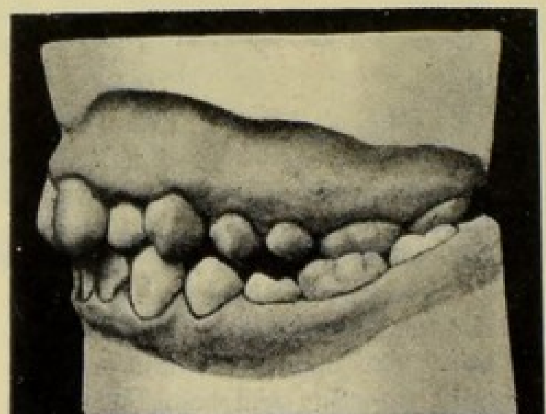


FIG. 329.—Before treatment.

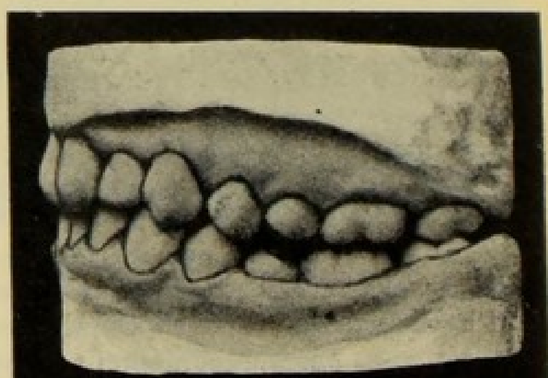


FIG. 330.—After treatment.

to relapse. On the other hand, removal of the lateral incisor would permit the central to fall back and assume a more vertical direction and the canine would move forward and fill up the gap. There would be true relief of the crowding (both roots and crowns), and no tendency to relapse. On the right

FIG. 331.—Before treatment.

FIG. 332.—After treatment. The second permanent molars have erupted.

side, but little room is required, and removal of the lateral to correspond with removal of the left lateral is out of the question. The treatment, therefore, resolves itself into the removal of a premolar or a molar. The molar is free from caries, so that a choice must be made between the first

and second premolars. Removal of the first premolar would, in all probability, result in a gap between the canine and the second premolar. Removal of the second upper premolar alone, and retraction of the first premolar would also leave a gap, because the first premolar would eventually occupy

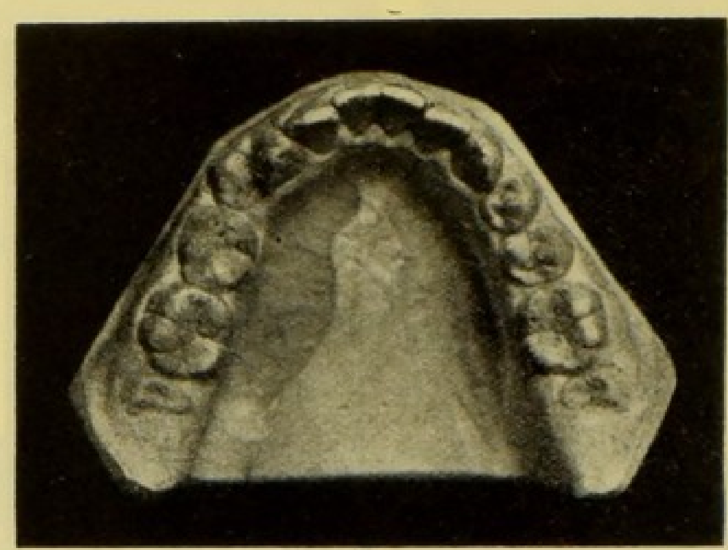


FIG. 333.—Before treatment. The second molars have partially erupted.

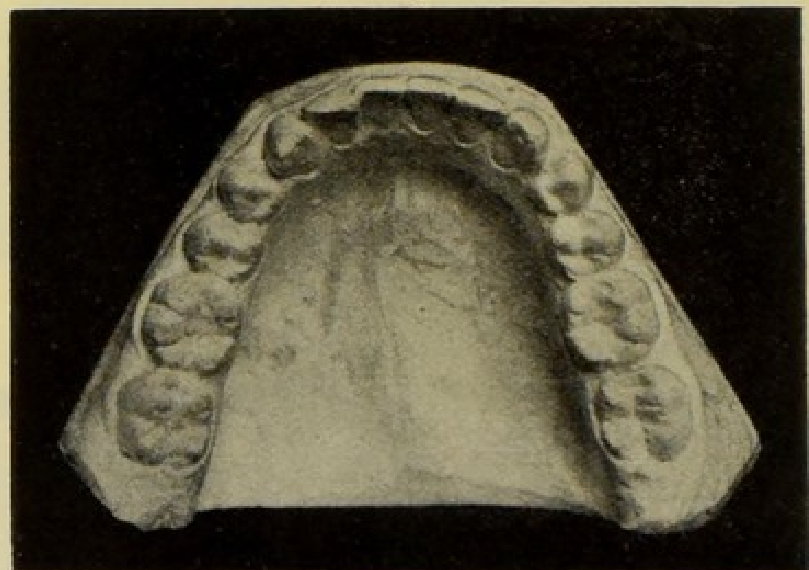


FIG. 334.—After treatment. The second molars have completely erupted.

the same position as the second premolar. Removal of the lower second premolar as well as the upper second premolar would allow the first premolars, upper and lower, to move back sufficiently to overcome the crowding of the incisors and canine, while the molars would move forward and assist in filling up the gap. In addition, mechanical methods would be avoided. Treatment consisted in the removal of the left upper lateral incisor and the

right upper and lower second premolars. The result of treatment is seen in figs. 321, 324, and 326. On the right side, a slight gap has resulted between the premolar and canine, but when the case was last seen the molars had moved still more forward and had considerably improved the occlusion of the upper premolar with the lower premolar and first molar. With the advent of the third molars, the space will, no doubt, be entirely closed.

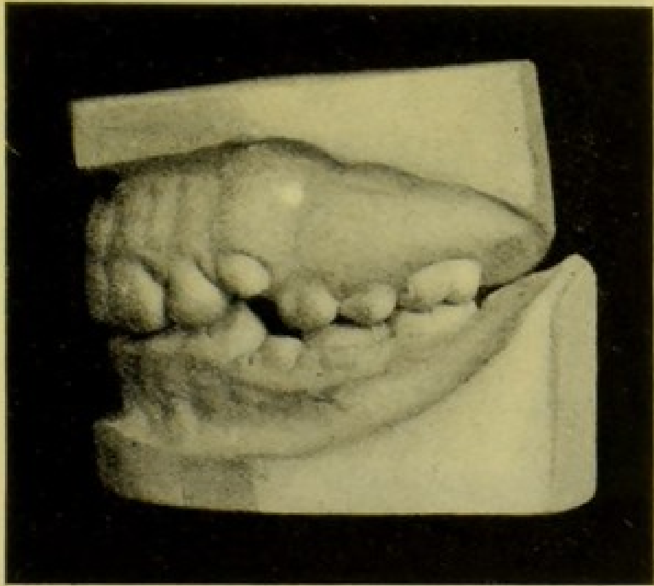


FIG. 335. —Left side before treatment.

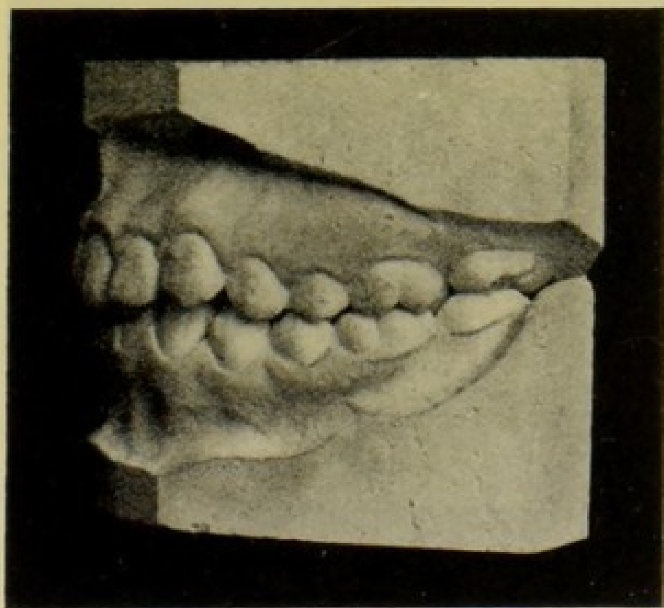


FIG. 336.—Left side after treatment.

The operation of expansion may be adopted in cases where the general lie of the premolars and molars is inwards, and where

the articulation and the personal appearance of the patient will be improved by the operation. A case treated by expansion is shown in figs. 327 to 330. The method adopted was a plate similar to that shown in fig. 257.

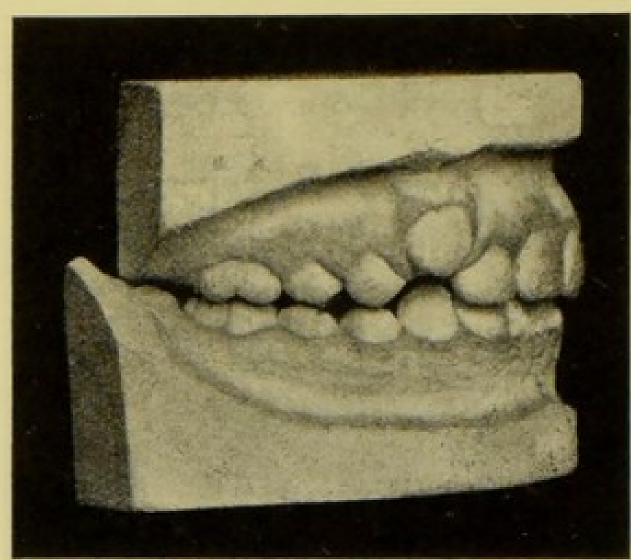


FIG. 337.—Right side before treatment.

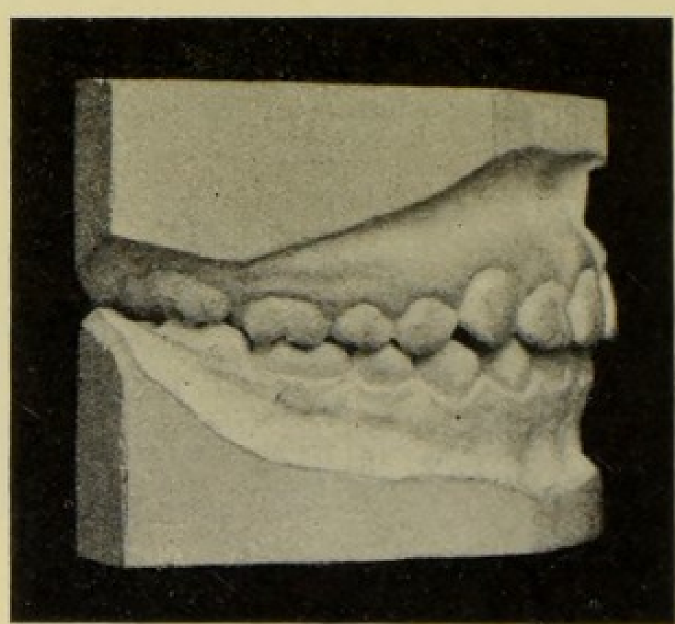


FIG. 338.—Right side after treatment.

Figs. 331 to 338 are the models of a case of crowding of the teeth, under the care of Mr. G. Northcroft, which he treated by means of expansion. The child was breast-fed for three months and then hand-fed, a boat-shaped bottle

being used. No adenoids. The first models of this patient were taken at the age of 8 years 4 months, and then showed slight crowding of the upper and lower anterior teeth. As the condition did not improve and the occlusion was getting worse, it was decided at the age of 10 years 9 months to adopt operative treatment. From the models shown in figs. 335 and 337, it will be noticed that the molar occlusion is correct on the left-hand side, but on the right-hand side the upper molar is in advance of its normal position and presents a flush occlusion. The treatment consisted in applying expansion arches to the upper and lower teeth, combined with inter-maxillary reciprocal traction. Pressure was brought to bear on the first maxillary molars, and a band and spur applied to rotate the left upper lateral. At the end of a little over four months, the appliances were removed and vulcanite retention plates inserted. The models, as shown in figs. 332, 334, 336, and 338, represent the case a year and three months after completion of treatment.

The following are the comparative measurements of the case when seen at 10 years 9 months and when completed :—

	10 yrs. 9 mths.	Completion of treatment
Width between 3|3 at tips	35·5 mm. ..	37 mm.
,, ,, 4|4 ,, gum-line	24·6 ,, ..	27 ,,
,, ,, 5|5 ,, ,, ...	30·5 ,, ..	33 ,,
,, ,, 6|6 ,, ,, ...	36 ,, ..	38 ,,
Depth of palate at 6|6 from gum-line	11 ,, ..	15 ,,
Length of jaw from palatal sulcus of molar to 1|1	35 ,, ..	36 ,,
The combined distances between 4|4 and 2|2 are	6·5 ,, ..	12·9 ,,

The average expansion being about 2 mm.

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CHAPTER IX

Abnormalities in Position of the Teeth associated with Abnormally Developed Jaws—(*Continued*)

Superior Protrusion—Inferior Protrusion—Open Bite

(A) SUPERIOR PROTRUSION

THE term "superior protrusion" is usually applied to the type of irregularity where the maxillary front teeth project abnormally. In the majority of cases, the lower lip, when the mouth is in repose, passes behind the upper teeth, and as the upper lip fails to cover them completely they remain exposed.

Opinions differ as to the causes underlying superior protrusion, and in order to arrive at a clear understanding of the problem, it will be advantageous at the outset to consider briefly certain facts and circumstances which are incidental to this form of irregularity, and which may be ascertained by an examination of a series of cases.

In the first place, **the deformity is not always associated with adenoids.**

A narrowing of the arch is invariably present.—In cases not associated with adenoids, the narrowing is more marked in the premolar than in the molar region, while in cases associated with adenoids, the narrowing is more marked in the molar region. The following figures which relate to hand-fed children illustrate this point :—

	A		B
Normal without adenoids	34·1	..	25·61
Protrusion without adenoids (18 cases)	33·9	..	24·5
Ordinary cases with adenoids	33·56	..	24·9
Protrusion with adenoids (20 cases)	32·48	..	24·31

An important feature of protrusion cases is the **frequency of an abnormal occlusion.** In seventy-two cases examined, the

occlusion was normal in 21 per cent., in 33 per cent. the maxillary teeth were the whole breadth of a premolar forward, while the remaining 46 per cent. presented on one or both sides varying degrees of abnormality. If these figures are compared with those obtained from cases of irregularity not showing superior protrusion, the point which is most noticeable is the increase in the percentage of cases showing the maxillary teeth the whole breadth of a premolar forward. In 140 cases without protrusion, only five showed this type of mal-occlusion.

This abnormal forward occlusion indicates either a normal maxilla with an imperfectly developed mandible, or a move forward of the whole maxillary arch. There are many who maintain that protrusion of the upper teeth is the result of a defective mandible, but no satisfactory data have yet been adduced in support of this view, nor has it been explained whether the want of growth of the mandible is due to congenital defect or to disuse through lack of function. If some congenital defect is responsible for the imperfect development of the mandible it is necessary to explain why the mandible should be the only bone in the body so liable to congenital defect, especially in view of the relative scarcity of such defects in other bones. If the defect is due to disuse from lack of function, then it must be shown why the mandible should be affected more than the maxilla.

On the other hand, the frequent presence of adenoids causing nasal obstruction, and the fact that lack of nasal respiration interferes in a marked way with the growth of the maxilla, suggest that the maxilla is the bone under-developed. By the foregoing remarks it is not intended to suggest that the mandible is never at fault in superior protrusion ; it probably is in a few cases.

An examination of models and skulls showing superior protrusion seems to confirm the view that the trouble is in the maxilla, and that it is a thrusting forward of the whole arch of teeth. This thrusting forward is seen in fig. 339, where the maxillary teeth are a half premolar forward; the abnormal tilt of the upper teeth is well shown ; the anterior portion of the mandible is well developed, but shows the characteristic flattening of the incisors so often seen in these cases which arises from pressure of the lower lip. Another case of superior protrusion, is shown in fig. 340.

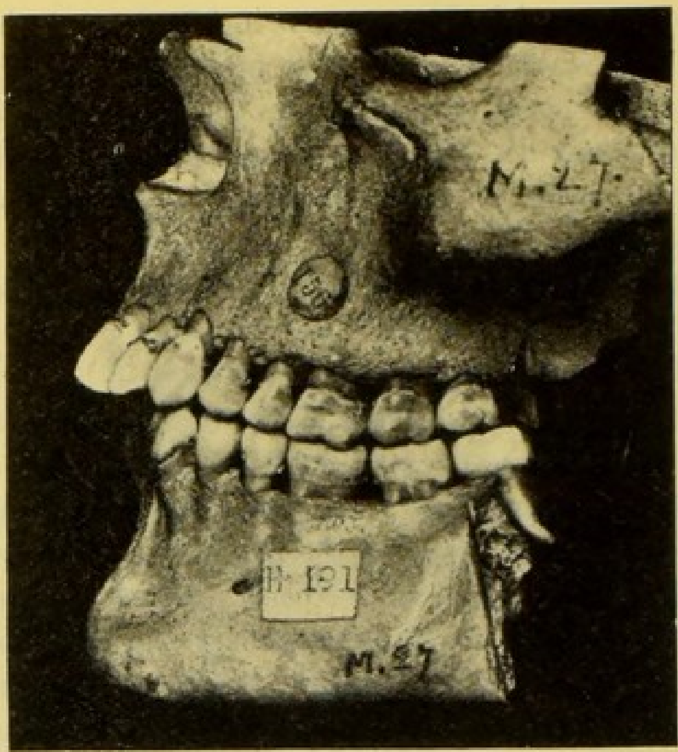


Fig. 339.

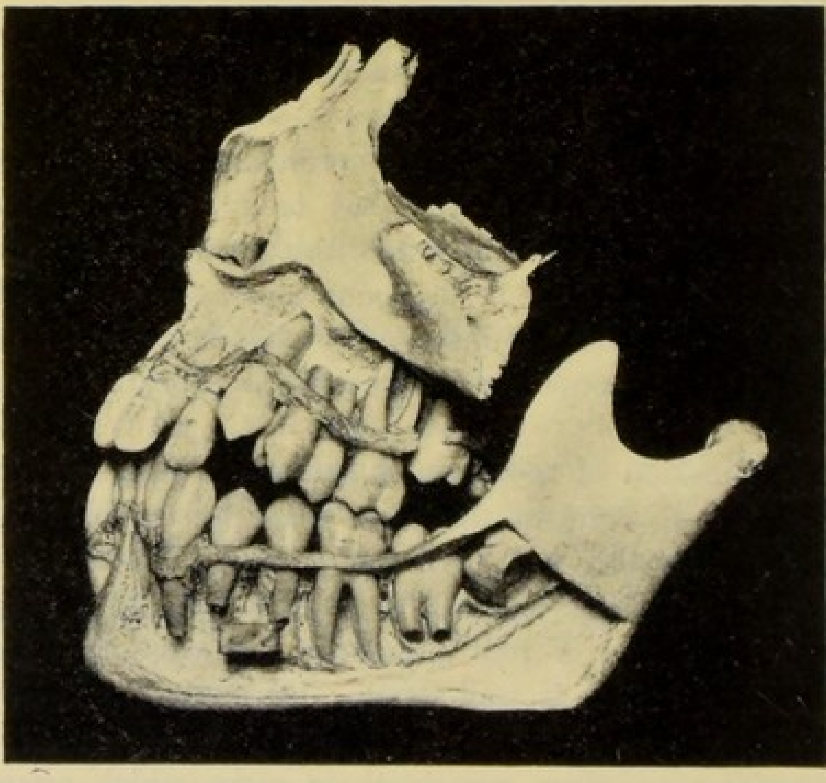


Fig. 340.

In this specimen the first molars are in normal occlusion. The maxillary incisors present a crowded arrangement, the apical portions of the roots being directed towards the median line, with the root of the lateral incisor partially covered by that of the central incisor. The canine and premolars have an abnormal forward slope, suggesting that there has been a forward movement of the arch.

The mandible is better developed than the maxilla. The incisors and canines are crowded, presenting a "fan-shaped" arrangement (see p. 241).

In discussing the effects produced by the presence of adenoids, it was shown that this affection interferes with the growth of the bone, and leads to a narrowing of the arch, and that the occlusion is often disturbed, possibly owing to a forward movement of the first permanent molar. The fact that adenoids are frequently associated with cases of superior protrusion is not a sufficient reason for assuming that there is a causal association, for if a

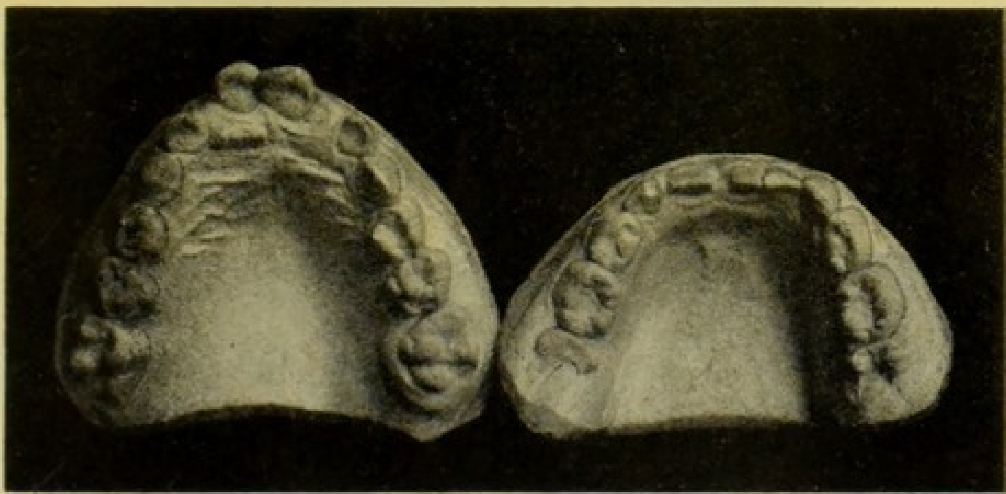


Fig. 341.—A case of the superior protrusion due to persistent thumb-sucking. Breast-fed. No adenoids.

considerable number of children suffering from adenoids are examined it will be found that while many of them have superior protrusion a larger proportion of them will have simply a crowded condition of the teeth. The frequency of abnormal occlusion in cases of superior protrusion would suggest that other causes are operating to produce this forward movement of the arch; still further, this mal-occlusion is quite as frequently seen in cases free from adenoids. The general effect conveyed to the mind on examining many protrusion cases is that the arch has been

subjected to lateral pressure and has given way in the direction of least resistance, namely, forwards. The question that naturally

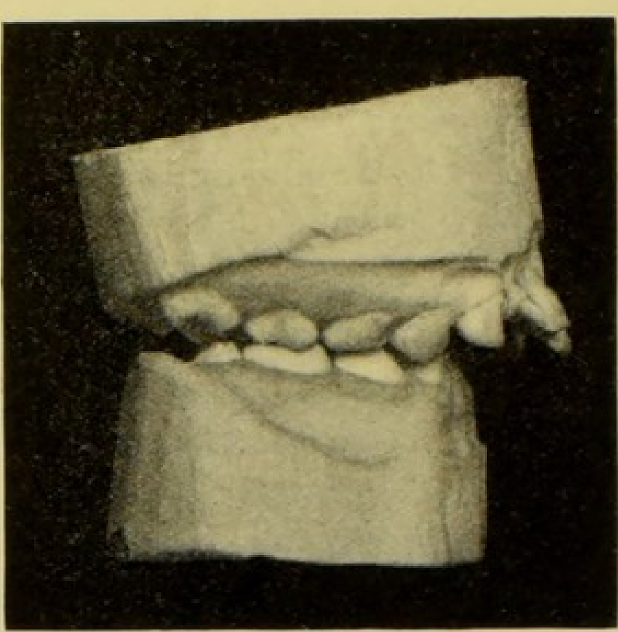


FIG. 342.—Side view of case shown on fig. 341.

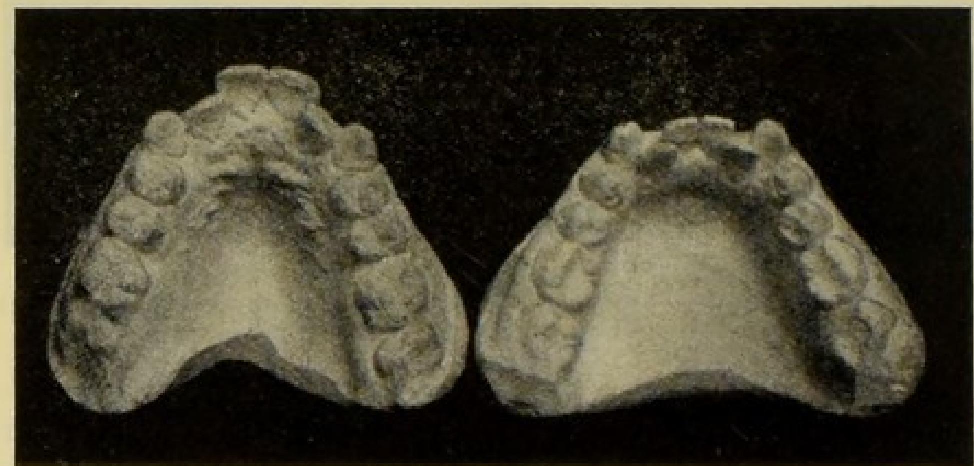


FIG. 343.—In this case there was no history or signs of adenoids. The occlusion was XX. Breast-fed for three months, after this a tube feeding bottle was used. There had been a habit of finger-sucking. Measurements: A, 3·3; B, 2·1. The lower incisors did not impinge upon the upper gums.

arises is whether such a factor has been at work in these cases. In a paper already referred to, Dr. T. F. Pedley has drawn

attention to the "baby comforter" and rubber teat as a causative factor, and an examination of my own cases tends to confirm

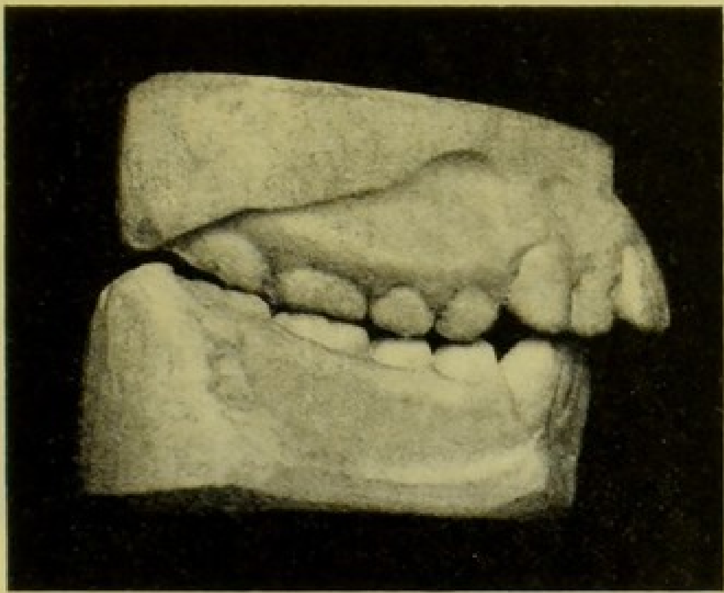


FIG. 344.—Side view of case shown in fig. 343.

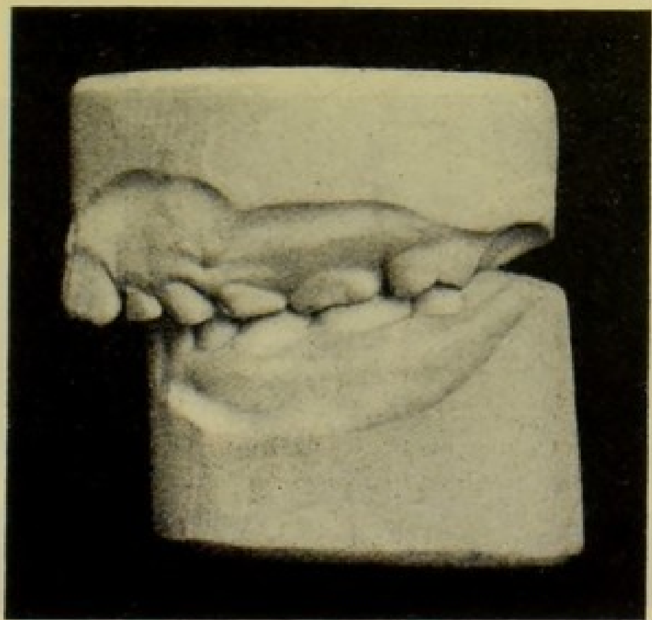


FIG. 345.—Breast-fed four months, then hand-fed with "boat-shaped" bottle. No adenoids. Thumb-sucker until 4 years of age. Measurements: A, 3·35; B, 2·4. The occlusion is 0·0. The arch of the incisors and canines is regular. The lower incisors do not impinge upon the upper gums.

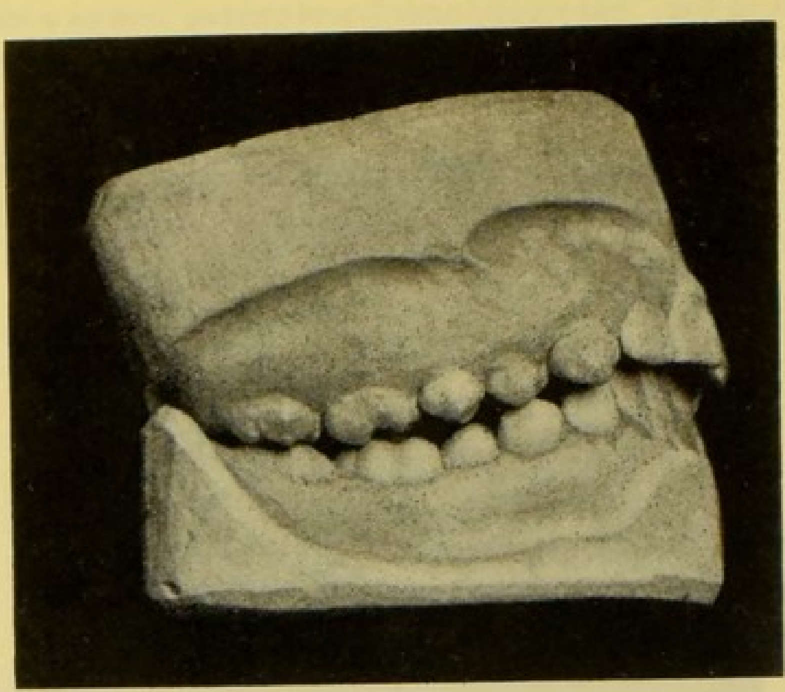


FIG. 346.—Hand-fed with tube bottle. Comforter used for three years. The arch is regular and the lower incisors free from the upper gums. Occlusion right side X, left side IV. Measurements: A, 3·2; B, 2·2. This patient was free from adenoids until 8 years of age.

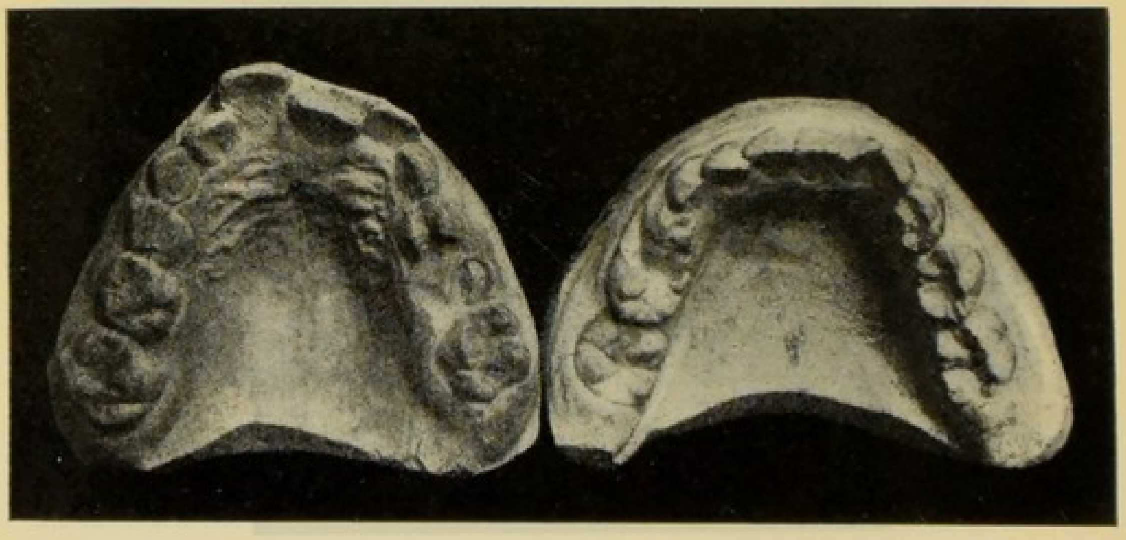


FIG. 347.—Hand-fed with a boat-bottle. Suffered from adenoids until 8 years of age. Comforter used for nine months. Occlusion 0·0. Measurements: A, 3·2; B, 2·3. Upper incisors show a crowded condition. Lower incisors impinge on upper gums.

the view he holds, viz., that the deforming action of these "products of civilization" are much more insidious than we have hitherto been led to believe. There can be little doubt, that thumb-sucking and, occasionally, lip-sucking are determining factors and act in a similar way to the "comforter."

Confirmation of this view is to be found in cases of superior protrusion not associated with adenoids, for in these cases there is invariably a definite history of the use of the comforter or thumb-sucking over a prolonged period. The amount of damage

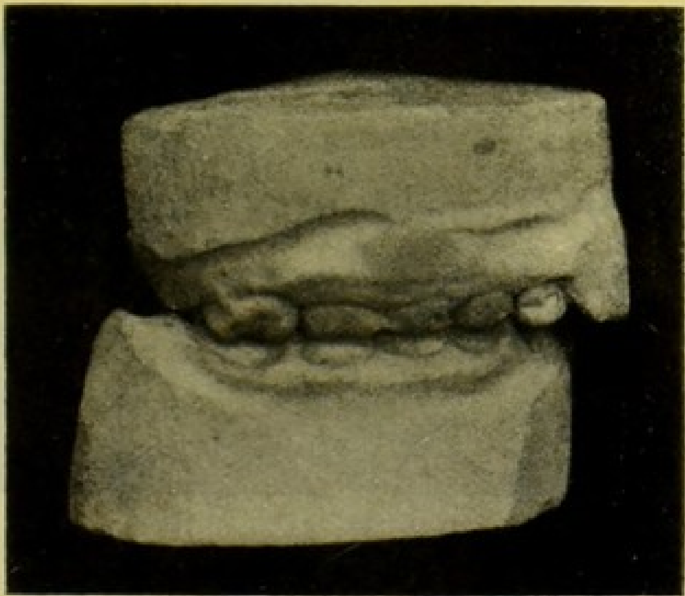


Fig. 348.—Side view of case shown in fig. 347.

to the arch from these two causes is indeed astonishing to those who have investigated the matter. Models showing different types of superior protrusion are shown on figs. 341 to 348.

The cases in which the lower incisors impinge on the cingula of the upper teeth, or the gum behind, form a well-defined group. An examination of these cases will usually show that the molars and premolars are stunted in their growth, the condition being associated with what appears to be a rectangular ascending ramus of diminished length. The mandibular incisors are often arranged in a fan-shaped manner, and rise high enough to press on the cingula of the maxillary incisors. This upward rising of the lower teeth tends to force forwards the upper incisors, and, when once

16

these have passed from under cover of the lower lip, the lip tends to increase the outward movement. The fan-shaped arrangement of the lower incisors is due to the pressure of the growing canine. The incisors are wedge-shaped teeth, the thin ends of the wedge being at the apices. If four wedge-shaped pieces of wood are placed side by side, and squeezed together at the narrow ends, the central ones will be forced upwards; and this is exactly what happens with the lower incisors when the growing canines exert pressure on the roots of the laterals (see fig. 349).

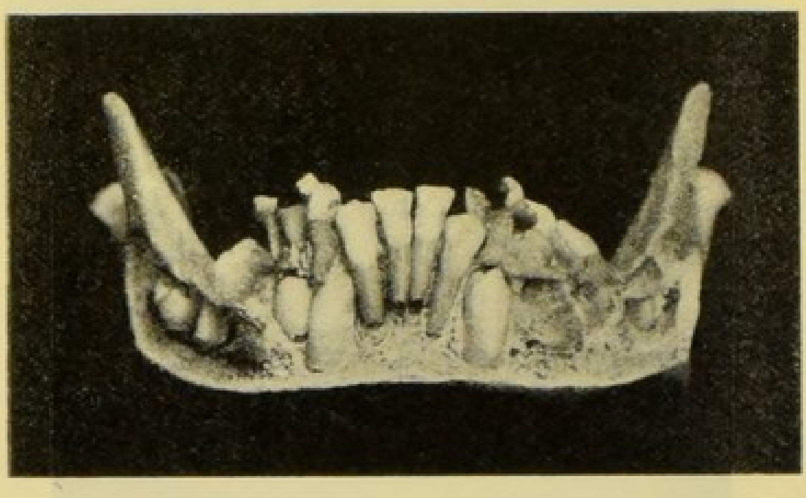


FIG. 349.

These cases are invariably associated with adenoids, and it would seem that the want of growth in the molar region is due, in a great measure, to insufficient growth of the antrum (see p. 111). The upper and lower molars and premolars oppose one another and are therefore held down, but there is nothing to prevent the incisors growing to their normal length, so that the mandibular incisors rise in the manner described and bring an outward pressure on the upper teeth, with the result that, unless this is counteracted by a strong muscular upper lip, the teeth move forward over the lower lip. If the forward pressure is met by a strong muscular lip, the upper incisors are driven backward and strike the gum covering the labial aspect of the lower incisors.

In cases of superior protrusion, there is a rapid increase in the deformity as the child approaches the age of twelve years. This

is due to the action of the canines in erupting. The four incisors may be pushed forward, the teeth maintaining a good curve; or the laterals may be forced under cover of the centrals, giving rise to what is sometimes styled a "rabbit-shaped" mouth (see figs. 350 and 351).

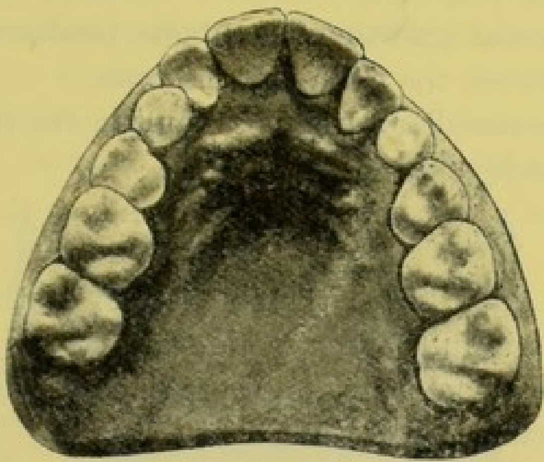


FIG. 350.—Upper model of a case of superior protrusion showing the arrangement of the teeth after the eruption of the incisors.

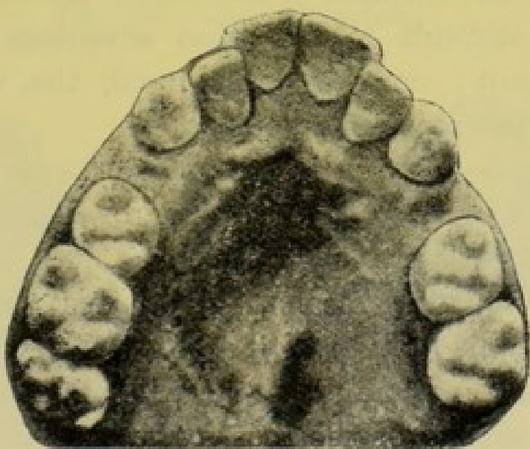


FIG. 351.—Model of the case shown in fig. 350 after the eruption of the canines. Note the forward movement of the central incisors and the backward displacement of the lateral incisors.

Treatment

For purposes of description it will be convenient to divide cases of superior protrusion into two groups, namely, those where the lower incisors do not impinge upon the cingula of the upper incisors or the gum posterior to those teeth, and those where they do.

(i.) **Cases in which the lower incisors do not Impinge on the Cingula of the Upper Incisors.**—In the previous pages, attention has been drawn to certain facts in connection with protrusion of the upper teeth, namely :—

(*a*) That the condition is usually accompanied by a certain degree of abnormal growth of the bone, producing an imperfect relationship between the teeth and the jaws.

(*b*) That the maxillary arch is at fault in the majority of cases and not the mandibular.

(*c*) That the protrusion increases rapidly with the eruption of the canines.

These facts indicate that extraction of teeth to relieve the crowding, and, still further, extraction at an early age, is the best treatment. Treatment based on these lines certainly gives by far the most permanent and satisfactory results. This treatment, however, does not receive the support of all, and there are many practitioners who urge that no attempt at correction should be made until after the eruption of the second permanent molars and canines. It is difficult to see what advantage can accrue by delaying treatment ; on the other hand, the disadvantages of delay are only too apparent, namely :—

(1) The canine in erupting will move forward, increasing the protrusion of the incisors, and also the crowding of their roots.

(2) When treatment is commenced, the canine must be retracted by mechanical means, and in this process, instead of moving bodily back, and so giving true relief to the pressure in the front of the mouth, the crown will only swing backwards, leaving the upper end of the root in much the same position as it erupted. The result will be a constant tendency for the protrusion, when corrected, to relapse, because the roots of the anterior teeth will remain more or less crowded.

(3) The retraction of the incisors will take longer, partly because there will be more protrusion to overcome, and partly because the alveolar process will be more resistant.

(4) Owing to the prolonged mechanical treatment, disorganization of molar and premolar occlusion is more likely to ensue.

With treatment carried out before the eruption of the canines these teeth will erupt well back, pressure will immediately be taken off the incisors, the protrusion will not increase, and the

amount of mechanical treatment will be only slight. Still further, the teeth will come into good alignment, and the tendency to relapse will be reduced to a minimum.

If early treatment is adopted, the room for the canines should be obtained by removing the unerupted first premolars as soon as the lateral incisors are in place. The method of carrying out this operation has been referred to on p. 205.

After the removal of the premolars, the case should be left alone until the canines have fully erupted, the patient being

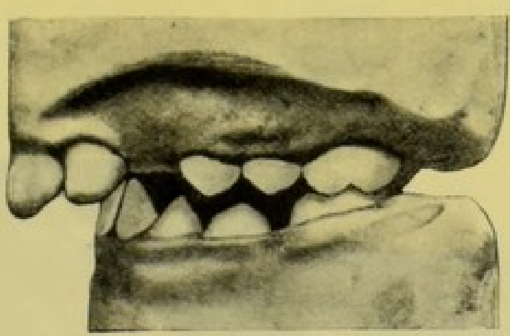


FIG. 352.—Before treatment.

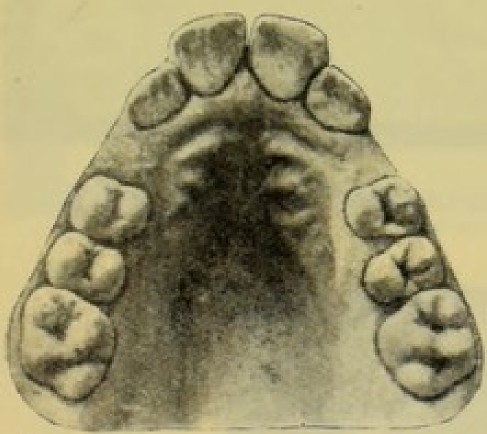


FIG. 353.—Before treatment.

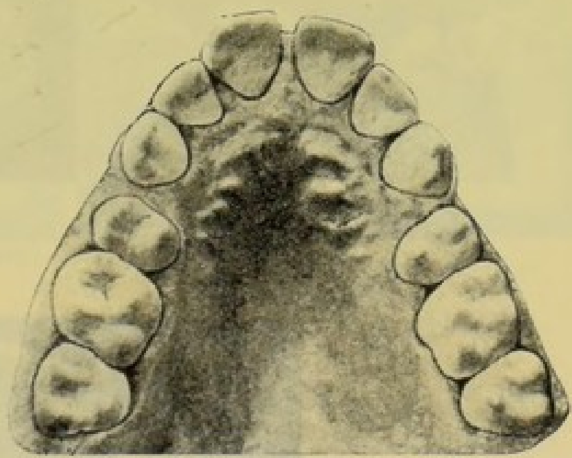
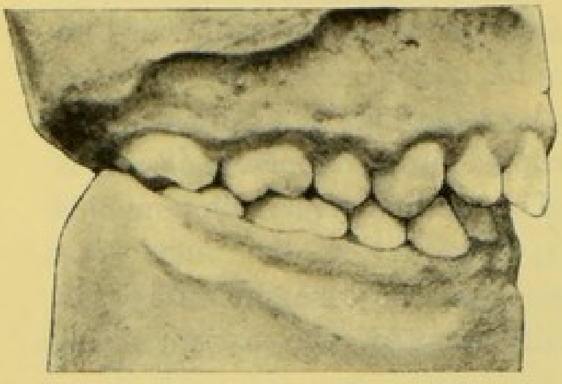


FIG. 354.—Stage at which mechanical retraction of the teeth was commenced.

strongly advised to keep the lower lip in front of the upper teeth. Occasionally, this simple expedient is sufficient to bring about a complete cure of the case. The effect of removing the pressure of the canines on the incisors is interesting. The laterals soon show a tendency to travel backwards, and this movement indicates a complete relief of the crowding of the anterior teeth. The incisors are eventually brought in with a simple mechanical



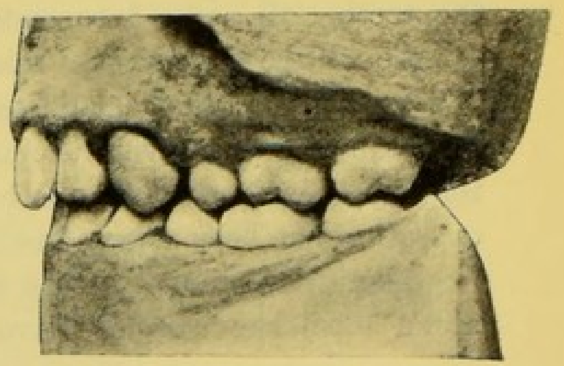
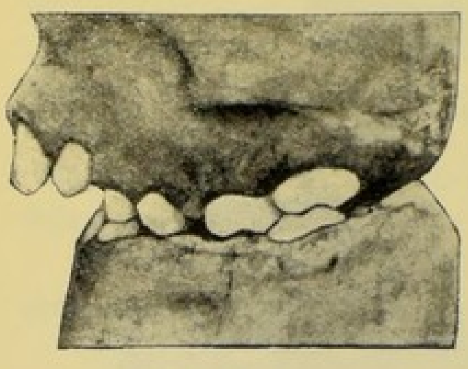


Fig. 355. Fig. 356.

After treatment.
Case shown in Fig. 352.



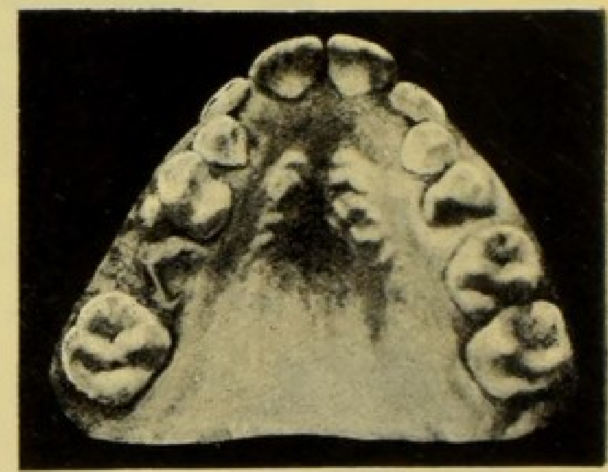


Fig. 357. Fig. 358.

Before treatment.

Fig. 359.

Stage at which mechanical retraction of the teeth was commenced.

contrivance, the teeth being retained in position until after the second permanent molars have erupted.

With regard to the lower teeth, the treatment must depend on the condition existing. If crowding is present, the first premolars must be removed, but their removal should be delayed until the canines have commenced to erupt. Little advantage is gained by removing the mandibular premolars at quite an early age, and in this respect the treatment differs from that recommended in the case of the maxilla.

When superior protrusion is treated at an early age excellent results are obtained; there is no tendency to recur; the amount of mechanical treatment necessary is trifling, and the occlusion of the premolars and molars is good. The cases shown in figs. 352 to 361 are examples of this mode of treatment.

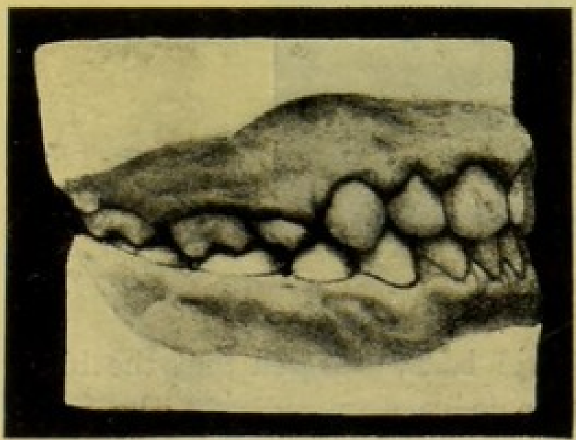


FIG. 360.

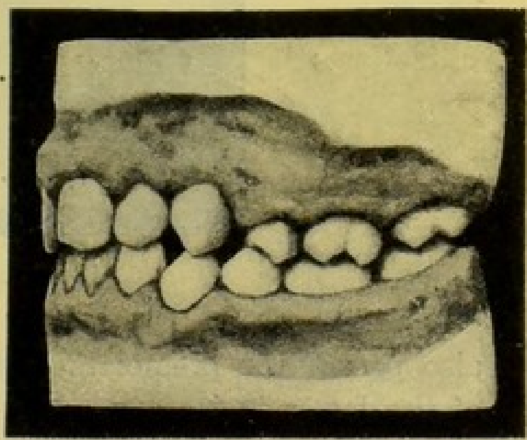


FIG. 361.

After treatment.

If the protrusion increases before the canines erupt, it is better to retract the incisors at once, but the results obtained are not quite so satisfactory as when the retraction is left until after the canines are in place.

In cases of superior protrusion that are not seen until after the canines have erupted, a prolonged spell of mechanical treatment is usually necessary, and the results obtained are often far from satisfactory. The models shown in fig. 362 illustrate a variety often met with. The upper teeth are in a fairly regular arch, but the premolars and molars are abnormally placed in relation to the lower teeth. The fault is entirely with the maxilla,

the mandible being normally developed. Provided that the first permanent molars are savable, the treatment in such a case would be the extraction of the first upper premolars, followed by the retraction of the canines, and subsequently the incisors.

If the first molars are unsavable, they must be removed. The extraction of the upper teeth may be undertaken as soon as the second permanent molars are sufficiently through to allow of their being retained in position by means of a splint plate (fig. 299). This plate, as before mentioned, will prevent the second molars from moving forward, and will allow them to erupt fully. It will

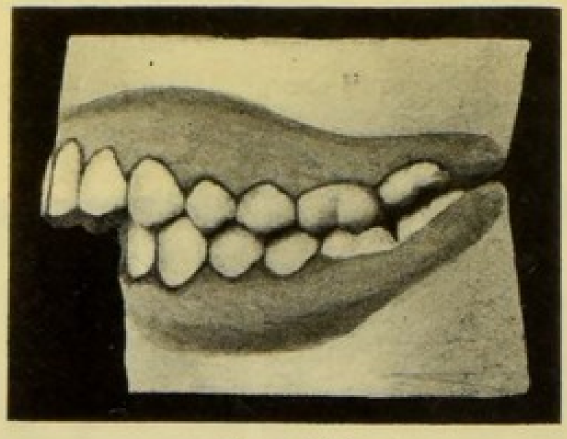


FIG. 362.

also permit the premolars to travel back, provided that the bite of the lower incisors on the plate is so arranged that the premolars, upper and lower, are separated from one another during occlusion. No attempt should be made to move back the premolars by mechanical means until the second permanent molars are firmly implanted, as the molars are liable to move forward if mechanical force is used too soon.

For retracting the premolars, a plate similar to that shown in fig. 207 may be used. It is important that the plate should occlude correctly with the lower teeth, in order that its rigidity may be augmented. It is advisable to retract only one premolar on each side at a time. If both premolars are retracted simultaneously, the second molar is very likely to move forward, as the resistance offered by two premolars is frequently greater than that of one molar, especially if the latter is not fully erupted. The premolars should be moved far enough back to allow the anterior

planes of the upper teeth to strike the posterior planes of the lower teeth, otherwise the posterior planes of the upper teeth will tend to drive the lower teeth backwards and so cause the abnormal articulation to persist (see figs. 363 to 365). If possible, the lower first molars should be retained until the premolars in the upper have been brought into correct occlusion. When the premolars are sufficiently retracted, the canines and then the incisors may be treated.

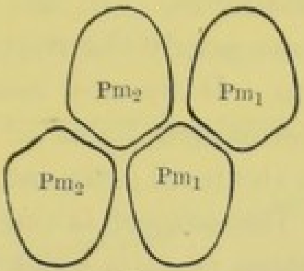


FIG. 363.—Diagram of articulation of superior protrusion cases which often require retraction of the upper premolars.

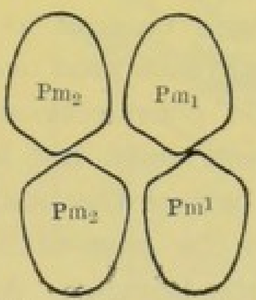


FIG. 364.—Diagram showing the least extent to which upper teeth must be retracted. The posterior plane of the lower teeth will tend to drive the upper teeth backwards.

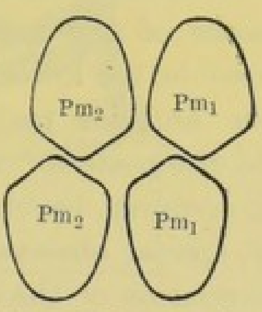


FIG. 365. — Diagram showing an insufficient amount of retraction of upper teeth. The posterior planes of the upper teeth will tend to drive the lower teeth backwards and so cause the abnormal articulation of the premolars to persist.

The results obtained are not very satisfactory, and there is usually a tendency to relapse. This is in a measure due to the fact that extraction of the molars gives but little relief to the crowding of the anterior teeth.

If the protrusion is excessive and the first molars unsavable, it may be necessary to remove the first premolars, in addition to the first molars. In such cases, the molars must be removed because they are unsavable, but their removal will not materially aid in the treatment of the protrusion. If the protrusion is left

alone, the teeth are almost certain to be lost at an early age from periodontal disease. If the protrusion is to be treated with any hope of obtaining a permanent result, the premolars must be removed, and, when the one alternative is weighed against the other, the advantage would seem to be in favour of the extraction of the premolars and the permanent retention of the front teeth.

The operation of "jumping the bite" is recommended by some practitioners as a method of dealing with the variety of protrusion under consideration. In the case fig. 362 the lower premolars and molars are nearly the width of a premolar behind their correct articulation. If by any means the patient can be made to acquire the permanent habit of bringing the mandible forward so as to make the teeth articulate normally, the bite will have been "jumped." The subject is one which has been largely written upon, and on which there is much diversity of opinion.

Dr. Ottolengui,[1] who claims to have "jumped the bite" on many occasions, adopts the following plan: "The frontal prominence of the superior jaw having been reduced as much as is possible, the lower jaw is moved forward to a good occlusion with the anterior part of the jaws, little consideration being given to the posterior teeth. The lower jaw must not be progressed, however, beyond what becomes a part of the best facial contour, special observation being given to the pose of the lips and the relation of the chin to the rest of the features. As soon as it is decided just where it is most desirable to have the lower jaw, a plate is made which snugly fits the roof of the mouth, and which has, at the anterior part, an inclined plane, which not only prevents the closure of the mouth in the old position, but by catching the tips of the lower teeth causes the teeth gradually to slide forward in closing, so that the mouth shuts in the desired pose. This plate is worn until the habit becomes fixed. The new bite may become a new habit in two or three months, and a child may adopt it in less time, without the inclined plane and with nothing whatever to produce the change except an indomitable will power and sufficient interest in her own welfare to second the efforts made on her behalf."

An interesting example of "jumping the bite" is recorded by

[1] *Dental Practitioner and Advertiser*, vol. xxv, p. 194.

Dr. Bogue,[1] in which, after increasing the width of the arch across the upper canines, the mandible moved forward, and a normal occlusion resulted. In this case, the lower teeth were apparently prevented from moving forward by the upper canines.

It is clear from the cases recorded that patients can be made to acquire, at least temporarily, the habit of protruding the jaw, and so "jumping the bite." Does this habit become permanent, and, if so, what structural changes take place in the parts involved? By some[2] it is maintained that the changes are accomplished in the glenoid cavity (1) by an extension of the condyle

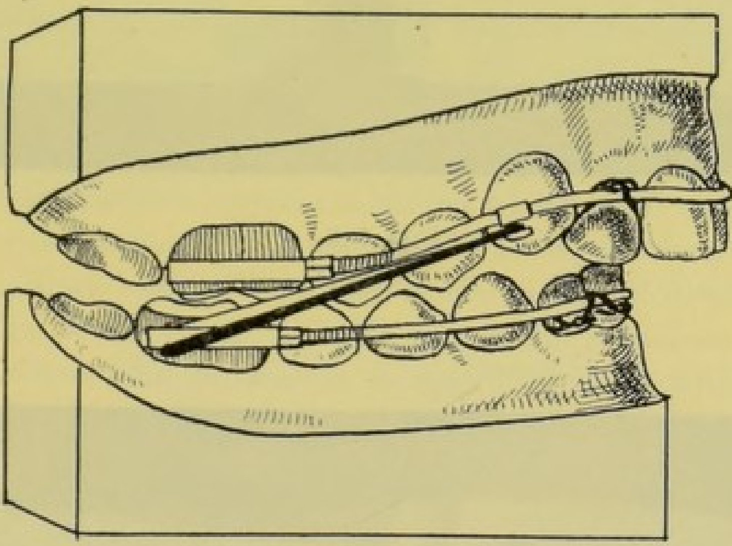


Fig. 366.

of the mandible, which practically amounts to a bending backwards of the neck; (2) by the filling up of the cavity posterior to the condyle. These explanations do not seem compatible with our knowledge of the anatomy and physiology of the temporo-mandibular articulation. A more probable explanation is that the teeth move forward in the sockets. When the teeth are occluded in the new position, namely, with the bite jumped, there must be a constant tendency on the part of the muscles to retract the mandible to its old position; this backward tendency is arrested by the upper teeth, with the result that the lower teeth are drawn forward in their sockets, and absorption and

[1] *Dental Cosmos*, May, 1887.
[2] *Trans. World's Columbian Dental Congress*, vol. ii, p. 760.

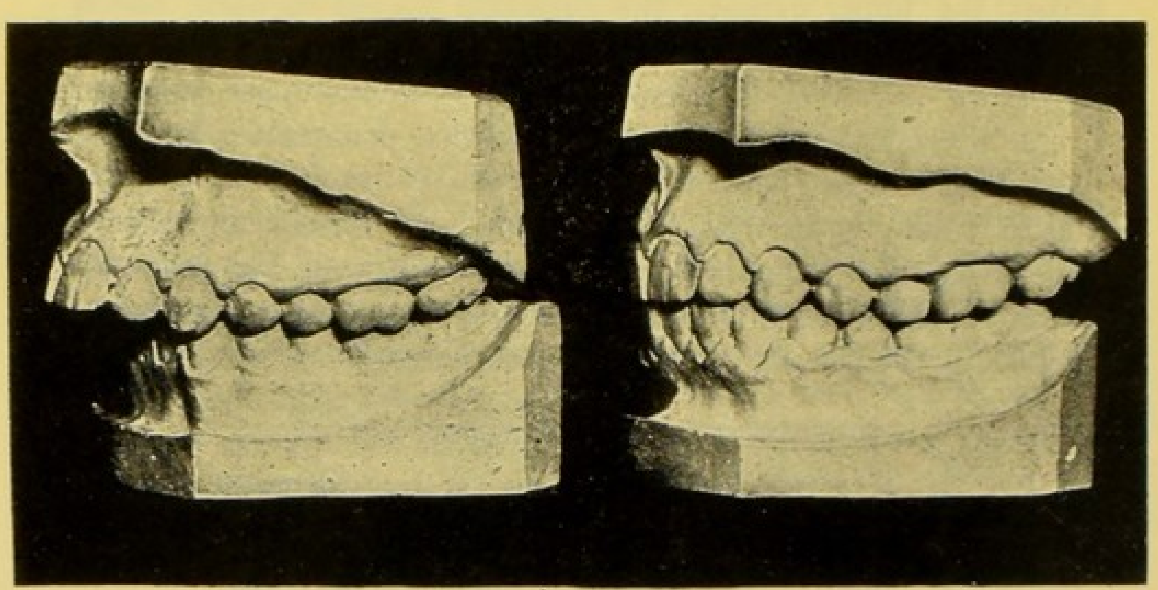


Fig. 367.[1]

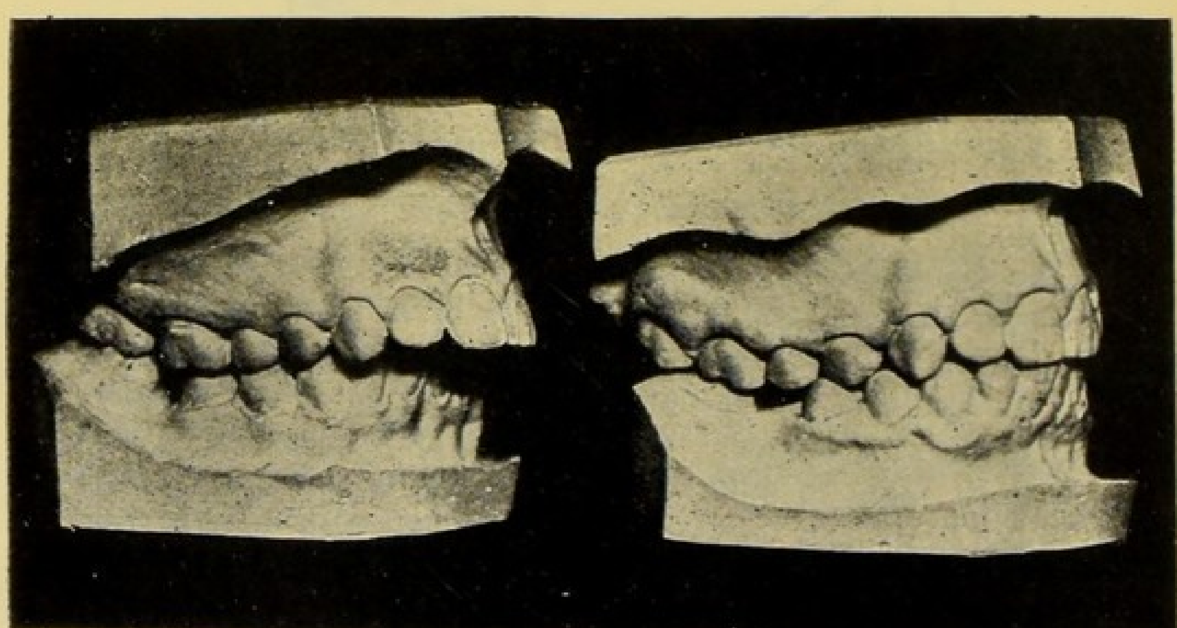


Fig. 368.[1]

[1] From "Operative Dentistry," by C. N. Johnson.

re-deposition of bone in the tooth sockets take place as when a tooth is moved by mechanical means.

Dr. Angle[1] refers to this point, and states that cases examined four years after the termination of treatment show the backward tilt of the upper teeth and the forward tilt of the lower ones.

With some practitioners a method of treating cases similar to that shown in fig. 362 is by means of intermaxillary traction. Expansion arches are adjusted to both jaws, and the teeth spread to the desired position; the expansion arches are then connected by elastic bands, as shown in fig. 366. It is claimed that by these means the lower teeth can be easily moved forwards and the upper backwards. When the teeth are in normal occlusion, a retention apparatus is applied. In figs. 367 and 368 are shown the models[2] before and after treatment of a case treated in this way. The author states that "the models on the right of figs. 367 and 368 illustrate the very perfect occlusal relations which were established." A careful examination of the models will show, however, that the second maxillary molars have been rendered almost functionless.

Cases in which it is difficult to obtain permanent results are those where the protrusion is complicated by tilting of the laterals. The crowns of the incisors are arranged in a fair arch, but in such a way that the roots of the laterals lie towards the median line. This condition is probably the result of adenoids, or some other form of nasal obstruction. The anterior nares, being functionless, do not develop properly, and so indirectly, and perhaps directly, affect the growth of the premaxillæ. In these cases the canines come down in such a way that their roots lie towards the median line. When retraction is applied to the tooth, although the crown is drawn backwards, the pressure on the root of the lateral is not relieved, and is possibly increased. The space gained in the arch by the retraction of the canines admits of the incisors being retracted to a certain extent, but the effect of the retraction is to crowd the roots still more, with the result that there is a constant tendency for cases of this type to relapse, unless a retention plate is regularly worn at night. The choice lies between (1) leaving the case alone, with the inevitable result that the condition becomes worse, and periodontal

[1] "The Treatment of Mal-occlusion of the Teeth." Seventh Edition.
[2] From "Operative Dentistry," by C. N. Johnson.

disease supervenes; and (2) treating the case, and when the teeth are retracted, impressing on the patient the necessity of wearing a retention plate during the night.

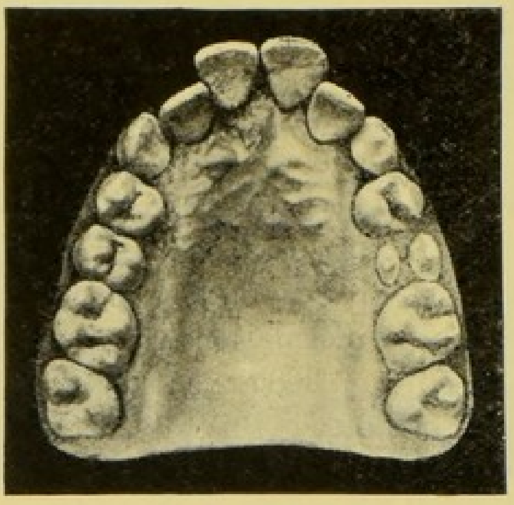


Fig. 369.[1]
Before treatment.

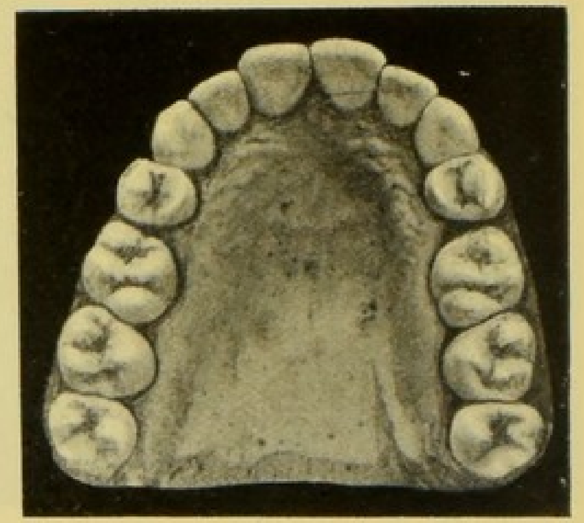


Fig. 370.
Case shown in fig. 369 after treatment.

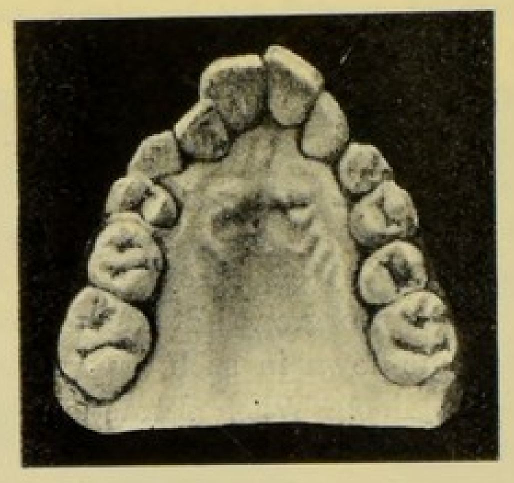


Fig. 371.[2]

In the case shown in fig. 369 the lateral incisors have been forced slightly behind to the central incisors. In this

[1] This patient was hand-fed and suffered from adenoids, which had not been treated.

[2] This patient was hand-fed, a tube bottle being used, she had also suffered from adenoids. The latter condition was probably responsible for the interference in the growth of the premaxillæ, the use of the tube bottle for the marked narrowing of the arch.

type of cases, although the crowns of the teeth may be brought into a good arch, the roots will remain crowded, and there will be a constant tendency to relapse unless a retention plate is worn regularly at night. This occurred in the case shown in fig. 369.

In cases of protrusion where there has been considerable interference with the growth of the premaxillæ, so that the root of the lateral incisor is covered by that of the canine, by far the most satisfactory results are obtained by the extraction of the laterals. A typical case is shown in fig. 371.

(ii.) Cases where the Lower Incisors Impinge on the Cingula of the Upper Incisors, or on the Gum Posterior to these Teeth.—These cases are difficult to treat, and the results obtained are frequently unsatisfactory. If the mouth of a patient presenting this form of superior protrusion be examined, it will be noticed that the lower incisors are on a higher level than the premolars and molars. This may be due to some abnormal condition of the incisors, the height of the premolars and molars being normal; or the incisors may be normal in their arrangement and the premolars and molars unduly short; or again, both incisors, premolars and molars may be at fault. In order **that treatment may be successful, it is essential that the lower incisors should not impinge on the cingula of the upper incisors when the latter have been retracted.** It is therefore needful that attention should be directed to the treatment of the lower teeth. It has already been pointed out that the abnormal uprising of the lower incisors is due to crowding from lateral pressure of the canines, and that the shortness of the range of the molars and premolars probably arises from a defect in the development of the bones. As a first step in treatment, most practitioners endeavour to raise the bite—in other words, induce the molars and premolars to elongate and so prevent the lower incisors from impinging upon the cingula of the upper teeth. There are two strong **objections to treatment by raising the bite:** (1) the obstinacy, at times, on the part of the molars and premolars to rise; and (2) their liability to relapse by being forced down again into their sockets. It is not surprising that disappointments attend the practice of "bite raising," since the treatment is not in accord with our anatomical knowledge of the condition. **Failure to raise the bite** seems more likely to occur in cases where the molar and

premolar region is well developed. There is a common impression that if teeth are separated from one another they will always elongate. That this view is erroneous will readily be seen by a study of that type of irregularity called "open bite." When the ascending ramus is short, the premolars and molars are probably prevented from rising to their normal height. If, therefore, the jaws are separated, the teeth will no doubt rise. It is in these cases that the liability to relapse occurs. Raising the bite does not affect in any way the ascending ramus, which is the real cause of trouble. The mouth is in reality propped open artificially, and the muscles which close the mandible are in a state of tension. As soon as the plate is removed, the muscles have again free play, and the pressure they exert drives the premolars and molars back to their original positions.

In a few cases, with the eruption of the second molars, the bite becomes raised by natural means, probably from a rapid growth of the ascending ramus about this period. It is possible that in cases in which raising the bite by artificial means has been permanent the same natural causes have been at work.

More reliable results can be obtained by directing treatment to the mandibular incisors. Where the incisors and canines are not very crowded, their cutting edges should be ground down until they are clear of the upper teeth ; at the same time it is most important that all lateral pressure should be relieved by the removal of a premolar or molar. If this is not done, there is a risk that when the third molars erupt they will exert a forward pressure and cause crowding of the front teeth. Where the incisors are very crowded, with the canines lying slightly anterior to the laterals, or where the fan-shaped arrangement is well marked, it is an excellent plan to remove an incisor. The crowding of the remaining teeth is efficiently relieved and the incisors usually fall to their normal level and are so prevented from impinging upon the upper gums or teeth. Removal of an incisor slightly narrows the lower arch, and this, is, in my opinion, a distinct gain as far as treatment is concerned. Some, however, maintain that the narrowing of the arch may be detrimental to the facial expression because it will allow the lower lip to fall in. This view is incorrect. The prominence of the chin is governed by the mental process, and is in no way dependent upon the

alveolar portion of the jaw, which is alone involved in the removal of an incisor. When the upper teeth have been retracted the lower lip should close outside them, and should not be dependent upon the arch of the lower incisors for its position. A case treated in this manner is shown in figs 372 to 377.

The amount of protrusion is shown in fig. 372.

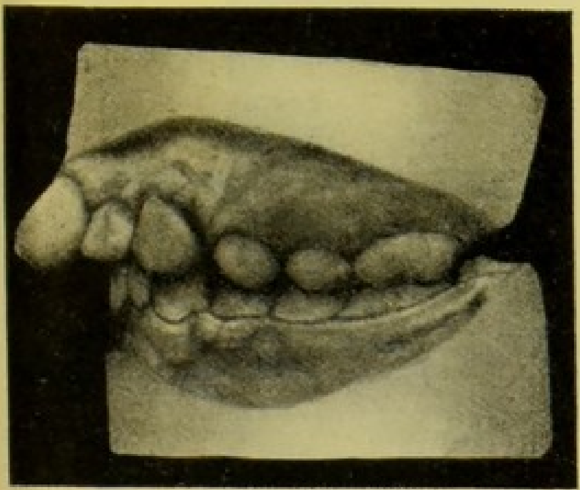


FIG. 372.—Left side before treatment.

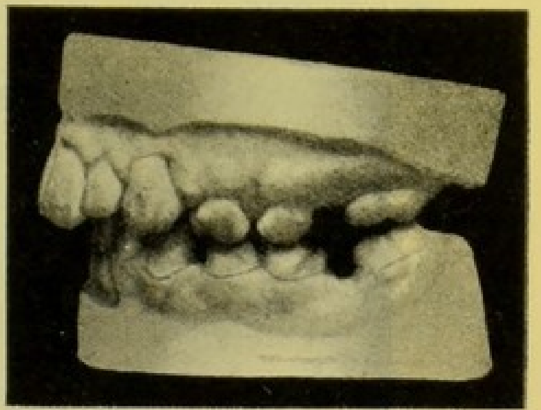


FIG. 373.—Left side after treatment.

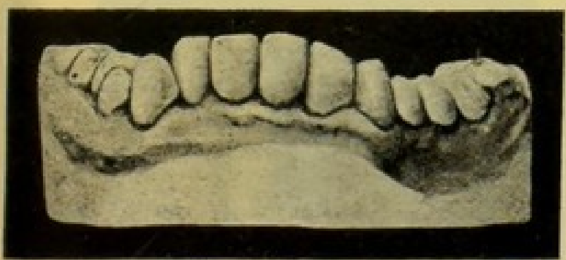


FIG. 374.
Lower incisors before treatment.

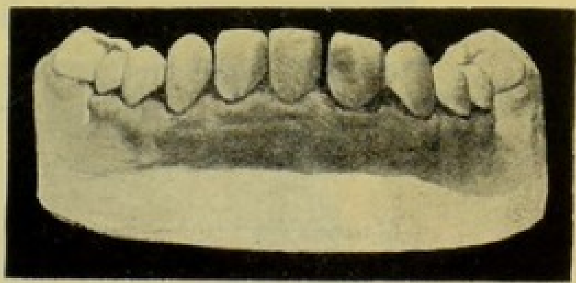


FIG. 375.
Lower incisors after treatment.

An examination of the models shows that the right upper premolars are erupting normally as regards occlusion with the lower teeth; on the left the upper premolars are not quite half a tooth in advance of their correct positions, the anterior planes of the upper teeth just striking the posterior planes of the lower teeth. The lower incisors are crowded and show the typical heaped-up appearance already alluded to (fig. 374). The cutting edges of these lower incisors strike the gum just posterior to the upper incisors (fig. 376). The direction of the roots of the lower incisor teeth indicated that the left central should be removed.

This tooth having been extracted, the case was left for a year, as the first permanent molars, which were unsavable, had to be removed, and this could not be done when the patient was first seen, as the upper second molars had not then erupted.

When examined one year afterwards, the gap caused by the removal of the lower central had closed up, the teeth had apparently dropped down to a lower level (see fig. 375), and were quite free from the upper gum. By the removal, therefore, of this central incisor one of the great difficulties in treating this type of case had been overcome. The first permanent molars were now extracted and a splint plate put in to keep the second permanent molars from moving forward, and at the same time allow the premolars to travel back. The canines were then retracted and the incisors brought in. The result is seen in figs. 373 and 377. The lower incisors are quite clear of the upper teeth and the lower lip also passes in front of them. The upper teeth could have been retracted still more, but it was not considered advisable from an æsthetic point of view.

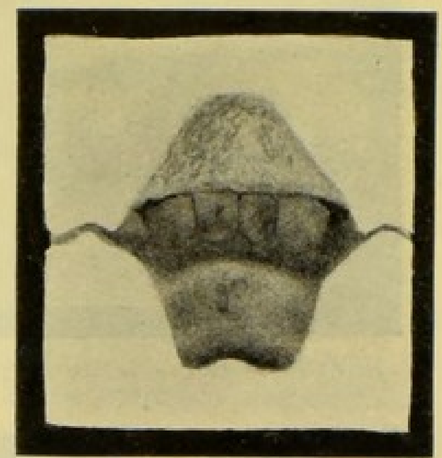


FIG. 376.—Showing relation of the lower incisors to the upper teeth at the commencement of treatment.

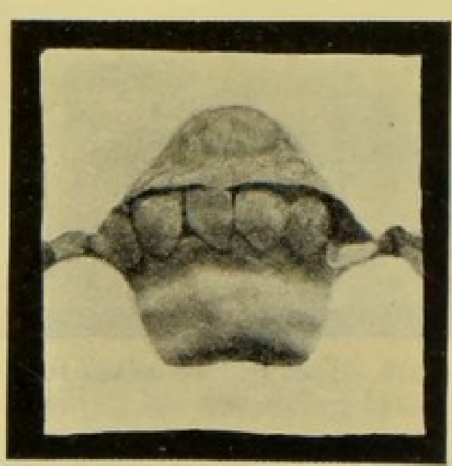


FIG. 377.—Showing relation of lower to upper incisors after treatment.

Much has been written respecting the tendency of cases of superior protrusion in relapse. There will be no tendency to relapse if we can—

(1) Ensure that the lower lip in occlusion passes in front of the upper incisors.

(2) Ensure that the lower incisors do not press unduly upon the backs of the upper incisors.

(3) Prevent crowding of the upper incisors and canines.

The less we are able to overcome these difficulties the greater will be the tendency to relapse.

In fig. 378 is shown a type of irregularity which is, fortunately, rare, and which may for convenience be described under the heading of superior protrusion. In the maxillary arch the teeth anterior to the first molar fall completely without the

lower arch. In these cases the mandible seems to be generally small in character.

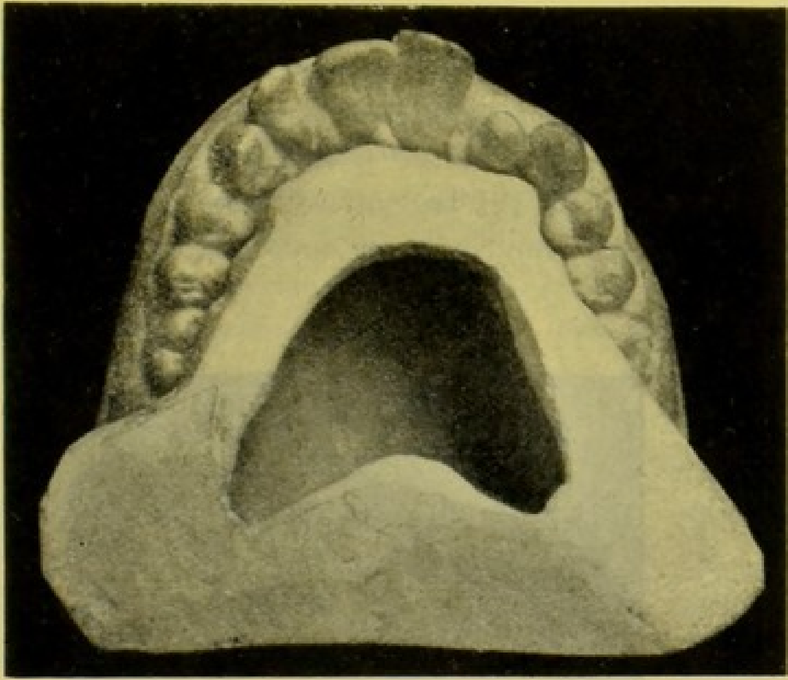


Fig. 378.

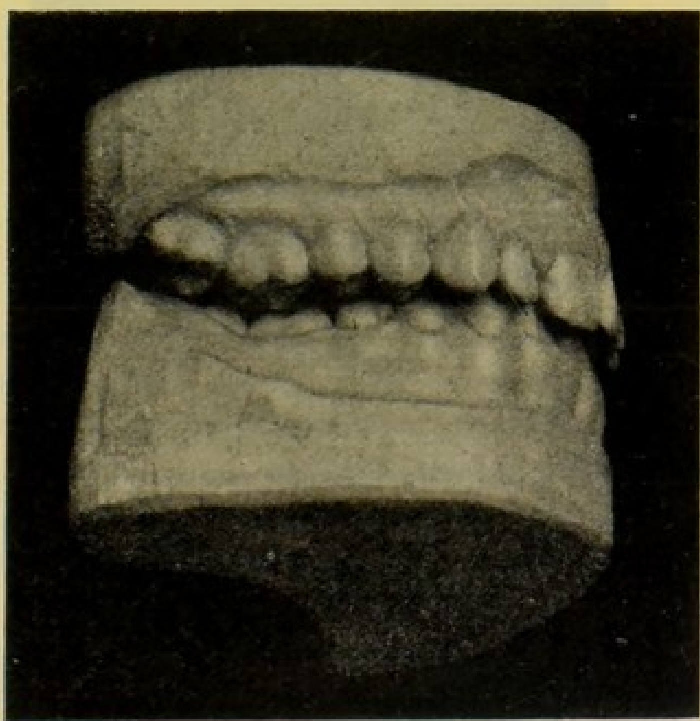


Fig. 379.

The abnormal occlusion of the premolar and molar may be limited to one side, and an example of this is shown in fig. 379. The occlusion of the anterior teeth and the left premolars and molars is normal, but the right upper premolars and first molar have erupted outside the lower teeth. In this patient the first indication of this abnormal condition was the eruption of the right upper first molar in the position shown in fig. 380. The deciduous molars, it will be noticed, were in correct occlusion, but the premolars erupted in an outward direction as shown in fig. 379.

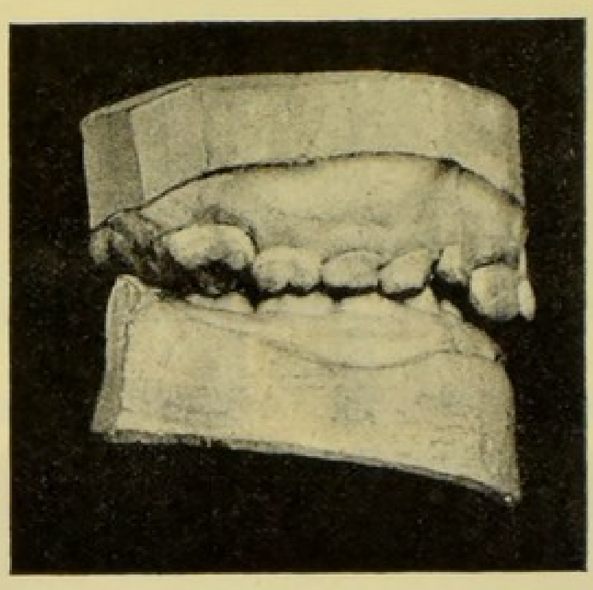


Fig. 380.

(B) INFERIOR PROTRUSION—UNDERHUNG BITE

In this condition, when the mouth is closed, the upper front teeth pass within the arch of the lower teeth, instead of outside it; in other words, the mandible protrudes. This abnormal arrangement of the teeth may be limited to the incisors and canines, or it may involve the premolars and molars as well. Protrusion of the mandible is a natural condition in the edentulous.

Etiology and Pathology.—In the more simple examples the irregularity is due to a faulty occlusion of the teeth in jaws otherwise well developed; but in other cases it arises from faulty growth of the bones themselves.

In the *first group* may be included those examples which are traceable to **habits**, one of which is the **constant protrusion of the mandible** and another the **hooking of the fingers over the lower teeth**, causing a forward movement of the incisors until they occlude anterior to the upper teeth.

In a definite variety of cases the irregularity is due to the **eruption of the upper incisors internal to the existing deciduous teeth.** The permanent teeth, when fully erupted, pass behind the lower incisors, and these teeth assume a more forward position. The permanent maxillary canines in erupting move slightly towards the median line and so lock, as it were, the incisors. Cases of this character are recognized by the general direction of the incisors, the upper teeth sloping backward and the lower teeth forward. The occlusion of the premolars and molars is usually normal. In fig. 381 is shown an example of this type of protrusion.

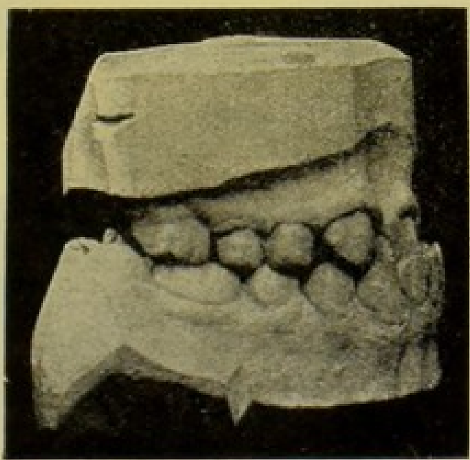


Fig. 381.[1]

In the *second group* the etiology and pathology is frequently obscure. In many cases the trouble can be traced to a **defective growth of the maxilla**, associated with adenoids. The lack of growth may be limited to the premaxillæ, so that the only teeth involved in the deformity are the incisors, or the maxillæ may be generally affected. An examination of the mandible in these cases will not disclose any defect of growth.

[1] From "Text-book of Operative Dentistry" (Kirk).

The most obscure cases, however, are those in which the **defect is traceable to the mandible**. In some examples the mandible seems to be of undue size, the relation of the ascending to the horizontal ramus being normal. In other cases the pro-

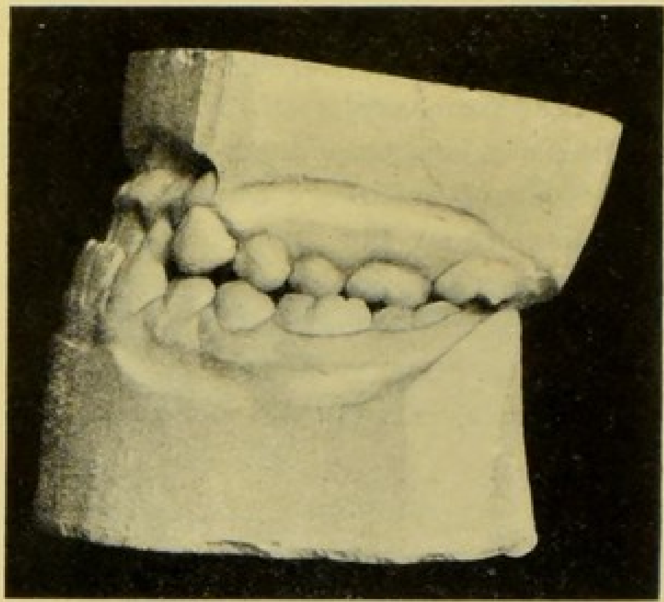


Fig. 382.

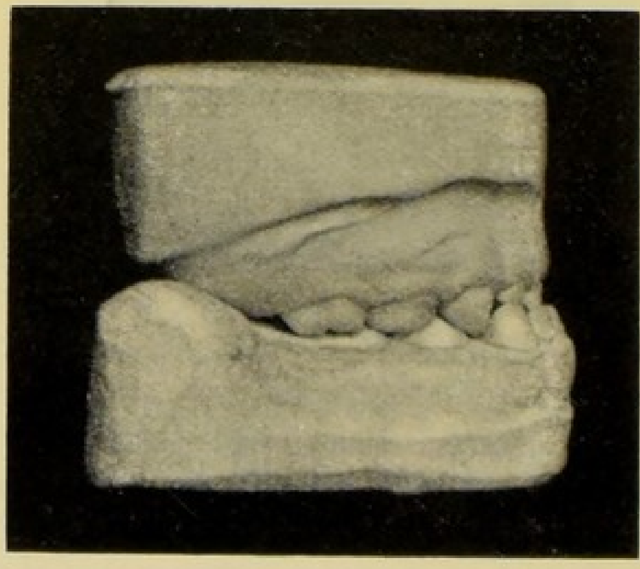


Fig. 383.

trusion would appear to arise from a thrusting forward of the horizontal ramus through an excessive growth of the ascending ramus. In the skulls shown in fig. 384 this point is well shown.

It will be noted that in the one marked (A) the mental process is unduly prominent, a condition not unfrequently seen in these cases. An examination of the skulls will also show that the condyle of the mandible articulates correctly in the glenoid cavity.

In fig. 382 are shown the models of a case of inferior protrusion due to defective growth of the mandible. The lower teeth in occlusion are in advance of the normal. In fig. 383 are the models of a boy aged 5, showing well-marked protrusion of the mandible.

(A)

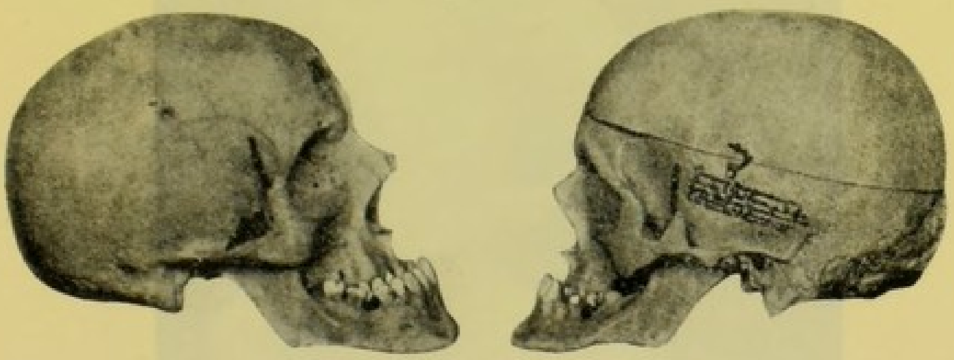


FIG. 384.

In some cases of forward bite, however, the articulation of the condyle is not normal, and in the fig. 385 the condyle rests on the eminentia articularis. Dr. Cryer,[1] who drew attention to this peculiarity, inclines to the view that the abnormal position of the condyle in these cases may be due to the use of forceps at birth; the mandible, he thinks, may be drawn forward, and if the displacement is not reduced the temporo-mandibular articulation will be changed from the glenoid fossa to whatever position the condyles may assume.

Dr. L. S. Chilcott[2] thinks that similar injury may follow difficult "breech presentation" cases. Cryer also quotes a case of forward bite associated with mal-position of the condyles in a man aged 35, who had been a case of breech presentation.

In acromegaly the mandible is frequently found enlarged. In examining patients showing inferior protrusion, it will often

[1] *Dental Cosmos*, November, 1906.
[2] *Ibid.*, March, 1906.

be noticed that when the jaws are in repose the upper and lower incisors are in contact, leaving a space between the opposing premolars and molars, but during mastication the mandible is brought forward to obtain the necessary occlusion of the posterior teeth. This point should be remembered when cases are being examined with the object of ascertaining how far back the mandible can be taken.

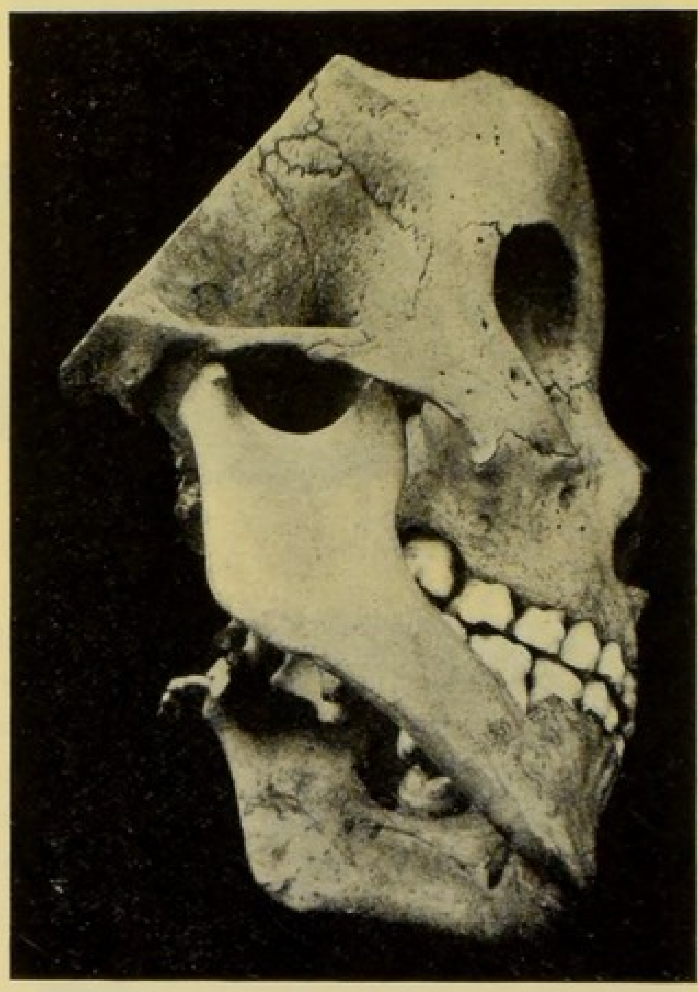


Fig. 385.

Treatment

Where the irregularity is limited to the dental arches the mandibular incisors may be brought into correct position by mechanical means. A plate capping the mandibular premolars and molars, with a half-round gold wire impinging on the labial surfaces of the protruding teeth will usually suffice.

If the protrusion is due to constant thrusting forward of the mandible, the child must be broken of the habit and a skull and chin cap, similar to that shown in fig. 386, worn day and night. Cases of this type are curable.

In cases due to faulty growth of the jaw, the treatment adopted must depend in a very great measure upon the cause and extent of the deformity.

FIG. 386.[1]

In those cases where the fault is traceable to the maxilla and where the irregularity is slight, an expansion of the upper arch will often result in a considerable improvement and at times a complete correction of the irregularity. Where the irregularity is more marked it is desirable that, in addition to expanding the upper arch, an endeavour should be made to reduce the arch of the lower teeth by the extraction of an incisor or the first pre-molars. By this treatment it is often possible to make the arch of the maxillary teeth pass beyond that of the mandibular teeth, and some slight improvement in the expression may be gained, but too frequently the treatment causes a complete disorganization of the articulation between the teeth. Still further, the superior teeth even though they may be in a plane anterior to the inferior,

[1] From " Malocclusion of the Teeth," by E. H. Angle.

do not overlap, the result being that a retention plate must be worn for a prolonged period to keep them in position.

The models given in figs. 387 and 388 show a fair example of a case in which an improvement may be obtained by the treatment being directed to both the upper and lower teeth. The patient was aged 18 when first seen, and had had the left lower premolar removed in addition to the first permanent molars. In the lower teeth the arch was reduced by the extraction of the

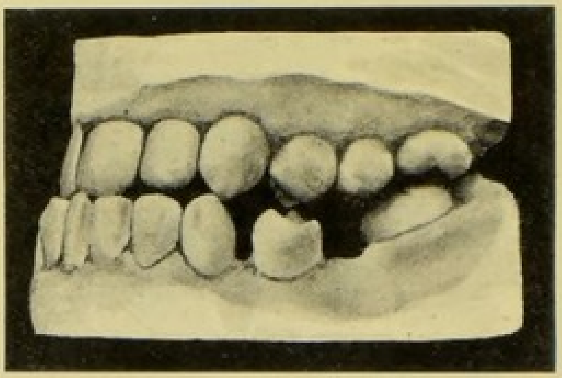


Fig. 387.

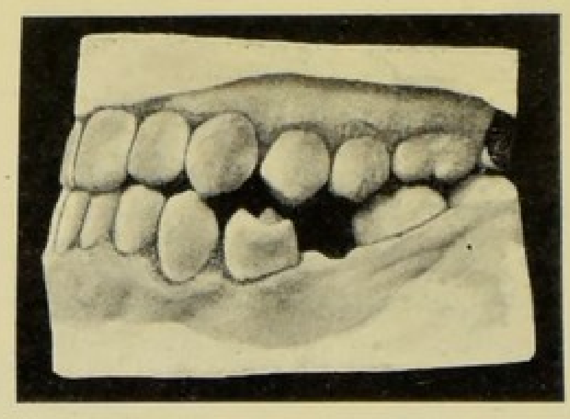


Fig. 388.

left central incisor, and, in the upper, increased by expansion. The result is shown in fig. 388. There was a distinct improvement in the personal appearance.

The case, the models of which are shown in fig. 389, will help to illustrate one or two points in treatment. The patient was a girl, aged 14. It will be seen that in complete occlusion there is a good deal of protrusion. In the mandible the first molars

have been removed, and in the maxilla the left upper first premolar has been removed to make room for the canine which erupted external to the arch. The superior and inferior premolars fail to occlude, the result being that the whole process of mastication has to be carried on by the molar teeth.

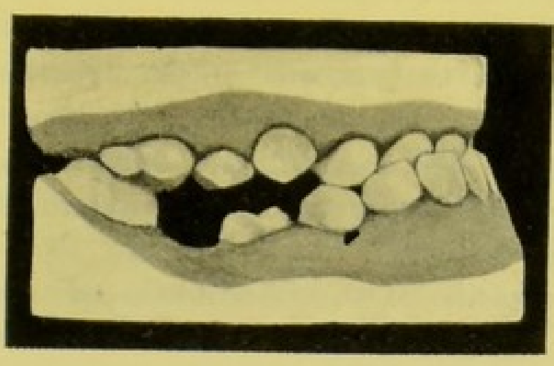


Fig. 389.

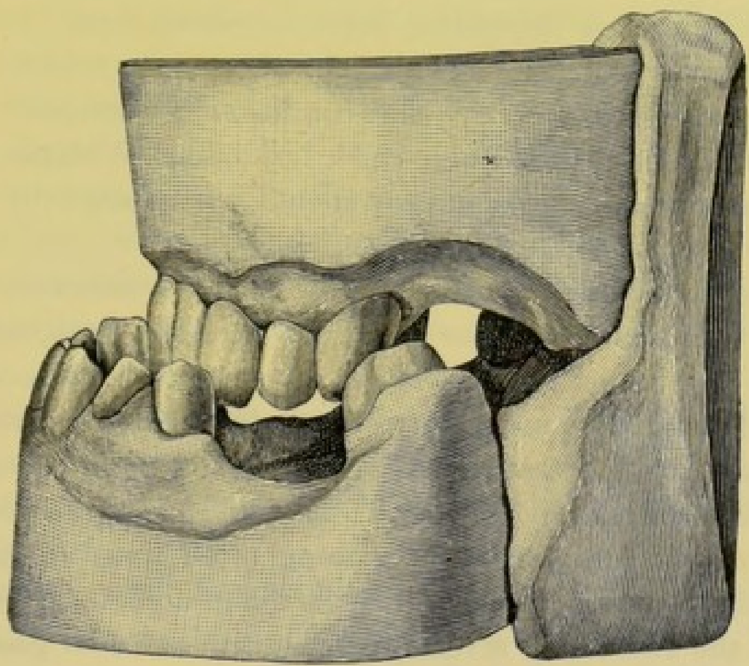


Fig. 390.

On examining the patient, it was at once noticed that the mouth was kept slightly open, the lower incisors being brought into contact with the upper. The patient stated that this position was the most comfortable, and that, during mastication, she constantly suffered from discomfort in the region of the articulation. An examination of the articulation with the teeth in occlusion,

as shown in fig. 389, demonstrated that the condyle was brought forward, and was not resting in its normal position in the glenoid cavity. The protrusion was thus to a great extent artificial, and a fair result could therefore be anticipated with proper treatment.

The lines on which treatment in such a case should be carried out are as follows: The anterior superior teeth should be brought forward and a biting apparatus inserted on the lower.

In such cases as that shown in fig. 390 the deformity is greatly exaggerated by the loss of the posterior teeth. The insertion of artificial dentures will not only assist in restoring the masticating area, but, if the bite is raised, will hide the deformity to some extent.

When the protrusion of the mandible is so marked that the upper teeth bite completely within the arch of the lower, some steps should be taken to procure a masticating area. This may be effected by the insertion of dentures, the exact plan to be followed in each case depending upon circumstances. In severe types of inferior protrusion, similar to those just referred to, it might be possible to improve the condition by surgical means. In the *Dental Cosmos* for July, 1898, Dr. James Whipple reports a case where considerable improvement was effected by double resection of the mandible.

In considering the advisability of adopting resection of the mandible, the pros and cons must be carefully weighed. Resection of the mandible is always an operation attended by considerable risk, and moreover, even if the resected parts unite, the occlusion of the teeth is very likely to be so defective as to necessitate the use of dentures. It would therefore seem that by resection we cannot rely on gaining more than an improvement in appearance. Whether it is justifiable to submit the patient to the risks of a severe operation in order to gain some, perhaps, improvement in personal appearance is a doubtful question.

When it is necessary to obtain a masticating surface, the better plan would certainly seem to be to disregard the question of appearance and treat the case by the insertion of dentures. In one case under my care (a young girl) the question of resection was carefully considered, and the method suggested was the resection of the mandible in the median line in preference to

resection on either side. Treatment on these lines would be attended with less risk than bilateral section.

Cross Bite.—Cases in which there is unilateral protrusion of lower teeth, a condition familiarly known as "cross bite," may conveniently be included in this section. This irregularity may be traced to habit, or may arise from a defective growth of the maxillæ, the "cross bite" being acquired by the child in its efforts to obtain an occlusion of the premolars and molars.

When the irregularity is due to habit, an apparatus may be contrived to counteract the habit and so restore the normal occlusion. Where, however, the "cross bite" arises from want of proper growth of the maxilla, an improvement may be obtained by an expansion of the upper arch.

(C) LACK OF OCCLUSION—"OPEN BITE"

This term is applied to that abnormality in which the back teeth alone occlude when the mouth is closed, the remaining teeth being separated by an interval.

From a clinical point of view "open bite" may be considered under three groups :—

(1) Cases where the premolars and the molars occlude, but the cutting edges of the upper and lower anterior teeth are separated from one another by a space more or less oval in shape.

(2) Cases where the majority of the posterior teeth, as well as the anterior teeth, fail to occlude.

(3) Cases of partial lack of occlusion in the premolar and molar regions.

Etiology and Pathology.—In group (1) the deformity is invariably the result of an acquired habit, such as thumb- or finger-sucking, the thumb or finger being bent and inserted horizontally between the cutting edges of the upper and lower teeth. The pressure thus exerted forces the superior teeth, as well as the alveolar process, in a direction upwards and slightly outwards. The lower teeth are forced downwards, but the displacement is far less marked than in the upper.

Cases included under group (2) vary greatly in the degree of their severity, so that while in some cases the irregularity

may merely consist of a slight separation between the teeth, in others it may extend to the condition shown in fig. 394. This type of "open bite" is invariably accompanied by a marked narrowing in the region of the premolars and molars. In twenty-four measurements taken, the figures were 30·56 mm. between the first molars and 21·35 mm. between the first premolars. Compared with normal breast-fed children, the width across the molars and premolars is 100 : 88·4 and

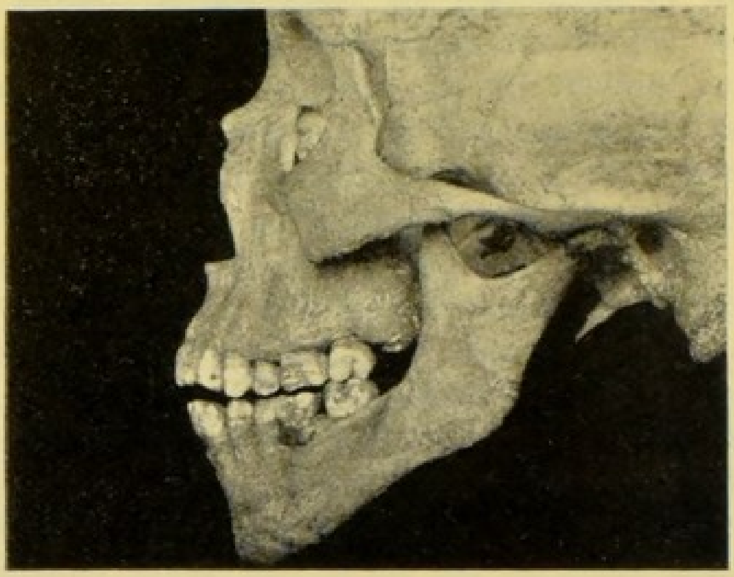


Fig. 391.[1]

100 : 80·7 respectively. The occlusion of the teeth is not so abnormal as in superior protrusion, only a small percentage showing the "too forward occlusion." Hypoplastic teeth are invariably present, the condition often being very marked, and there is almost always a history of long-standing adenoids. The maxilla is defectively developed, the arch in the region of the molars and premolars being often within that of the mandibular teeth. In one section of the cases the opening increases progressively from behind forward; in another section, there seems to be marked bending down of the lower arch in the region of the first mandibular molar; while in a third group the mal-occlusion is considerably accentuated in front by an upward curvature of

[1] From a photograph by Dr. J. E. Grevers.

the maxillary incisors; and a fourth group is found to combine the defects of groups 2 and 3. Unfortunately, morbid anatomy specimens of "open bite" are rare. In fig. 391 are illustrated certain points noticeable in many cases, namely, an unusual growth of the anterior part of the mandible, a short sloping ascending ramus, and a marked bending of the mandible at a point near the spot where the facial artery crosses the bone. The pathology of the condition is obscure. Dr. Sim Wallace[1] is of the opinion that owing to disuse there is insufficient development of the muscles during the growth of the jaw, and this leads to a diminished deposition of bone on the lower border of the jaw, and the posterior margin of the ascending ramus in the region of the angle; in other words, there is a failure in the growth of the ascending ramus. H. Schmidt, as quoted by H. Baldwin,[2] considers that when the mouth is held open, as in marked nasal obstruction, the tongue is held down to the floor of the mouth and the tongue's tip is pressed against the front part of the lower jaw and teeth, exerting a downward and forward pressure. This pressure, operating on yielding bone, causes the alteration of the angle and so produces the deformity.

The constant presence of adenoids, and the association of the condition with hypoplastic teeth, which must be regarded as a sign of previous rickets, suggest that "open bite" is due to the ill-effects of adenoids plus rickets. We know that the weight of the cheeks tends to narrow the jaw, and if this weight is acting on easily pliable bones the effect will be accentuated. This will account for the marked narrowing of the arch. In severe cases, the mandible takes a marked bend downwards, near the anterior border of the masseter; and this condition is probably due to a bending of the bones caused by the downward pull of the muscles which open the mandible, counteracted by the elevators of the mandible. The upward displacement of the maxillary incisors is probably due to the action of the comforter or the teat of the bottle on bones softened by rickets. In other words, the agencies which produce general crowding and protrusion, when combined with rickets, produce grosser lesions, which show themselves in the form of "open bite."

[1] "The Irregularities of the Teeth," p. 40.
[2] *Dental Record*, vol. ix, p. 147.

The cause of **partial lack of occlusion** in the premolar and molar region is often obscure. In a few cases, faulty extraction seems responsible for the condition.

Treatment

It is impossible to lay down any hard-and-fast rules for the treatment of "open bite," as each case must of necessity be considered on its merits.

Class (1), namely, **cases where the deformity is limited to the anterior teeth.** In cases seen at an early age, before the eruption of the permanent teeth, much may be done by breaking the patients of any vicious habits they may have acquired, and, with the eruption of the permanent teeth, the condition will be improved to some extent. When the habit of thumb-sucking, &c., has been continued during the eruption of the second dentition, or

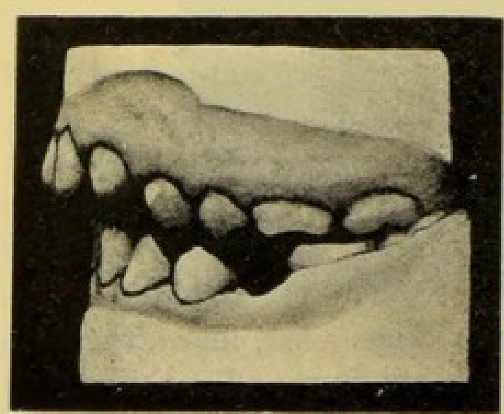


Fig. 392.

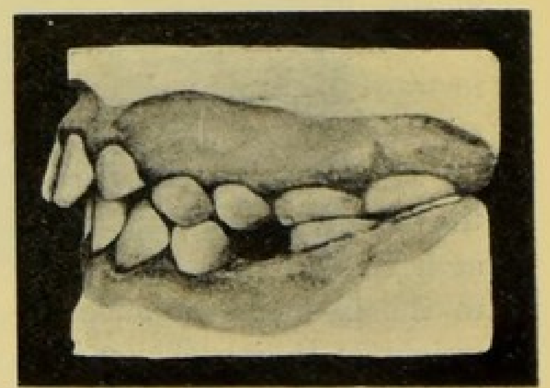


Fig. 393.

when the deformity is severe, treatment is of little avail. But it should be remembered that, although the appearance of the patient is a little unsightly, the premolars and molars articulate, and the posterior teeth can, therefore, perform their function of mastication perfectly well. In these circumstances, it is generally better not to interfere, although, where the personal appearance is of great importance, the crowning of the upper six anterior teeth might be deemed advisable. In a very severe case crowning would hardly be practicable, and it would be preferable to remove the anterior teeth and insert a denture.

Class (2), namely, **where the majority of the posterior teeth fail to occlude.** A considerable improvement may be made in

many cases by cutting in the bite. This method is extremely satisfactory, and may be used alone or in combination with either extraction or the skull and chin cap. The treatment consists in grinding down the teeth until the premolars and molars articulate. This operation might with advantage be more

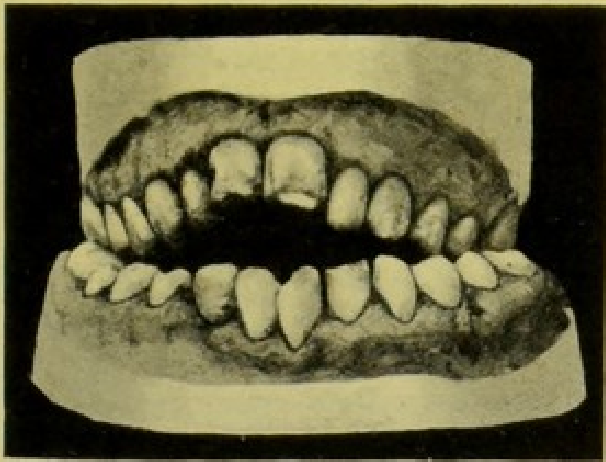


Fig. 394.

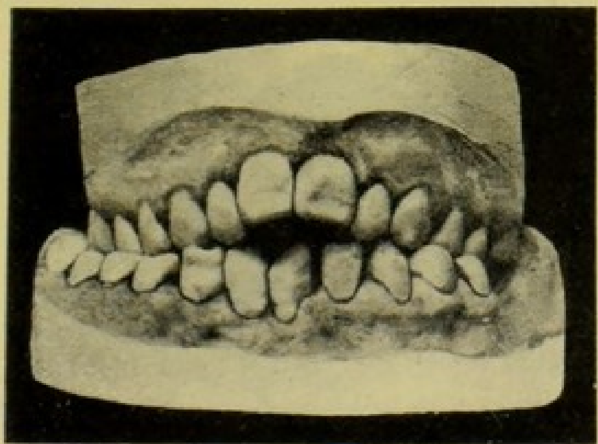


Fig. 395.

generally adopted. The points in its favour are: (1) It gives the patient a good surface for mastication; (2) it is permanent—teeth forced down by the skull and chin cap tend to rise again as soon as the apparatus is discarded; (3) it relieves the patient of a long and tedious course of treatment.

The operation should extend over several sittings, and a fair interval should be allowed to elapse between each. In the case shown in figs. 392 and 393, the treatment was spread over the

period of one year. The object of leaving an interval between each sitting is that the pulp has time to react to injury caused by the operation, and the secondary dentine thus formed allows a greater portion of tooth structure to be eventually removed. The patients should be directed to apply spirits of wine to the cut surfaces twice a day, and the necessity of thoroughly drying the surfaces and keeping them free from saliva for about a minute after the spirit has been applied should be impressed on them. By this means, the cut surfaces of the dentine are hardened to some extent and any sensitiveness that may exist is diminished. It is also a good plan, after each sitting, to apply nitrate of silver to the cut surfaces.

Another case treated by cutting in the bite is shown in figs. 394 and 395.

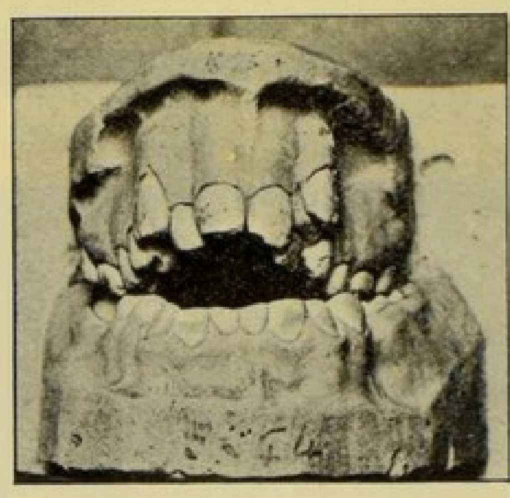


Fig. 396.—Patient, aged 21. Breast- and hand-fed fifteen months. Neave's food. Tube feeding bottle used. Adenoids present, not treated. Teeth hypoplastic. History of rickets; no history of use of comforter or thumb-sucking.

In patients where the deformity is only slight, an attempt may be made to correct the condition by the use of the skull and chin cap. If this treatment is to succeed, the apparatus must be constantly worn and the elastic bands stretching between the chin and skull caps arranged so as to exert pressure in an upward and not a backward direction.

In the majority of cases, the removal of teeth will be necessary. The extraction of the second molars may suffice to remedy

some examples, but unfortunately the first molars are generally unsavable, and in these circumstances the removal of the second molars is hardly justifiable. Under such conditions, the following course of treatment will often yield satisfactory results. The

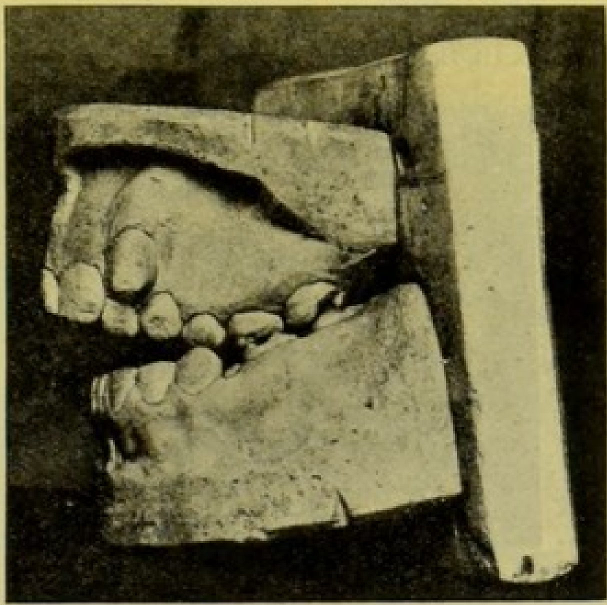


Fig. 397.

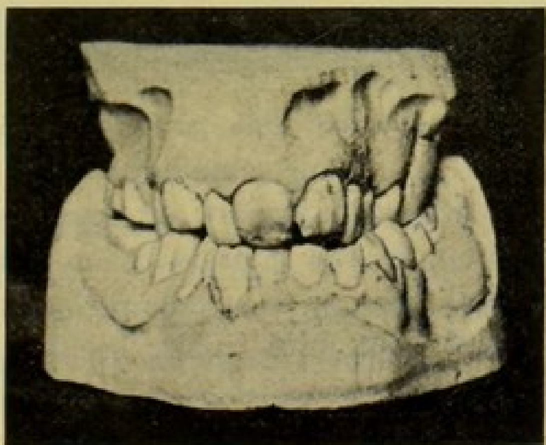


Fig. 398.

first molars are removed and a skull and chin cap used for a period of from six months to one year. If the occlusion is then still open, the operation of "cutting in the bite" may be resorted to. In those cases where the arch of the maxillary teeth is

contracted, the occlusion may often be improved by tilting the molars and premolars outwards.

In severe forms, such as that shown in figs. 396 and 397 extensive extraction must be resorted to, followed by the insertion of dentures.

In this case $\begin{array}{r|l} 7\,6\,5 & 3\,4\,5\,6\,7 \\ \hline 8\,7\,5\,4 & 5\,6\,7 \end{array}$ were removed and dentures adapted with the result seen in figs. 398 and 399.

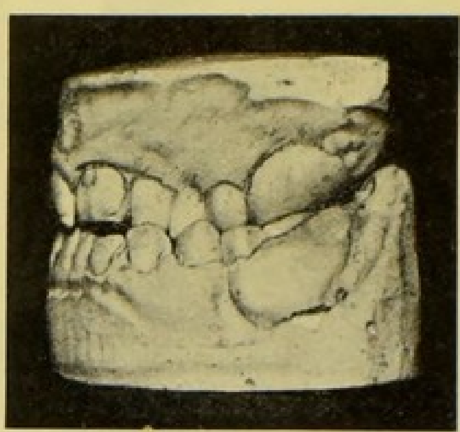


Fig. 399.

Some practitioners, in treating "open bite" cases, adopt the plan of shortening the molar region and lengthening the incisors, canines and premolars, but such treatment cannot be relied on to give permanently good results. In connection with such treatment, it must be remembered that patients with "open bite" invariably have gingivitis of long standing. The multiplicity of bands and ligatures required to carry out this treatment cannot fail to add considerably to the gum lesion and it is more than probable that they will give rise to serious periodontal disease.

Cases of "partial open bite" must be dealt with by some form of mechanical appliance if it is considered expedient to treat them.

Abnormalities of the Teeth associated with Congenital Defects of the Jaw

This class of irregularities forms a small but well-defined group.

(i) **Associated with Arrest in Development of the Mandible.**—A partial arrest in the development of the mandible may

occur. The effect of the malformation on the dental arches will be to draw the teeth towards the affected side and at the same time cause the lower incisors to pass well behind the upper teeth, with the result that the lower lip will fail to cover the upper teeth and a marked protrusion of these teeth will follow. In

FIG. 400.

treating such irregularities, little can be done beyond reducing the upper arch and retracting the incisors.

(ii.) **Hare Lip.**—In cases of hare lip, in which the suture in the incisor region is involved, considerable irregularity of the incisors frequently follows. Great caution should be exercised in attempting the correction of these irregularities. The roots of the incisors are often malformed, and, if treatment from an æsthetic point of view is necessary, the extraction of the teeth and the insertion of a denture is usually the wisest course to pursue.

(iii.) **Cleft Palate.**—In cases of cleft palate involving the incisor region, the incisor teeth on the affected side invariably erupt in irregular positions.

A rare form of irregularity is shown in fig. 400. In this case the portions of the arch have become displaced, the larger portion overlapping the lesser.

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CHAPTER X.

Bacteriology of the Mouth

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(A) GENERAL CONSIDERATIONS

THE science of Bacteriology has developed during the last few years with rapidity, and it is therefore necessary in any book dealing with dental surgery to embrace some consideration of the Bacteriology relating to the flora of the upper air-passages, and especially to the organisms which may be met with in the mouth.

Bacteria are the lowest form of plant life, and are termed the Schizomyces or Fission Fungi. Their development is by binary fission, and the cycle of development at optimum temperatures and environment results in the production of two individuals from one in about half an hour. This enormous rate of development becomes checked by the products elaborated by the growth of the bacteria themselves; accumulation of waste products and the exhaustion of the nutrient substratum bringing development to standstill in about forty-eight hours.

Bacteria are divided into three main groups according to their morphology or shape :—

(*a*) *Cocci :* organisms round or pear-shaped in form, and being not more than twice as long as they are broad.

(*b*) *Bacilli :* rod-shaped, and filamentous forms, being more than twice as long as they are broad.

(*c*) *Spirilla :* being curved and twisted, and spiral in form.

Bacteria may be again divided into two main groups :—

(1) Those which produce disease, or **Pathogenic Bacteria.**

(2) Those which, although at times associated with the pathogenic organisms, are not of themselves capable directly of pro-

ducing disease, and are known as Saprophytes, or **Saprophytic Bacteria.**

Amongst the former may be stated as examples those bacteria producing suppuration ; and amongst the latter, a number of the bacteria concerned in dental caries. Further, both the pathogenic and non-pathogenic organisms are often again subdivided according to their ability to develop in the presence of free oxygen into **aerobic**, or in the absence of free oxygen into **anaerobic** organisms. All aerobic organisms require oxygen in the free state as it is present in air, or as air dissolved in water, whereas the anaerobic organisms are able to obtain their necessary oxygen by splitting up the foodstuffs with which they are in contact. In some instances the organism will only grow when free oxygen is rigorously excluded ; such organisms are termed **Obligatory Anaerobes**, and as an example *Bacillus tetanus* may be cited.

A considerable number of higher fungi also come into the domain of Bacteriology, particularly in Pathological Bacteriology, as for example the streptothricæ, *e.g.*, *Streptothrix actinomyces*, and the *Streptothrix madura*. Certain moulds and yeasts are also occasionally met with in pathological lesions, *e.g.*, *Saccharomyces neoformans*, *Saccharomyces albicans*.

To separate bacteria one from another, the bacteriologist makes use of what are known as artificial culture media, to facilitate the recognition of the various species and varieties of species which may be co-existent in pathological fluids or in infected tissues. Such artificial culture media are compounded to resemble, as far as possible, the composition and reaction of the natural habitat of individual organisms.

In the present chapter no attempt is made to describe the methods and appliances of practical bacteriological work, and for details of laboratory work the student is referred to the author's text-book on the subject ("Mycology of the Mouth").

Before entering upon a more detailed consideration of the mouth bacteria proper, it is necessary to call to mind some of the general bacteriological facts underlying present surgical methods.

Spores.—Certain bacteria of the class Bacilli produce towards the end of their existence round or spherical bodies termed spores. These spores are highly resistant to the usual methods of destroying bacteria ; many spores will even withstand boiling, and most

will resist the action of antiseptics for a considerable time. Whereas the vegetative forms, or forms from which the spore is produced, or the ordinary bacteria in non-sporing varieties, are much less resistant to both heat and the action of antiseptics.

The thermal death-point of the majority of bacteria in the vegetative form is below 70° C. for half an hour, whilst the majority of spores not only withstand this temperature, but will, as in the case of the *B. mesentericus*, withstand boiling for an hour.

Spore formation, then, is a question of supreme importance to the surgeon; for should sporulating organisms require destruction either by heat or by antiseptics, stronger solutions must be used, or a greater degree of heat applied. The two commonest diseases caused by spore-forming bacteria are tetanus and anthrax.

Antiseptics or disinfectants are chemical compounds which when applied to the solution in which the bacteria are suspended prevent their growth or produce their death; but it is important to note that in the practical use of disinfectants the action of a too strong disinfectant solution upon the normal cells of the body may actually predispose to the inroads of the bacteria it is used to destroy, the corrosive action on the tissues destroying the outer layer of cells and producing fresh pabulum for the infecting organisms. For use upon living tissue antiseptics must be selected which possess the maximum inhibitory power against bacteria, and the minimum action upon the body tissues.

It is perhaps hardly necessary to point out that dental instruments in no way differ from other surgical instruments in the necessity for sterilization. Wherever possible boiling for three or four minutes is the best method of sterilizing. When instruments are to be sterilized by boiling a few grains of bicarbonate of soda should be added to the water in the sterilizer, as this prevents rusting. In the case, however, of some of the finer dental instruments, sterilization is impracticable in this way, whilst the soaking in antiseptic fluids tends to destroy the cutting properties of such instruments as burrs, drills, &c. For these fine instruments alcohol is an efficient method of sterilization, providing the instruments be left in it for a considerable time. Burrs and other drills may advantageously have the alcohol burnt off before use, and such a procedure does not impair the

temper of the steel. This method will not sterilize adherent masses of decayed dentine; all *débris* therefore requires to be removed from the instruments before they are placed in the alcohol. Other fine instruments may be boiled, if necessary, in oil or glycerine.

Various disinfectants are in use, and amongst these for the general purposes of the dental surgeon the three following are perhaps the best :—

Carbolic acid	1 in 100
Lysol	1 in 200
Formalin	1 in 2,000

Although the mercuric compounds such as mercuric chloride and mercuric iodide are exceedingly efficient antiseptics, they are both inclined to attack plated instruments, or to damage the finer surfaces of unplated steel instruments, and should be avoided.

The dental instruments which require the most scrupulous sterilization are all instruments which are likely to be used in making wounds in the soft tissue of the mouth; such, for instance, as dental forceps, elevators, and scaling instruments, &c., and on no occasion whatever should any scaling instrument —or for that matter, any dental instrument at all—be used for a second operation before it has been efficiently sterilized.

It may be thought that too much stress is here laid upon the sterilization of dental instruments, but as a rule sterilization of instruments, so far as the dental student is concerned, is not thoroughly understood.

Certain general considerations affect the flora of the mouth. Persons engaged in the care of infectious diseases often have in their mouths those organisms peculiarly associated with some special disease; for instance, nurses in consumption hospitals often harbour tubercle bacilli, and persons attending diphtheria patients frequently have diphtheria bacilli present in their mouths. About 33 per cent. of children exposed to diphtheria infection are found to possess diphtheria bacilli in their throats or mouths, notwithstanding that they show no signs of serious disease.

These pathogenic organisms living in the mouths of persons not suffering from the disease have been called by Hueppe **œcoparasites.** In some trades, such as milling and brewing, members

of the saccharomyces group are to be found in the workers' mouths. In persons with diseased conditions of the gums a very large number of organisms are to be found in the buccal mucus; some are pathogenic, others are non-pathogenic, but possess the power of becoming pathogenic under suitable stimuli; others, again, are merely saprophytes, and have no pathogenic significance. The pathogenic organisms of the mouth will be dealt with first.

(B) THE PATHOGENIC BACTERIA OF THE MOUTH

(1) The Pathogenic Cocci

The following pathogenic cocci may be found in the mouth either associated with a diseased condition, or as œco-parasites.

(*a*) The Streptococci.
(*b*) The Staphylococci.
(*c*) The Pneumococci.
(*d*) The *Micrococcus tetragenus*.
(*e*) The Meningococcus (Weichselbaum).
(*f*) The *Micrococcus catarrhalis*.

(*a*) **Streptococci** :—

(1) *Streptococcus brevis*.—Cocci 0·5 μ in diameter arranged in chains of three or more members, sometimes 100 or more. Single and diplococcal forms are common, and in old cultivations swollen individual elements of the chain appear; such involution forms have been termed arthrospores. Stains by Gram's method.

A streptococcus is found in all mouths, clean or dirty, healthy or unhealthy. It is found not only in the mouth itself, but on the tonsil, pharynx, nasal cavities, Eustachian tube and middle ear.

This streptococcus is the least pathogenic of all the cocci, and so far as my own observations go, both in the experiments performed in conjunction with the late Dr. Washbourn, and in a number of more recent observations, the special *Streptococcus brevis of the mouth has never proved definitely pathogenic*. Andrews and Horder have found a limited number of streptococci of the *brevis* type pathogenic, and Gordon has further noted a few varieties which exhibit pathogenic properties.

This streptococcus is not confined to the mouth, but may be

met with also in the intestine, in the urethra, in the vagina, &c. It occurs also in the mouths of animals, and I have succeeded in obtaining cultivations of the *Streptococcus brevis* from the mouths of monkeys, dogs, cats, guinea-pigs, and rabbits. It is probably one of the most widely spread of all the streptococci.

The diplococcal form of this streptococcus can easily be seen in smears made from the buccal mucus, and stained by means of Leishman's stain. A preparation made in this manner shows a large number of squamous epithelial cells (see fig. 401), around which are massed diplococci oval or pear-shaped, often having the appearance of short bacilli. The identity of this diplococcus with the streptococcus may be proved in the following manner :—

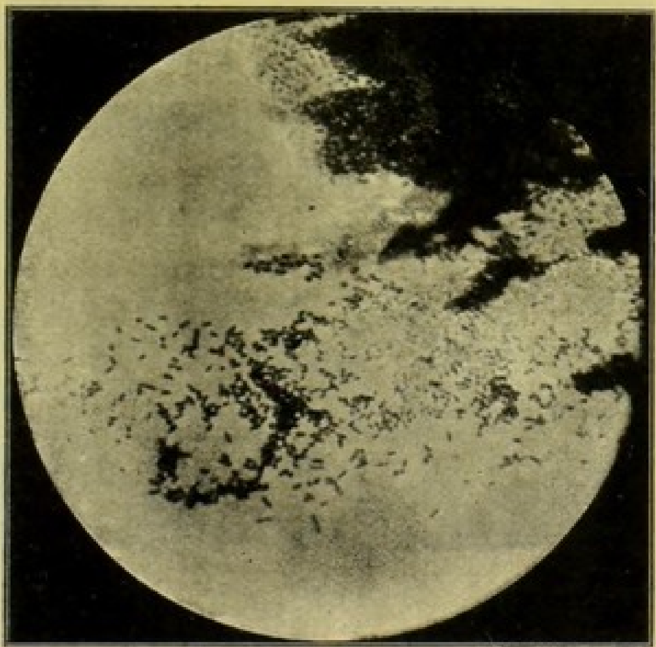

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Fig. 401.—Squamous epithelial cell from mouth surrounded by diplococcal form of *Streptococcus brevis*.

Sterile cover-slips are smeared with melted agar to which a a little saliva containing some epithelial cells has been added. When set the small cover-slip plate is cemented to a hanging drop slide. The preparation is then placed on the stage of the microscope, and an epithelial cell found to which the diplococci are attached. The position of the specimen is marked, and the preparation incubated at 37·5° C. At the end of twenty-four hours the preparation is examined; the diplococci are found to

have developed into streptococci, the chains of which can be easily made out, even with a $\frac{1}{6}$-in. objective, and if necessary a small portion of the colony may be removed with a platinum needle and sub-cultures obtained on an agar surface, when a good growth of streptococci will result.

The colonies of the streptococcus are exceedingly small, and difficult to obtain by the usual methods of plating. The following method adopted by Dr. J. W. Washbourn and myself gives more rapid results.

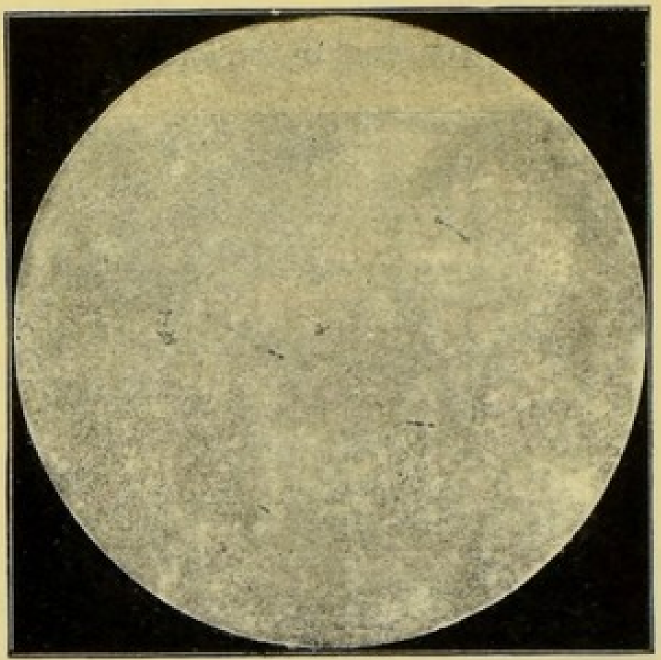

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FIG. 402.—*Streptococcus brevis.* Twenty-four hours' broth cultivation.

Broth cultures are made by adding a loopful of saliva to a tube of nutrient broth. The tube is incubated for eighteen hours, at the end of which time one loopful is transferred on to an agar slant; eighteen or twenty-four hours later a considerable number of small white-grey colonies will be observed, which when transferred to another tube give a pure culture of the mouth streptococcus (fig. 402). Some care must be exercised in selecting the colonies, as other organisms may be present; but there should be no difficulty in recognizing the streptococcal colonies.

This organism rarely grows in the mouth as a definite strepto-

coccus, and if stained preparations of pus from the mouth show the presence of distinct chains of cocci, the probability is that such streptococci are of a pathogenic nature.

(2) *Streptococcus pyogenes* (*longus*).—Cocci about 0·5 μ in diameter, generally arranged in chains of five or more elements, the longest chains growing on liquid media, although the type found in acute septicæmia is often quite a short chain organism. The organism stains by Gram's method, and occasionally a capsule has been described. The cultures of the streptococcus isolated from abscesses or septicæmia are not always pathogenic for laboratory animals. In pus direct the coccus may exist in the form of diplococci, but chains are generally found.

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FIG. 403.—*Streptococcus pyogenes.* Agar culture ; stained Gram.

The pathogenic streptococci most frequently found present in the mouth belong to the types of streptococcus described by Andrews and Horder as *Streptococcus fæcalis* and *Streptococcus angiosus*.

Von Lingelsheim was the first to point out that the streptococcus obtained from the normal mouth differs from the streptococcus found in erysipelas in certain important particulars. It

was not pathogenic for rabbits or mice; it rendered broth uniformly turbid, and the chains on this medium were shorter than those of the *Streptococcus longus*; it caused a slight liquefaction of gelatin. Lingelsheim therefore considered it to be a distinct species and named it the *Streptococcus brevis*, from the shortness of the chains on nutrient broth, giving the name *longus* to the erysipelatous organism. Marmorek, on the other hand, regards all streptococci as simple varieties of the same species, which can all be raised to a uniform type of virulence by appropriate means. Gordon and Andrews and Horder have investigated the reactions of the streptococcus family on a large number of carbohydrate media, and have selected from about forty carbohydrates tested, seven, the chemical reactions of which, together with the morphological form and the ability to grow upon gelatin at room temperature, affords a means of separating the different streptococci into main groups.

Other observers have been inclined to regard this grouping of the streptococci as of too artificial a nature, but as Andrews and Horder point out in their valuable communication, although a large number of the bacteria related to a group show the cultural characters of that group, yet there remain a number of the species in which the cultural characters are not so sharply defined, the groups merging one into the other; but that it is possible, in fact probable, that the cultural characters of the streptococcal group as a whole are not fixed, as are the characters of organisms higher in the botanical scale; further, that the cultural characteristics of a large number of individuals show a tendency to definite grouping. Andrews and Horder quote one particularly interesting case in support of their view. From three individuals admitted to three different wards of St. Bartholomew's Hospital, cultivations of a streptococcus were obtained which agreed in every cultural character. One of the workers in the laboratory had the misfortune also to become infected with a streptococcus, which gave the same cultural characters as the other three. It was found on inquiry that the three infected individuals were all members of the same family, who had been admitted within a short period suffering from the infected condition developed at or about the same time. In this instance, at any rate, recognition of the special variety of streptococcus by means of Gordon's tests was demonstrated.

My own view of the streptococci growing in the mouth is that in all normal mouths the *Streptococcus brevis* is a saprophytic, non-pathogenic variety which has lost any pathogenic characters it may have possessed, and that the pathogenic streptococci found in diseases of the mouth are adventitious forms, and not a mouth streptococcus which has become virulent.

The pathogenicity of the streptococcal group varies within wide limits, and almost every variety of so-called septic disease may be produced by members of the genus. For instance, such widely different affections as an acne pustule, an alveolar abscess, antral suppuration, rheumatoid arthritis, chronic infective endo-carditis, or acute septicæmia and pyæmia, may all be produced by the streptococcus.

Increase of virulence of various bacteria, among which the streptococci may certainly be classed, is sometimes produced by the presence of another infecting organism; thus it has been held that a more acute disease of the throat is produced by a mixed infection of the diphtheria bacillus with the streptococcus, than with the diphtheria bacillus alone; whilst the infectivity of a streptococcus may be definitely increased to a given animal if some other organism, such, for instance, as the *Bacillus pyocyaneus*, is inoculated into the animal at the same time. It is possible that in long-continued diseases of the mouth the association of certain saprophytic bacteria may contribute in raising the virulence of the normal streptococcus of the mouth to such a pitch that it is enabled to infect tissues which under normal circumstances would prove entirely resistant. For practical purposes it is better for the student to regard the streptococcus of the mouth as capable of being raised to a degree of pathogenicity by supplementary causes, than to remain oblivious to the possibilities of streptococcal infection because of the academic question of the identity or non-identity of the streptococcus with the pathogenic forms.

(*b*) **The Staphylococci** :—

Cocci 0·5 to 0·75 μ. In old cultures large and swollen forms grow, and these have been termed arthrospores. Stains by Gram's method and by the usual aniline dyes. The cocci are arranged in clusters of irregular shape, and through their supposed resemblance to bunches of grapes have received the name of

staphylococcus. Capsules are not found. Staphylococci occur in air, in water, and in milk; they are generally found in pathological conditions in pus, but are also found in bone disease, and occasionally in septicæmia, when they are generally associated with the streptococci. In acne pustules, boils, and carbuncles, they are mostly present in pure culture. The *Staphylococcus albus* is generally present on the surface of the skin, and frequently contaminates cultivations when blood is obtained by venesection.

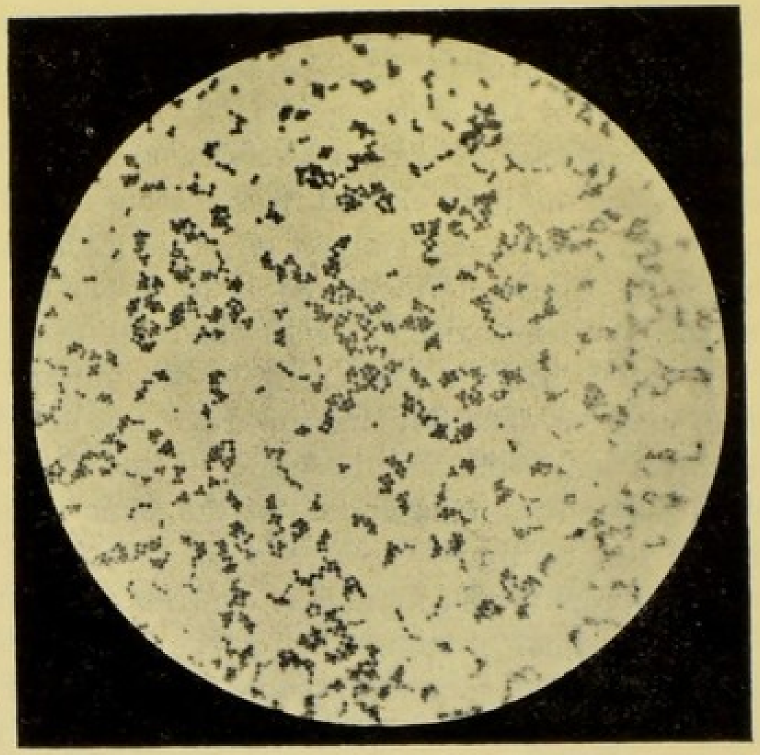

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FIG. 404.—*Staphylococcus aureus.* Twenty-four hours' agar culture from mouth; stained Gram.

The staphylococci group are represented in the mouth by the *S. aureus*, the *S. albus*, the *S. citreus*, and by a staphylococcus (Gram negative) which has been described by Freund as *Staphylococcus citreus granulatus*.

(i.) *Staphylococcus aureus.*—The *S. aureus* is usually the most pathogenic of these four cocci, and is not very frequently present in the mouth, as might be supposed from its common occurrence in mild affections causing pus-formation in other parts of the body.

The staphylococci are more often found in persons who neglect the care of their teeth, than in those who are more careful; in healthy mouths staphylococci are uncommon.

Netter found the *S. aureus* seven times out of 127 persons examined. Vignal and Miller found the *S. aureus* only occasionally. My own researches confirm those of Netter, who found the staphylococcus in about 15 per cent., and I find on referring to notes on the examination of some two thousand mouths, that 12 per cent. of the cases showed the *S. aureus*, and in these cases some pathological lesion was present. The organisms thus obtained were frequently pathogenic for rabbits; inoculation intraperitoneally or intravenously of 1 c.c. of an agar culture emulsified in 10 c.c. sterile broth, producing death in two to four days, usually with abscesses in the cortex of the kidney. The staphylococcus is particularly liable to produce abscesses in this region; moreover, its hæmolytic power is often great, and is of considerable importance where secondary septic anæmia is a symptom.

The *S. aureus* is by no means difficult to identify; it stains by Gram's method and the usual aniline dyes, grows rapidly upon the usual laboratory culture media used, and produces the well-known orange-yellow pigment. There are a number of varieties of the *S. aureus* shading insensibly from one to the other; in fact, the whole of the staphylococcal group, together with the sarcinæ, are classed by Lehmann and Neumann under one group as *Micrococcus pyogenes*. But as this grouping would place certain non-pathogenic forms, such as the sarcinæ, with organisms possessing well-defined pathogenic power, it is not convenient for the purposes of medical bacteriology.

(ii.) *Staphylococcus albus*.—The *S. albus* is more common in the mouth than the *S. aureus*, and an organism related to the *aureus* on the one hand and the *albus* on the other is often found in the saliva, particularly in alveolar osteitis. This staphylococcus does not produce the bright orange pigment common to the *aureus*; at the same time it partakes more of the *albus* in its liquefaction of gelatin.

It has been shown by Eyre and Galloway that the *S. albus*, when grown anaerobically, loses its power of liquefaction of gelatin.

(iii.) *Staphylococcus citreus*.—This staphylococcus is intermediate in its coloration between the *S. aureus* and *S. albus*, and gives a pigment of a brightish lemon-yellow colour. It is exceedingly common in air, but it is not so common in the mouth, though it is to be met with in a few instances. It is as a rule feebly, if at all, pathogenic, and is so closely related to the other two forms of staphylococcus that it only requires a brief mention. It should be stated, however, before leaving the group of staphylococci, that the form of *S. aureus* obtained from the mouth very rarely shows the bright orange pigment commonly referred to the *S. aureus*, but that the colour is, as a rule, of a dry brown, perhaps of a brownish-yellow tinge, and that the colonies, unlike the *S. aureus*, obtainable from pus and other lesions, are often quite minute, scarcely larger than the streptococcus, and somewhat sticky in consistency.

The *S. albus*, on the other hand, conforms much more to the usual type of staphylococcus found in other parts of the body.

(iv.) *Staphylococcus granulatis citreus, of Freund.* — This organism, which is not at all uncommon in the pus of the mouth, and which occasionally when inoculated into animals produces local suppuration, was first described by Freund. It differs from the other three staphylococci in that it is Gram negative, and is important from the fact that the young colonies on the surface of agar closely resemble that of the *Micrococcus catarrhalis*. When grown for some little time, however, and particularly at 22° C., they become a very pronounced lemon colour, sometimes even a bright yellow sulphur colour, but the colonies remain somewhat small and streptococcal in type. The organism as a rule does not occur as a well-marked staphylococcus, but has rather unequal cocci often isolated and in pairs, and shows a considerable amount of irregularity in size and arrangement of its groups. It fails to retain the stain by Gram's method, and produces no reaction on glucose, lactose, cane-sugar, and manitol, and may certainly therefore be regarded as a distinct species.

Speaking generally, I have observed that the staphylococci which are the most pathogenic in the mouth are those which ferment carbohydrates energetically, which produce rapid liquefaction of gelatin, which produce hæmolysis of red blood corpuscles,

and which reduce glucose neutral-red broth, and reduce nitrates to nitrites.

(*c*) **The Pneumococci:—**

The *Pneumococcus* or *Streptococcus pneumoniæ* is another variety of the pathogenic cocci which is by no means infrequently met with in the human mouth, even in the saliva of healthy persons—not, it is true, always in a condition of great virulence, but, as has been shown by Dr. Eyre and the late Dr. J. W. Washbourn, the virulence of a pneumococcus obtained from the saliva may be raised to a very high pitch of virulence by means of passage through animals (rabbits). A pneumococcus isolated from saliva required the passage through the bodies of fifty-three animals before it could be brought to the same standard of virulence as that of another race of pneumococci obtained from a fatal case of pneumonia obtained after passage through only eight rabbits.

Netter found the pneumococcus present in 15 per cent. of healthy individuals; Wolf, Claxton, Frankel, and Eyre have constantly noted the pneumococcus present in healthy mouths, often in a fully virulent condition.

The presence of the pneumococcus in saliva may best be determined by the inoculation of a mouse. A small amount of saliva or pus is injected under the skin of the back; pneumococci, if present, rapidly cause the death of the animal; cocci showing the characteristic capsules are to be found in the heart blood.

An organism closely related to the pneumococcus, and probably merely a variety, is the *S. mucosis capsulatus*. For further reference to this organism the student is referred to the original literature.

The *Pneumococcus* or *Diplococcus lanceolatus*, are cocci pyriform in shape; they exist in the animal body as diplococci arranged with their largest diameters in apposition, and surrounded by a gelatinous capsule which stains by means of acetic acid and carbol-fuchsin or MacConkey's capsule stain. The cocci themselves retain the stain by Gram's method.

Although generally occurring as a diplococcus, the organism may show streptococcal forms, and on broth and other liquid media usually takes a streptococcal form. The cocci are about

·7 μ wide in their largest diameter, but are frequently less. Inoculation of animals, rabbits or guinea-pigs produces gelatinous exudations at the site of inoculation when inoculation is performed subcutaneously. The cocci are found in the blood-stream, where the diplococcal capsulated form is usual. Capsules are not formed on most artificial media, but on the serum water of Hiss, and occasionally on gelatin cultures grown at blood temperature well-marked capsules are found.

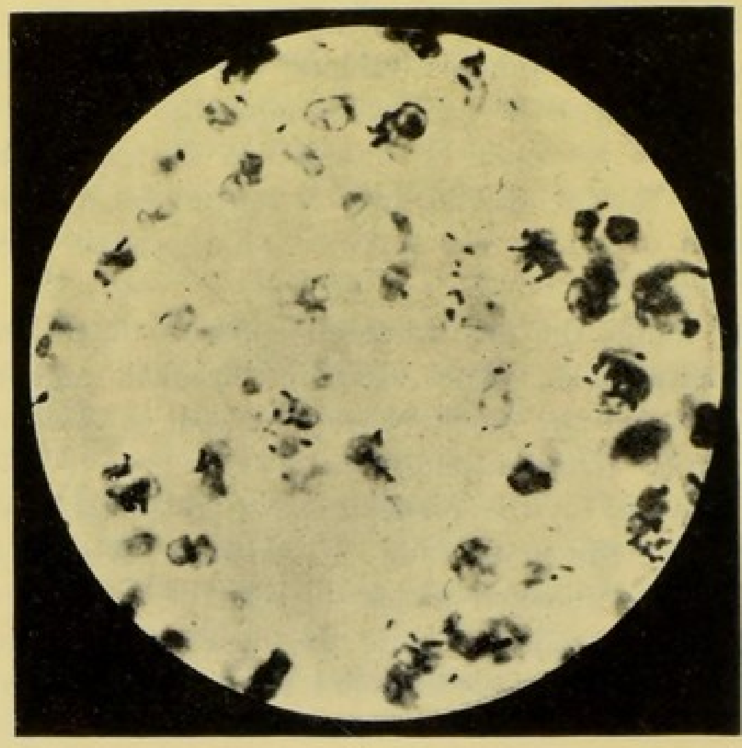

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FIG. 405.—Pneumococcus in lung tissue. Stained Gram.

The colonies of the pneumococcus closely resemble those of the streptococcus on agar, but in the most typical form the so-called "ring" colony is found. The ring form is best seen with transmitted light and a small hand-lens, the central portion of the colony being separated from the circumference by an annular transparent area.

The pneumococcus, like its nearest relative, the streptococcus, is found as the cause of many widely divergent pathological lesions; pneumococcal sore throat and pneumococcic gastritis are not uncommon; meningitis, pyæmia, as well as classical pneu-

monia, are caused by the pneumococcus. It is probable that residence in the mouths of persons subjects of gum disease may tend to increase the virulence of the organism, and in a certain percentage of cases the opsonic index of the blood of individuals suffering from pyorrhœa alveolaris shows deviations from the normal towards the pneumococcus.

(*d*) **The Micrococcus tetragenus :—**

The *Micrococcus tetragenus*, described first by Gaffky and Koch, was found first in association with the tubercle bacillus in pulmonary phthisis in cavities of the lung, also at times in bronchitis,

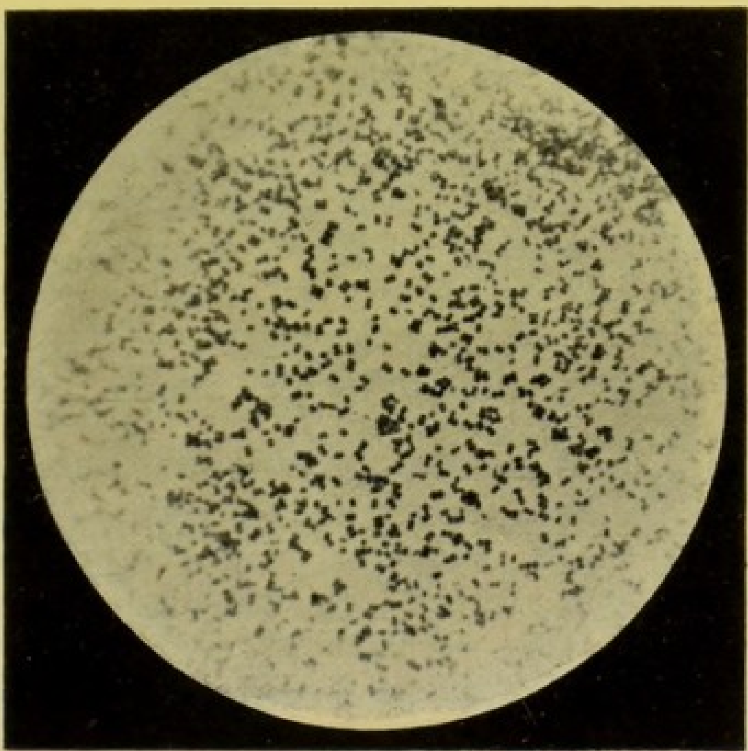

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FIG. 406.—*Micrococcus catarrhalis*, from mouth. Twenty-four hours' old ascitic agar culture ; stained aniline gentian violet.

bronchiectasis, and in bronchial catarrhs. It is not often present in the mouth, but may be sometimes found when saliva has been injected into mice for the determination of the pneumococcus.

The organism exists in its typical form of tetracocci in the blood of infected animals, the cocci being arranged in regular tetrads surrounded by an albuminous capsule. The organism is Gram positive.

It is not uncommonly associated with many other organisms in the pus oozing from the gums in chronic diseases of the alveolar processes. I have also found the *M. tetragenus* in the pus of dento-alveolar abscesses, sometimes in pure culture, at other times in conjunction with one or other of the mouth bacteria.

e) **The Meningococcus and (*f*) the Micrococcus catarrhalis :—**

The *Meningococcus or Diplococcus intracellularis* (Weichselbaum) and the *Micrococcus catarrhalis* belong to the group of cocci which do not stain by Gram's method, and to this group also belongs the *gonococcus*.

The *meningococcus*, the cause of cerebro-spinal meningitis, and the *M. catarrhalis* (which is now generally regarded as closely associated with coryza or common cold) may be found present in the mouth as small diplococci generally in pairs, closely resembling the pneumococcus, but not retaining the stain by Gram's method. In the cerebrospinal fluid the cocci are to be found in the cells, and closely resemble the gonococcus. The coccus sometimes occurs in tetrads and short chains, the base of the coccus slightly concave on the side, opposite to its fellow.

The *Diplococcus intracellularis* is not common, but has been found; but the *M. catarrhalis* is often present along the gum margins in the early or catarrhal form of periodontal disease. It grows with difficulty on the ordinary media, but better upon nutrose agar, to which normal serum has been added. The organism is large, irregular in shape, and occurs as isolated cocci, diplococci, or even irregular masses closely simulating the staphylococcus. Its growth upon agar is easily differentiated from most other cocci, being of a slightly slimy consistence, and growing but sparsely upon ordinary media.

The *M. catarrhalis*, when inoculated into animals, produces very little pathogenic lesion; on the other hand, inoculation of killed cultures into man for therapeutic reasons in the cure of susceptibility to "colds" has produced all the leading symptoms of acute coryza, headache, sneezing, and discharge of mucus from the nose, which make up the ordinary symptoms of "a cold in the head." I have myself often observed these symptoms in persons who have been injected with the *M. catarrhalis*

isolated from their own gum margins, but who were not at the time suffering from a cold.

(2) The Pathogenic Bacilli

(*a*) *B. diphtheriæ.*
(*b*) *B. tuberculosis.*
(*c*) *B. lepra.*
(*d*) The *Spirochæta pallida.*
(*e*) *B. pyocaneus.*
(*f*) *B. friedlander.*
(*g*) The Influenza bacillus.

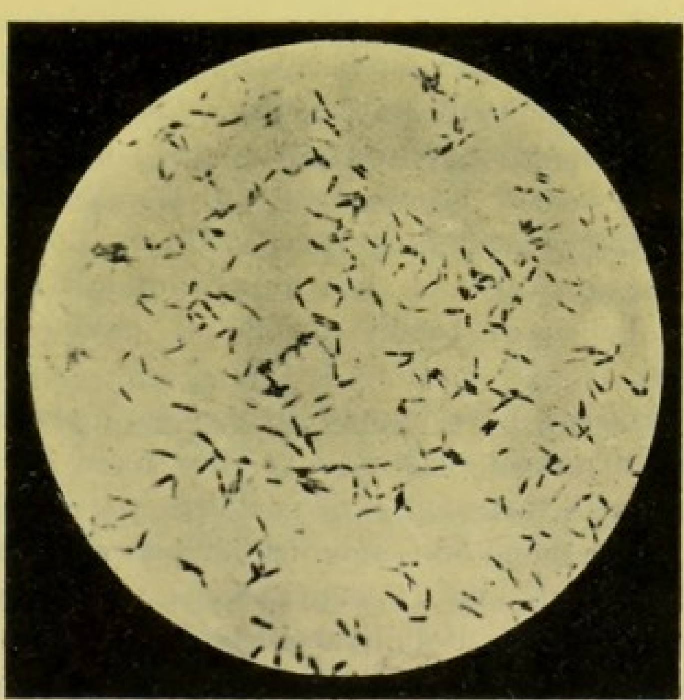

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FIG. 407.—*Bacillus diphtheriæ.* Twenty-four hour blood serum; stained Gram.

(*a*) The Bacillus diphtheriæ (*Klebs-Loeffler bacillus*).

The *Bacillus diphtheriæ*, or Klebs-Loeffler bacillus, is frequently met with in the mouths of healthy individuals, sometimes possessing a high degree of virulence. The *B. diphtheriæ* is a non-motile, rod-shaped bacillus 1·5 to 6 μ in length, often wedge-shaped, the two bacilli being united at the bases, and the distal end drawn out to a fine point. The bacilli often stain irregularly, and give a beaded or barred appearance, more particularly in the older cultures. The rods are either straight or curved. The

bacilli may be found arranged in masses like the portions of a paling (palisade arrangement). The ends of the bacilli are often swollen and thickened, forming the well-known club-shaped bodies. Spore formation does not occur. The organism stains by means of Gram's stain and by methylene blue; polychromatic granules are frequently seen. By Neisser's stain (acid methylene blue followed by Bismarck brown) the protoplasm stains irregularly; blue granules appear in the thread, three or more in number. Varieties of the diphtheria bacillus exist, the commonest being a short variety which stains uniformly with the ordinary dyes, and rarely shows the Neisser reaction. Several organisms are closely related to the diphtheria bacillus in morphological form, the nearest being the Hoffmann bacillus, which almost exactly resembles the short diphtheria bacillus. The Xerosis bacillus is another organism closely resembling the diphtheria bacillus. The *Bacillus coryza segmentosus*, or *Bacilli septus*, and a number of other pseudo-diphtheria bacilli or diphtheroid bacilli exist, but so far none of these organisms has been converted into true diphtheria bacilli capable of producing the diphtheria toxin.

Many observers have found fully virulent diphtheria bacilli in the mouths of normal individuals. Thus Aaser found the diphtheria bacillus 17 times out of 895 soldiers in a cavalry regiment. Park and Beebe found on examining 330 persons at random, that 8 had fully virulent and 24 characteristic non-virulent bacilli in their throats. Meade Bolton, amongst 214 persons more or less exposed to the infection by the diphtheria bacillus, found virulent bacilli in 41·5 per cent. In my own experience during the examination of a large school of 600 children, 33 per cent. had characteristic diphtheria bacilli present in their throats, and only fourteen out of the total number had clinical symptoms.

The importance of these bacilli-carrying persons (Bacillus-trägende) lies in the fact that the organisms can be easily transferred from one mouth to another through the agency of ordinary dental instruments, and in this way it is conceivable that a non-resistant or susceptible person might become infected with the organism from another's mouth, and so develop clinical symptoms of diphtheria.

The diphtheria bacillus being a non-sporing organism, is easily

destroyed by moderate degrees of temperature, the thermal death-point being given by Kolle and Wassermann as 60° C for fifteen minutes. The diphtheria bacillus may therefore be easily destroyed by boiling.

The cultural characteristics of the diphtheria bacillus, the method of diagnosis, &c., are out of place here, but it should be mentioned that in examining films of discharge from the mouth—particularly from the gums and in some pseudo-membranes—organisms closely allied to the diphtheria bacillus may be found, many of them staining by Neisser's method, though not with the characteristic regularity of the Klebs-Loeffler bacillus.

The pseudo-diphtheria bacillus, or *Bacillus hoffmann*, considered by some bacteriologists to be a non-virulent variety of the diphtheria bacillus, is not infrequently found in the mouth, but this organism does not give the characteristic dark granular staining by Neisser's method.

I have on a few occasions found the diphtheria bacillus present in the small painful ulcers on the tongue of children suffering from measles, diphtheria being occasionally a complication of this complaint; and in ulceration of the tongue of a child the possibility of the diphtheria bacillus as the cause of the ulceration should not be forgotten. Dr. E. W. Goodall, of the Eastern Fever Hospital, informs me that ulceration of the tongue and gums is occasionally seen in diphtheria, cultivations from the ulcers giving the diphtheria bacillus.

(*b*) **The Bacillus tuberculosis :—**

The *Bacillus tuberculosis* or tubercle bacillus, is perhaps more commonly present in the mouth than the last-named organism, particularly in those persons who are prone to infection by this organism owing to the nature of their avocation. The tubercle bacillus is a non-motile rod-shaped organism of 2 to 6 μ in length, and about 0·75 μ in width. It belongs to the class of organisms which are acid-fast. It stains with great difficulty with the ordinary aniline dyes, but retains the stain by Gram's method. The usual method of staining is by means of hot carbol-fuchsin for ten minutes, decolorizing in 25 per cent. sulphuric acid, and counter-staining with carbolic methylene blue. Few other organisms than the tubercle bacillus stain by this method, but from time to time other bacilli may be met with in the mouth which are acid-fast.

A large number of acid-fast species are now known, some of them growing readily on the usual culture media; others, like the organism next to be described, the lepra bacillus, have so far resisted all attempts at cultivation on artificial media. The bacilli found in butter and described by Rabinowitsch belong to this category (see also Newman's "Bacteriology of Milk"); certain members of the strepotothrix group are also acid-fast, and in a tuberculous patient when the tubercle bacillus is frequently present in the oral secretions, the possibility of acid-fast organisms of mouth origin is of some importance.

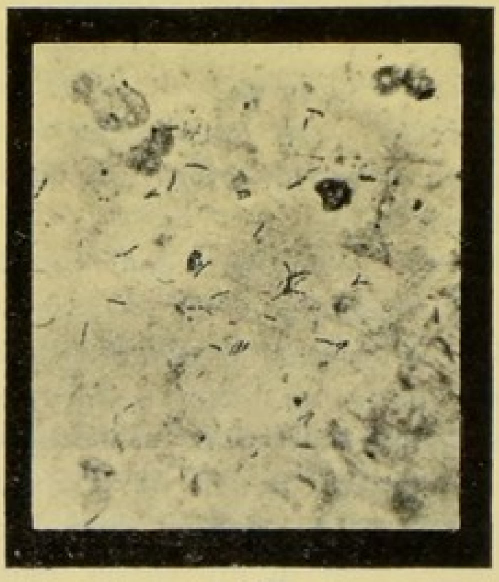

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FIG. 408.—*Bacillus tuberculosis* in sputum. Stained carbol-fuchsin.

The tubercle bacillus, in common with the diphtheria bacillus, may show true branching, and has been therefore classed by Lehmann and Neumann under a separate order, Myco-bacteria, a name which suggests their close relationship with the genus Streptothrix.

The growth of the tubercle bacillus on glycerine agar or on potato qualified with glycerine, is dry, powdery, or tough, and closely resembles that of a streptothrix.

Tuberculous lesions of the mouth are not uncommon. In advanced general tuberculosis, tuberculous ulcers of the tongue and pharynx are found, and occasionally tubercular disease of the jaw.

The relationship of the tubercular cervical glands to infection with the tubercle bacillus from the mouth is supposed to be of

common occurrence; it is suggested that the tubercle bacillus finds its way from the mouth along the lymphatic channels already in a state of chronic inflammation from septic gums and teeth, but particularly deciduous teeth, as tuberculous cervical glands are commonest in children. It by no means follows, however, that the tubercle bacillus has gained entrance from the mouth, although the swelling of the glands is directly due to the oral infection. Recent research on the etiology of tuberculosis suggests the intestine as the source of infection, the tubercle bacilli being taken up into the blood-stream and settling down and developing at the *locus minime resistantæ*.

In any doubtful case of necrosis of the jaw, the tubercle bacillus should certainly be looked for; if it cannot be found microscopically, an animal (guinea-pig) should be inoculated with some of the material removed from the bone itself. A case of this sort came under my notice: two sinuses leading down to bare bone in the region of the maxillary antrum were present. As the patient had suffered from tubercular disease of his lung, it was thought possible that the condition might be one of tubercular osteitis, especially as the sinuses were long-standing. Mr. Jacobson operated on the case, and I inoculated some of the curettings into guinea-pigs, which subsequently developed a generalized tuberculosis.

The tubercle bacilli have been described as occasionally present in carious dentine, and it is quite possible in tuberculous subjects that the bacillus may gain access to already softened dentine; but I have never myself met with it in the deep layers of infected dentine, and I much doubt if the tubercle bacillus ever gains access to the body through the teeth themselves as suggested by some American authors.

The thermal death-point of the tubercle bacillus is 58° C. for fifteen minutes; the organism also rapidly dies when exposed to direct sunlight.

(*c*) **The Bacillus lepra:—**

The *Bacillus lepra*, or leprosy bacillus, found in the lesions of leprosy, closely resembles the tubercle bacillus in its staining properties, but is more susceptible to the decolorizing influence of acids than is the tubercle bacillus. It is of course not common in the mouth, but I have met with it in three cases of leprosy, in

which leprous infection of the nose had been followed by ulceration of the fauces and the palate. One of the patients was a European, and the other two were Chinese. It was present in large numbers in all three cases.

(*d*) **The Spirochæta pallida**:—

The spirochæte which has been recently demonstrated in the lesions of syphilis, by the brilliant work of the late Professor Schaudinn, although not properly belonging to the bacteria, so closely resembles the class of bacteria known as spirilla or spirochætes that it requires inclusion in any description of mouth bacteria.

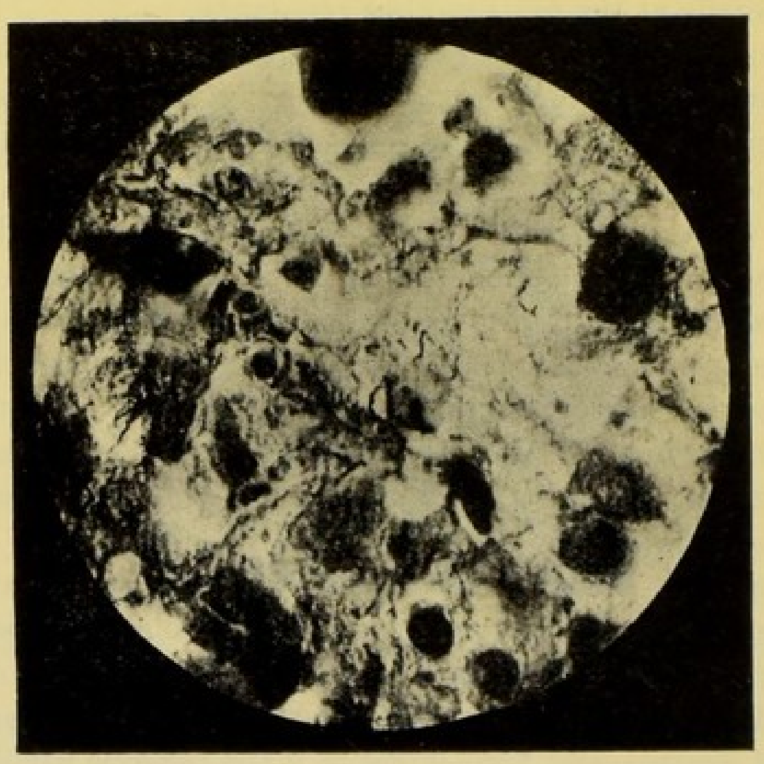

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FIG. 409.—*Treponema* (*Spirochæta*) *pallidum*. Section of syphilitic liver (congenital); stained silver nitrate.

The organism is a long and delicate spirochæte, having a large number of "turns" in the length of its thread. It is exceedingly fine, and much longer than the ordinary spirochætes found in the mouth; the latter are described under another heading, as they do not belong to pathogenic bacteria of the mouth.

The *S. pallida*, or *Treponema pallidum*, has been found in all the lesions of syphilis, and particularly in primary and secondary lesions. It stains with considerable difficulty, but

may be stained by Giemsa's method, a modification of Romanowski's, or by Leishman's stain; but perhaps the best effects are produced with the silver nitrate and pyrogallic method, and the latter is probably much the best for staining the organisms in tissue. If, however, Romanowski's or Leishman's method is used, the specimen should be floated on a little fresh normal serum before staining with the dye.

The organism, when once observed, is very characteristic in its form, the extremely delicate twists of the spirilla and its length giving it a very characteristic appearance.

The *S. pallida* belongs to a class of organism which is intermediate between the bacteria on the one hand and the protozoa on the other; hence the term "treponema" by which it is generally known.

(*e*) **The Bacillus pyocyaneus:—**

The *Bacillus pyocyaneus* is occasionally present in dento-alveolar abscesses, but is not common. This bacillus is a fine rod-shaped organism, with squarish or roundish ends, 3 μ to 4 μ in length, and about 0·5 μ wide, and possessed of peritricheal flagella. No spores are formed. The organism is decolorized by Gram's method, and stains by ordinary aniline dyes. In addition to the pigments produced, toxins are also formed.

The organism, as its name implies, is characterized by a beautiful blue-green pigment. This pigment is composed of two different substances, the one fluorescin and the other pyocynin; the fluorescin gives the green colour, and the pyocynin a brownish or even orange pigment.

The *B. pyocyaneus* is important, as a very considerable amount of the early bacteriological work on toxins and immunity was performed with it. Coley's fluid, used in the treatment of inoperable sarcoma, is composed of the toxins of the *B. pyocyaneus* together with the *Streptococcus pyogenes*.

Lehmann and Neumann class the bacilli which produce green pigment together under one heading. Amongst this group is the *B. fluorescens*, a sub-group of organisms which produce the fluorescin pigment only. These organisms are common in water, and may from time to time be found inhabiting the saliva; they are closely related to the pathogenic *B. pyocyaneus*; graduations from one type to the other are well known. The

motility of the organism, its bright pigment, the absence of spores, and its decoloration with Gram's method, make the class an easy one to recognize.

(*f*) **The Bacillus friedlander:—**

The *Bacillus friedlander*, or *B. pneuoniæ*, bacilli 3 μ long by 0·75 μ wide, often occurs as diplobacilli. In the living animal tissues, and occasionally in culture media surrounded by a gelatinous capsule; in these capsules the organism is often a diplobacillus, Gram-negative, non-sporulating, and non-motile. It was one of the earlier organisms described as the cause of pneumonia, before Frankel demonstrated the etiological significance of the *Diplococcus pneumoniæ*.

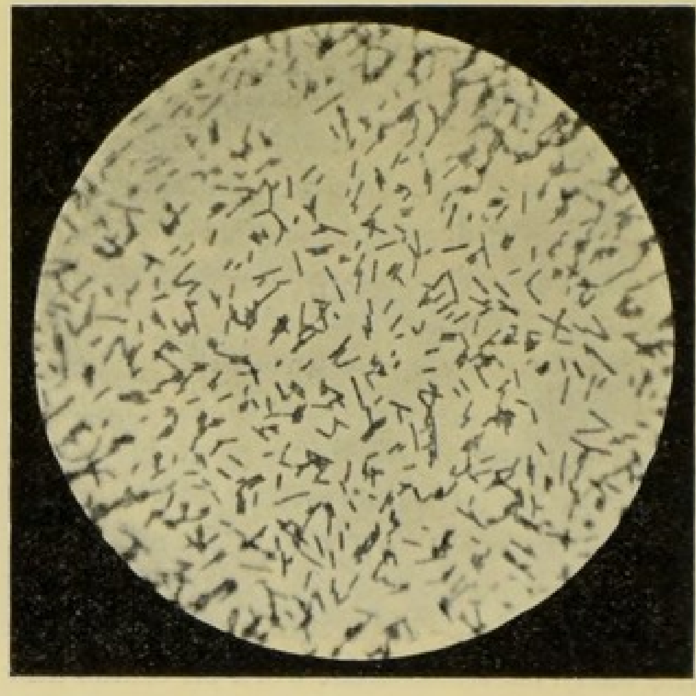

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FIG. 410.—*Bacillus pyocyaneus.* Twenty-four hours, agar cultivation; stained aniline gentian violet.

The *B. friedlander* is frequently present in the lung in even simple bronchitis, and probably gains access to the lung from the oral secretions.

A number of organisms closely related to the *B. friedlander* are known, two of them being the *B. ozænæ* and the *B. rhino-scleroma*, organisms more associated with the nose than the mouth, each being supposed to be the cause of the special disease

with which their name identifies them. They are classed for general purposes as belonging to the Friedlander group, differing only in unimportant points from the type organism.

The particular characters of this group are the non-staining by Gram, the non-liquefaction of gelatin with the characteristic "nail-like" growth on gelatin stabs, and the rapid fermentation of a large number of varieties of carbohydrate with the production of both acid and gas.

The *B. friedlander* sometimes has strongly marked pathogenic powers, in which case inoculation into animals produces death in a short time by general septicæmia. The organism, however, is never so virulent as the pneumococcus, though it may be concerned in pus formation.

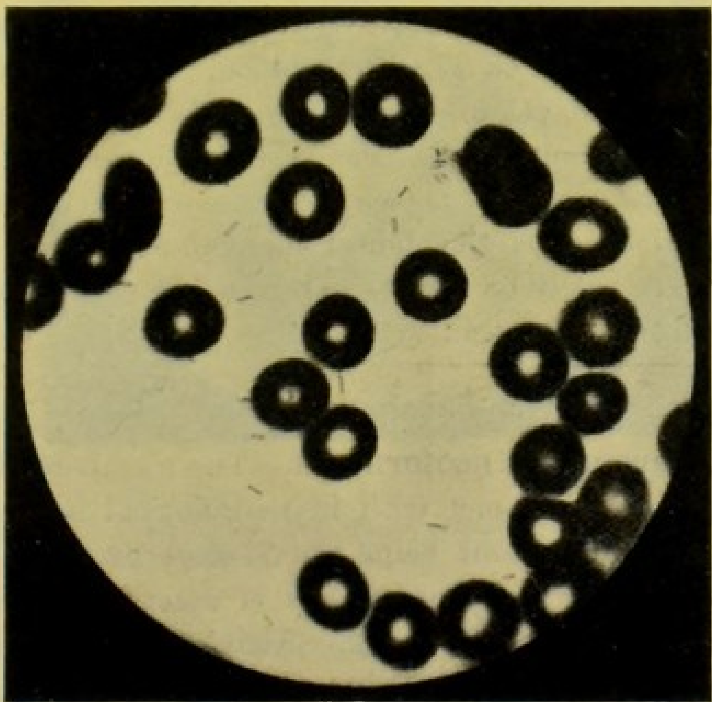

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FIG. 411.—*Bacillus influenza* in blood. Leishman's stain.

(*g*) **The Bacillus Influenza:—**

The Influenza bacillus, or Pfeiffer's bacillus, first described by him in 1887, is associated with epidemic influenza, and has lately become to be recognized as a constant cause of that disease. It is the smallest of all the pathogenic bacteria so far as we know, and exists in its typical

form as a minute diplobacillus staining with carbol-fuchsin, with a clear space centrally, and well-defined polar staining. It is found in a number of affections of the respiratory tract, and in persons suffering from acute or chronic influenza. During the winter months, in many persons who are not suffering from influenza at all, its presence may be detected in the saliva.

The organism is somewhat difficult to stain, and this is best done by smearing some of the buccal secretion upon a cover-slip and staining in very dilute carbol-fuchsin in the incubator for half an hour to two hours, when the characteristic staining is demonstrated.

The influenza bacillus does not grow well on the usual laboratory media, and rapidly dies out even upon sub-cultivation. It grows best upon serum agar made with normal serum or upon the agar medium devised by the late Dr. J. W. Washbourn, which consists of agar smeared with fresh blood. The colonies on this medium are minute, colourless, and resemble small drops of gum.

Very little immunity is produced by an attack of this organism, and its constant presence in the oral secretions should never be overlooked by the dental surgeon, as it is an organism which may very easily be transferred from one patient to another with unsterilized instruments.

(3) Saccharomyces

(*a*) **Saccharomyces neoformans.**—The members of the Saccharomyces group are met with in pathological lesions of the mouth, the most important being the *S. neoformans* of Sanfelne. An organism similar in many respects is described by Klein, and isolated by him from London milk. Klein's organism was pathogenic for guinea-pigs, and when inoculated produced appearances resembling sarcoma in various situations in the internal organs. A section of the nodules showed them to be made up of masses of yeasts closely packed together, and cultivations gave a pure growth of the organism which had been used for inoculation (see fig. 412).

During my researches on the bacteria of the mouth I have frequently met with a variety of yeast closely resembling, if not identical with the one described by Klein, and whose cultural characters so far resemble those of the *S. neoformans* that it may be regarded as an identical species.

This organism is frequently present in the acute stages of so-called pyorrhœa alveolaris, where much bone destruction has taken place and considerable hypertrophy of the gum is found. I have frequently met with it in the granulation tissue found attached to extracted teeth. The organism grows well upon the usual culture media, but best upon maltose agar; it stains by Gram's method and by the usual aniline dyes, and in old culti-

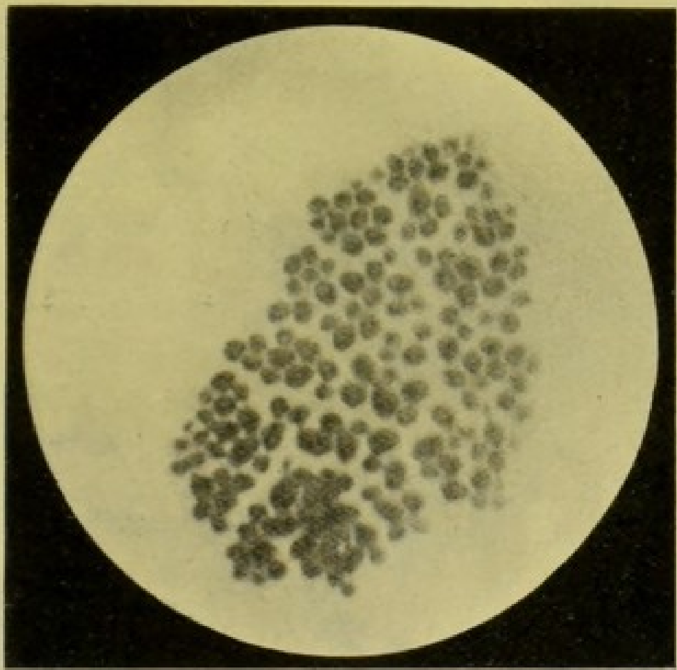

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FIG. 412.—*Saccharomyces neoformans* from mouth. Twenty-four hours' glucose agar culture; stained Gram.

vations development of mycelium may be found, particularly on the surface of potato. The organism differs from the *S. albicans*, from which it is easily differentiated by its unmistakable yeast-like form, the moist, greyish, raised colonies, and from its fermentation of glucose, lactose and cane-sugar without the evolution of gas.

(*b*) **Saccharomyces albicans** (syn. *Oïdium albicans*, or the thrush fungus) is not often met within the mouth in health, but is found present in the oral fluids in the later stages of certain wasting diseases, but even in such cases only when little or no attention has been given to mouth hygiene.

The organism grows as short, thick rods, sometimes jointed in long chains, at other times showing the development of an irregular mycelium, from which portions become detached, the joint of the detached portion showing a slightly swollen and thickened limb. The organism stains by Gram's method and by the usual aniline dyes. The colonies on the surface of the agar,

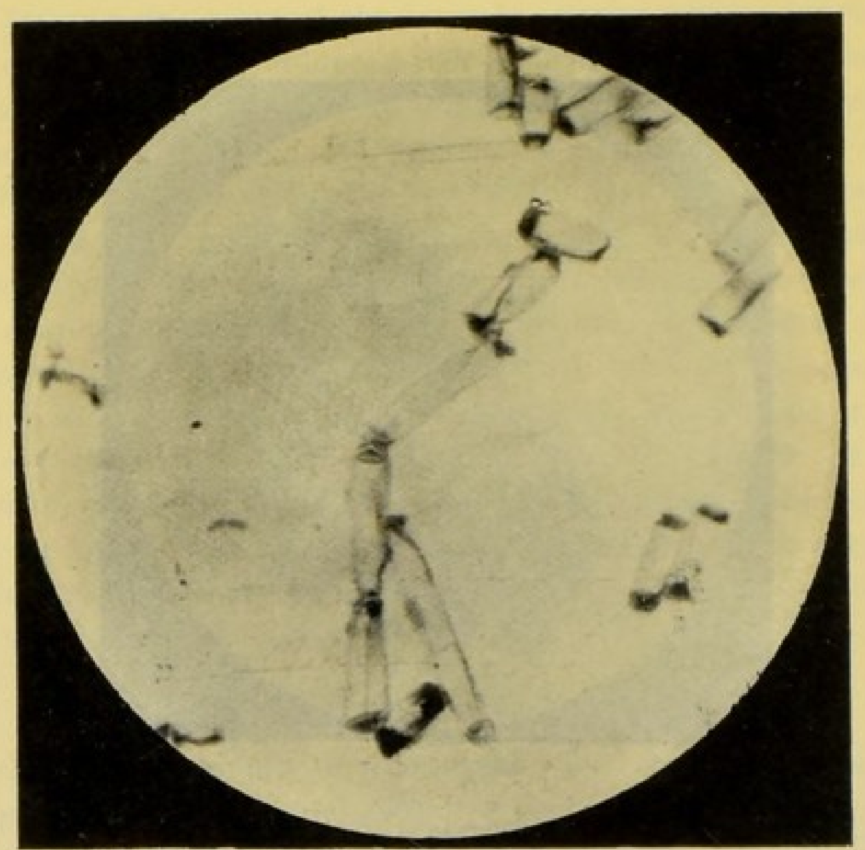

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FIG. 413.—*Saccharomyces albicans*. Three weeks-old cultivation on glucose agar; stained Gram.

or, better still, on glucose or maltose agar, are exceedingly characteristic, somewhat resembling the early stage of a mould colony, but having a much more delicate and rayed appearance with a minute central point from which the rays extend. The growth of the organism on agar is flat, thin, veil-like, and of a rather cobwebby consistency. It is included here amongst the pathogenic organisms of the mouth, as it is often also associated with other pathogenic bacteria, causing a white pseudo-membrane upon the buccal surfaces, and it may even exist as white patches

on the tongue or the fauces, and has been mistaken for diphtheria membrane; simple microscopical examination of stained films from the membrane at once determines the diagnosis.

(4) The Genus Streptothrix

The genus **Streptothrix** comprises a number of micro-organisms whose exact botanical position has been the subject of a considerable amount of discussion. Harz places the Streptothricæ (the first recognized species was the *Streptothrix bovis communis*) amongst the Hyphomycetes, but later writers disputed the arrangement and have suggested placing the Streptothrix amongst the Schizomyces. It is true that the Streptothrix produces a large number of pleomorphic forms, particularly when grown upon certain media such as potato, and these curious forms have been regarded as different types of an original pleomorphic organism, rather than degenerative forms of a mycelium.

The curious efflorescent or white powder found on the surface of many colonies of Streptothricæ on microscopical examination consists of rounded bodies, closely resembling cocci, and have been thought by some to be spores. These round bodies are, however, more nearly related to arthrospores, such as the arthrospores described by Hueppe and others in certain of the cocci and the cholera bacillus. The behaviour towards staining reactions, and the very slight heat resistance, together with the method of formation of the spores, by fragmentation at the end of the threads, rather than by concentration of the internal protoplasm of the filaments, certainly places these curious bodies in a different category to that of the ordinary endogenous spore of the Schizomyces.

The best known variety of the group of Streptothricæ is the *Actinomyces* (*Streptothrix*) *bovis*, or the Ray fungus. This organism, together with certain other closely allied forms, is met with in the mouth, and the *Streptothrix bovis* is occasionally found invading the bone of the jaw and producing a disease, termed at one time endosteal chondrifying sarcoma of the jaw; in calves infection of the tongue by the Streptothrix is known as woody tongue. The disease is not confined to the jaw alone, but may invade any part of the body, and has been found in the intestine, in the ribs, in the lung, liver, &c.

In the pus from a case of Streptothrix infection minute points of a yellowish colour may be seen, which under the microscope are found to consist of tangled masses of threads, the thickened club-like extremities of the threads being directed towards the outer side, the whole mass forming the so-called rosettes, to which the organism owes its name of Ray fungus. The growth of the genus *Streptothrix* is peculiar. On the surface of artificial media the growth is usually slow and dry, raised from the surface of the medium, the base of the growth biting deeply into the surface of the medium, and the portion of the growth above the surface becoming wrinkled, corrugated and twisted into cup-like and irregular distorted forms. At times the growth is ring-like, a series of concentric rings marking the various stages of the growth, and in the case of the *Actinomyces bovis* the colour is often of a bright yellow.

A large number of the species of the Streptothrix are now known. Fullerton and Price Jones described in 1902 a series of twenty-five species which they had obtained from various sources, and since this date a number of other species have been found.

The morphology of the organisms belonging to this group is somewhat strange. In young cultures a tangled mass of branching mycelium is to be seen (see fig. 420), and here and there portions of the branching threads are seen to be thickened and club-shaped; as development proceeds the ends of the threads undergo change, and on staining —best by Gram's method—an alteration in the protoplasm is observed which gradually produces a segmentation of the contained cytoplasm. Ultimately the whole of the mycelium, with the exception of the segmented portions, undergoes what is termed fragmentation, the mycelium disappears, and the remaining portions which have been segmented off from the threads remain as round, oval, or even rod-shaped forms, which constitute the white efflorescences, already referred to, which is found on the surface of the cultures (see fig. 421). The development of the organism is then completed, and if a little of this white or yellow powder be removed to a fresh culture tube the resulting growth is as before; firstly tangled mycelium, ultimately fragmentation. Most of the genus *Streptothrix* give off a characteristic smell resembling that of a damp cellar.

I have elsewhere described the Streptothrix which is met with in the mouth. This, however, is a non-pathogenic one, produces no darkening of the medium on which it is grown, produces no fermentation with carbohydrates, but rapidly peptonizes milk and starch paste. It is a freely growing organism, and is often found in the pus of cases of periodontal disease.

Another variety producing a bright pink colour is also found in the mouth from time to time. A number of cases of Streptothrix infection of the lung have been described, and as in many of these cases the filaments of the Streptothrix have proved to be acid-fast, the diagnosis from tubercle has not been easy. Fullerton and myself have described Streptothrix of various kinds obtained from the chronic dento-alveolar abscesses in man, differing in their cultural characters from the *S. bovis*. A Streptothrix has occurred in 8 per cent. of chronic dento-alveolar abscesses which I have examined bacteriologically, and I am inclined to regard the group of Streptothrix of importance in lesions about the mouth.

(5) The Sarcinæ

The Sarcinæ comprise a group of the cocci having a very wide distribution. For the most part they are non-pathogenic, and quite large doses inoculated into laboratory animals failed to produce any pathological change.

The Sarcinæ occur commonly in the mouth, and particularly in mouths which suffer from a lack of personal hygiene; and amongst them may be found the *Sarcina lutea*, *S. alba*, and less commonly *S. aurantea;* the *S. lutea*, giving a yellow pigment, being the commonest form. This well-known Sarcina exhibits a morphology common to all Sarcinæ, and is best seen in a hanging-drop preparation; the cocci are arranged in bunches of eight, owing to their binary fission having occurred in three planes at right angles to one another. Although the organism can hardly be regarded as pathogenic, a disease of the throat known as *Sarcina mycosis* is not uncommon. This condition is often stated to be due to the *Leptothrix buccalis*, but as so far there is no definite organism which can be described as a true *L. buccalis*, with the exception of the exceedingly hypothetical organism, *Leptothrix racemosa* of Vicentini, it is as well not to make

too definite a statement with regard to this disease. However, in a number of cases a practically pure culture of the *Sarcina lutea* may be obtained from the nodules and spreading, cheesy-like masses found in the tonsillar crypts, which has led to the description of *Sarcina mycosis*.

(C) BACTERIA PECULIAR TO THE MOUTH

The Leptothrix Group.—Almost from the very commencement of microscopic investigations of minute living objects by the old Dutch botanist Leuwenhoeck, *Leptothrix buccalis* hasbeen a generic term, under which all thread forms of bacteria met with in the mouth have been collectively arranged, without any reference to their true relations, origin or pathogenic significance. Miller, who first undertook the study of the organisms of the mouth in a scientific and thorough manner, also met with a number of thread-forming organisms which he classed as "Leptothrix," and the somewhat earlier observers, Robin, Vignal, and a few others, have also noted the presence of thread-forming bacteria.

On the other hand, Zoph, in discussing thread-forming organisms, arranges them in certain definite botanical groups, having well-marked characteristics, these groups being :—

(*a*) Leptothrix.
(*b*) Phragmidiothrix.
(*c*) Beggiatoa.

These groups come between the bacteria on the one hand and the moulds on the other. The class characteristics of the Leptothrix, as laid down by Zoph, are *organisms rod-shaped, spherical, and filamentous in form, the last showing a difference between the two extremities ; spore formation not known, filaments straight or spiral.*

Migula has proposed as a family name for the various higher bacteria *Chlamydobacteriaceæ*. Lehmann and Neumann class *Leptothrix*, *Cladothrix dichotoma*, *Beggiatoa*, *Phragmidiothrix* and *Crenothrix* as "higher fission algæ," but disclaim any personal knowledge of the group.

For further notes on the subject, the student is referred to "Mycology of the Mouth," p. 183.

The chief cause for the confusion that exists with the thread-forming organisms of the mouth is the extreme difficulty with which they grow on the ordinary laboratory media; the majority of the thread forms seemingly resist efforts at cultivation. Resource has therefore been had to the mere morphological form of the organisms, as found present in the mouth, to differentiate them into groups for purposes of description. If microscopical preparations be made from a mouth in which personal hygiene is a matter of no importance and where a certain amount

× 1,000.

FIG. 414.—Mycelium from pus, showing partial staining and degeneration of threads; stained Gram.

of salivary calculus is found adhering to the teeth, a very large number of morphological forms of organisms are seen. If the films be stained with Leishman's stain, the stain being left on for about half an hour, with subsequent thorough washing, some differentiation of the various bacteria present may be made. Films stained by Gram's method show little or no staining, the only organisms found stained by this means being some of the Gram-positive cocci, and a few portions of mycelium to be described later (fig. 414), which does not retain the stain as a whole, but only in granules scattered throughout the thread.

The morphological forms found with the Leishman-stained specimens are as follow :—

(1) *Thick threads*, some of them very much thinned and broken towards one extremity, the other often considerably thickened; no jointing.

(2) *Thick threads*, showing considerable jointing into separate elements; the individual elements may be very long, the threads 1 μ to 2 μ in width, and the elements 10 μ to 20 μ long (fig. 415).

(3) *Fine threads*, without divisions and not broken up into segments. Many of these threads show irregular staining, and here and there definite reddish granules are seen situated within the threads; the threads being often curved and twisted (fig. 415).

(4) *Fine threads*, similar to the foregoing, but jointed, suggestive of streptobacilli; but in these, as in the previous threads, polychromatic granules staining in a manner highly suggestive of chromatin are seen. The finer threads are generally not more than 1 μ, often less, in thickness, but are 30 μ to 40 μ in length.

(5) *Bacilli or short threads* with oval to rounded ends, 2 μ in thickness, and 20 μ in length, with well-marked irregular staining of protoplasm; the shape of the organism strongly resembles that of a large kidney bean. Frequently the protoplasm is broken up into septa, the septa staining a faint purple.

(6) *Jointed threads*, hardly taking a stain at all except at the junction at one thread with another, where a well-marked stained band passes across the end of the segment; the central parts of each segment are slightly wider than the ends, there appearing to be a constriction at the points of mutual apposition.

(7) *Fine-pointed bacilli*, 10 μ to 15 μ or more in length, but exceedingly fine-pointed ends. The internal part of the bacillus also shows irregular polychromatic staining (fig. 422).

(8) *Blunt-pointed bacilli*, rather shorter than the preceding ones, but about 1 μ in thickness, staining regularly with Leishman's stain, often with a division in the centre.

(9) *Spirochætes* :—

(*a*) Fine, irregularly twisted and curved filaments, showing little or no motility in the hanging drop, 0·3 μ in length.

(*b*) Regularly curved spiral forms, with polar flagellæ actively motile (fig. 428).

Both these forms show swollen cocci-like masses in the course

of growth; sometimes this thickened mass is placed at one end, and looks at first as if it were due to a twisting of the terminal portion of the filament: but this portion takes the stain more deeply than the rest, and gives a dark violet stain not unlike the nuclear staining of an ordinary lymphocyte.

(*c*) Minute spiral forms, with five or at the most six turns to the thread, and without the cocci-like forms.

(*d*) Comma-shaped organisms, highly motile, and staining uniformly (fig. 425).

Finally, in addition to the above-mentioned morphological forms, the various elements of the *Leptothrix racemosa* are seen (figs. 416 and 417). But very few of these forms are to be found on the surface of cultivations at the end of three days; in the first twenty-four hours a certain number of the organisms remain, but they gradually die out, and on the films made from the cultivations the number of cocci present are as a rule largely in excess of the bacilli or rod forms.

Certain morphological forms of bacteria are only met with in the mouth as far as is at present known, but as some of them do not occur on the ordinary culture media, at any rate in the form in which they exist in the mouth, it is impossible to state whether or no they belong to forms of well-known bacteria existing in a peculiarly modified variety in the mouth, or whether they are specialized forms related to the mouth alone.

Miller's original classification of the bacteria of the mouth included the following six forms:—

(1) *Leptothrix innominata.*
(2) *Leptothrix buccalis maxima.*
(3) *Bacillus buccalis maximus.*
(4) *Spirillum sputigenum.*
(5) *Spirochæta dentium.*
(6) *Iodococcus vaginatus.*

These organisms, however, together with the ones about to be described, appear rarely, if ever, in healthy mouths, but only where there is some amount of inflammation. Further, the three forms, *L. innominata*, *L. buccalis maxima*, and *I. vaginatus* are all of them to be included under the curious form of the *L. racemosa*: in fact, the only distinction given by Miller between them was that one gave the granulose reaction (turning blue on treatment with iodine acidulated with lactic acid), and the other did not.

The commonest mouth organism is the *Streptococcus brevis* of von Lingelsheim, but this has already been referred to, and as it appears elsewhere than in the mouth it cannot be regarded as peculiar. The following forms, however, may be sufficiently differentiated one from another as to be regarded as special species, and the ones marked with an asterisk are obtainable by cultural methods, not in every case in which they appear perhaps, but in a considerable percentage of cases where they appear in sufficient profusion from smears made from the mouth direct. The name given in brackets after the organism denotes the describer of the first cultures. For a complete description of the methods of obtaining cultivations and the biology of the organism in question, the student is referred to the original paper given in the reference.

(1) *Leptothrix racemosa*, of Vicentini, or *L. innominata*, and *L. buccalis maxima*.

(2) *Bacillus buccalis maximus* (Goadby). *Trans. Odonto. Soc.*, June, 1898.*

(3) *Spirochæta dentium* (Müller and Hartmann). *Zeits. für Hygiene*, November, 1906, p. 81.*

(4) *Streptothrix buccalis* (Goadby). *Trans. Odonto. Soc.*, 1898.*

(5) *Spirillum sputigenum* (Goadby). *Trans. Odonto. Soc.*, 1898.*

(6) *Bacillus fusiformis* (Ellermann). *Centralbl. f. Bakt.*, 1 Abt., Orig., Bd. 37, p. 729.*

It is highly probable that a number of other organisms will in time be added to this list, but those indicated here occur with sufficient frequency to warrant the term of "special mouth bacteria." A list is given in the Appendix of the various bacteria which have been described as occurring in the mouth, but it is impossible to include within the limits of the present chapter a description of all these organisms, many of which only differ very slightly in their cultural characters from well-known organisms.

(1) Leptothrix racemosa of Vicentini (Leptothrix innominata, Leptothrix buccalis maxima).—This organism, which so far as I am aware has not yet been cultivated, may be found present in nearly all mouths where there is any deposit upon the teeth, or where food has been retained between the teeth for any length of time. It is also commonly found occurring on the

under surfaces of artificial plates, and may be seen as a white layer adhering to the surface of artificial crowns. It apparently grows with great rapidity in the buccal cavity, and an artificial denture which has been completely cleansed from the adhering organisms is found two days afterwards teeming with them.

This organism was first described by Miller as the *Leptothrix innominata*, and as *L. buccalis maxima;* it has long jointed threads, some of the threads being fine and curved, others large and thick, showing internal degeneration and plasmolysis, resulting in

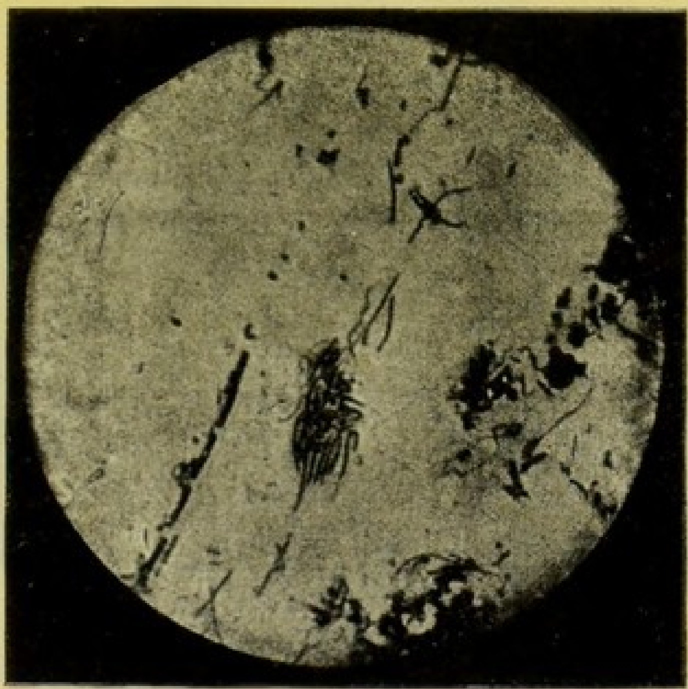

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FIG. 415.—Cover-slip preparation, mouth direct, showing thread forms.

unequal staining with the usual aniline dyes. Granulose reaction is given by the thicker threads. Miller had not examined the unbroken threads, and the descriptions he published apply to the threads alone without the adherent zygo-spores or cocci-like bodies.

Somewhat later Vicentini, in "The Cryptogamic Flora of the Mouth," described certain agglomerations of bacteria as *L. racemosa*. Vicentini having worked with fresh preparations unstained, and also with stained preparations made with great care to avoid damaging the organism, came to the conclusion that

this special Leptothrix was the parent form not only of all bacteria found in the mouth, but of all other bacteria of any sort or description discoverable in the oral secretions, in the sputum, nose, or throat. Unfortunately Vicentini based all his observations on the mere examination of smear preparations, entirely ignoring any of the facts to be derived from cultivations; at the same time and notwithstanding his somewhat rash conclusions, he delineated a number of curious morphological forms with considerable accuracy.

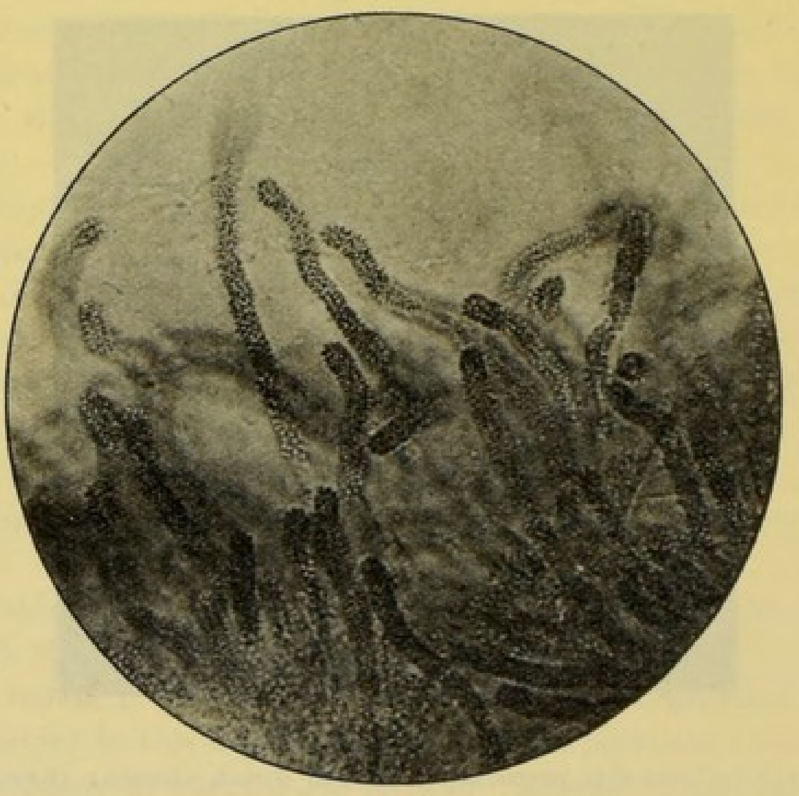

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Fig. 416.—*Leptothrix racemosa* of Vicentini, from mouth direct, showing "fruitful heads." Glycerine mount. Photomicrograph and specimen by by Leon Williams.

In an ordinary smear preparation stained by Leishman's stain, large bundles of cocci-like bodies are found, and in the middle of them a thread may be made out; the distal portion of the thread is free of adherent cocci, and shows irregular staining; very often this thread is entirely detached from any coccal bodies, and then has the form which has been described by Miller as the *L. buccalis maxima*. At times the thread is quite fine at its

distal or even proximal end, when the cocci-like bodies have become separated, and the end may become twisted and curled back upon itself, or into a form resembling the top of a whip; this is the form that was described by Miller as *L. innominata* (see fig. 415). Frequently two fine threads appear to be lying side by side, with their proximal ends twisted around one another and surrounded by a mass of cocci-like bodies—the distal portion of the threads showing distinct — with a clear space between

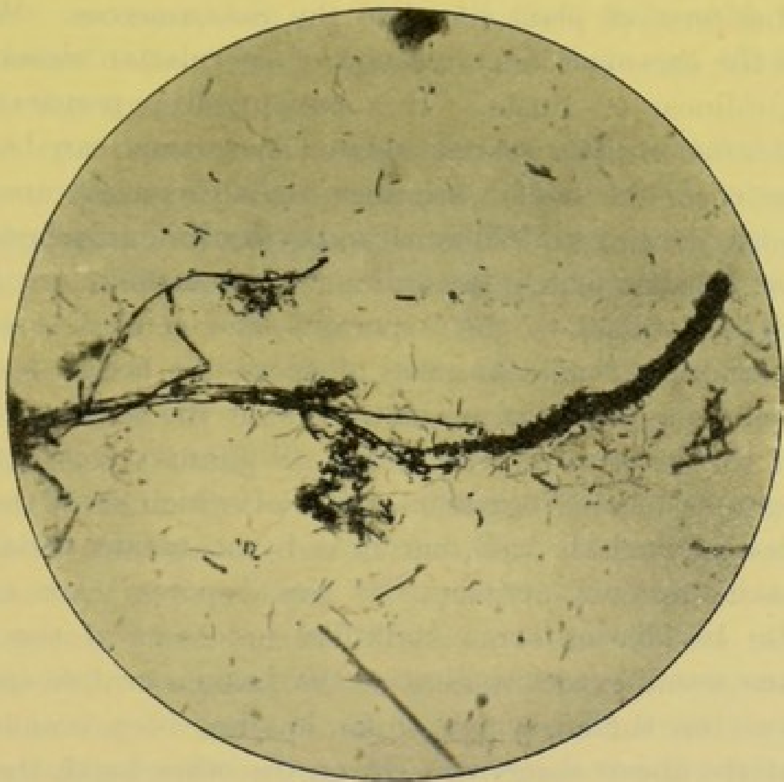

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FIG. 417.—*Leptothrix racemosa* of Vicentini, from mouth direct. Balsam mount. Photomicrograph and specimen by Leon Williams.

them; associated with the cocci-like bodies are numerous short bacilli which vary from minute diplobacilli, scarcely larger than *Bacilli coli*, up to threads 20 μ or 30 μ in length. These latter threads are sometimes found aggregated in masses and tufts, the ends of the threads being somewhat thickened, and to some extent resembling the so-called Ray colonies of the Streptothrix. If a suspension is made of material examined in normal saline, and a cover-slip carefully smeared, or better still a large drop allowed to evaporate in the centre, rather more structure may be

found; masses of cocci arranged in finger-like processes are to be seen, and occasionally in the centre a well-defined thread is found; at the same time these finger-like processes closely resemble the well-known granular casts found at times in pathological urine, and it is as yet uncertain what the curious forms are. Williams, who worked at this organism, adopted glycerine as a mountant, staining the specimens in glycerine and aniline violet. He claims by this means to produce far less damage in the mounting of a specimen, and regards the organism as belonging to a higher form of plant life than the Schizomyces. Williams considers the organism has a method of sporulation closely allied to the Uridineæ or Rusts. If a hanging-drop preparation be examined, after a little search isolated specimens can be found, when the cocci-like bodies are seen to be arranged in regular order, and, according to Williams and Vicentini, attached to the thread by basidia, which, according to the former, are seen to pass from the thread to the "spore." The central thread can easily be traced through the mass of spore-like bodies to its free end, the whole appearance reminding one of the common "friar's cowl" of the hedgerows when ripe. Williams gives a number of photographs of this organism, some of which show the cocci-like bodies particularly well, but it is by no means certain that these basidia are not artifact. If the "spores" are attached with these basidia or short stalk-like processes of the central thread, one would expect to observe the basidia on free spores, or on parts of the thread, which so far has not been accomplished by any of the above observres. If, on the other hand, the spores are attached one to another, they are more referable to the type of some of the moulds (*cf.* Penicillium).

The threads have been shown by Williams to stain in a special way with a modification of the Gram method, as follows: the material containing the threads, &c., is carefully made into an emulsion with distilled water and then stained with hot aniline gentian violet for from eight to ten minutes. The specimen is then placed in hot iodine solution to fix, washed in absolute alcohol, and then counter-stained with methylene blue. By this method of staining spore-like bodies are seen to occupy the ends of the segments of the threads. The spore-like areas may be stained in another way, which rather precludes their

description as spores. A cover-slip preparation is made and MacConkey's capsule stain[1] poured on. The preparation is then warmed until steam commences to be given off (it must not be allowed to boil), the stain is left on the cover-slip for five minutes, washed off, and the cover-slip mounted. The curious beaded appearance of the threads is brought out by this method: the stained "spores" are more to be regarded as arthrospores than true endogenous spores. On staining with Miller's iodine or with iodine acidulated with sulphuric acid, some of the areas apparently corresponding to the areas that stain with the foregoing method take a faint blue or violet tinge—in other words, they give the granulose reaction.

Good specimens of this organism are difficult to obtain, and great care must be exercised in making the cover-slip preparation. The best method to adopt is to suspend some of the material containing the organism in normal saline solution. A large drop is transferred to a cover-slip and allowed to dry—anything like spreading should be avoided. Flaming the cover-slip is also liable to break up the organism, and it is best to fix with alcohol and ether, as in staining blood-films.

When Vicentini first sent the description of the organism to Miller, the latter was of the opinion that it should be classified as a Cladothrix or Crenothrix rather than a Leptothrix, but upon the representation of Vicentini he withdrew his objection. Williams, while accepting the term Leptothrix provisionally, has shown that the "fruitful heads" may not be inaptly compared to the fructification of the *Cordiceps militarius* and *Botritis bassini*,[2] providing that the sterigmata and basidia exist. At the same time the method of sporulation or fructification of the Cladothrix and Crenothrix have some points in common with the organism under discussion.

The gonidia, or asexual spores of *B. bassini*, are supported upon well-marked sterigmata or basidia, the term basidium being used in both a general sense, when it is applied to the end of the thread that undergoes asexual sporulation, and in a special sense when it is used to indicate the stalk upon which the asexual

[1] Dahlia ·5 gm., methyl green (00 crystals) 1·5 gm., sat. alcoholic fuchsin 10 c.c., water to 200 c.c.

[2] Du Bary, "Morphology of Fungi," p. 65.

spore or gonidium is carried, and by which it is attached to the parent thread.

In Penicillium the carpophore, or special spore-bearing hypha, is an erect branch of the mycelium, the terminal portion of which divides into numerous branchlets, which in turn divide up into a chain of naked gonodia without special sterigmata—a condition, with a little modification, that is not unlike the sporulation of the *Leptothrix racemosa*.

Again, the Crenothrix breaks up into a multitude of spore-like bodies, the terminal portion of the thread undergoing multipartate division into gonidia; these may be extruded or remain attached to the interior of the thread. It is also to be noted that if a freely growing coccus, such as *Staphylococcus albus*, be grown in the presence of an equally freely growing bacillus, cover-slip preparations made from the mixed culture will show cocci apparently attached to the thread forms and to the shorter bacilli as well, much in the same way as the preparation from the mouth shows cocci-attached threads supposed to be the early sporulation of the *Leptothrix racemosa*. It is, moreover, not difficult to produce the appearance of sterigmata by using a stain like gentian violet, which is notorious for its quick deposit.

There are many other points of similarity between the *L. racemosa* and some of the Ascomycetes, for further particulars of which the reader is referred to Du Bary's book.

As the organism we have been discussing has as yet defied attempts at cultivation, it is difficult to assign it to any particular genus. Its morphology does not so far conform with any one class of Ascomycetes or Schizomycetes.

Zoph[1] gives as the definition of the genus *Leptothrix*; rod-shaped and spiral forms, which grow out into straight, wavy, or filamentous forms. These may show a difference between base and apex. Cocci-like reproductive bodies are formed by segmentation of the rod-shaped elements in the filaments.

The *L. racemosa* corresponds sufficiently to this general description to allow the provisional acceptance of the term, but if the sterigmata are really present and not artifact, the organism belongs to a much higher species and must be referred to the

[1] "Die Spaltpilze."

Ascomycetes. If such should prove to be the case by subsequent research, it is not improbable that it will be found that the so-called Leptothrix observed in the mouth is a phase form in the life-history of some organism living outside the body in another form. Before leaving the subject of the Leptothrix it must be pointed out that a rod-shaped bacillus may at times develop well-marked filamentous forms, and that these filamentous forms may undergo curious swelling and degeneration when grown upon certain forms of culture media. Walker has shown that the *Bacillus coli* under certain circumstances may develop into long threads; further, certain of the mouth bacteria which I have experimented with when grown upon the usual culture media only produce short diplo or single bacilli, but when grown on the surface of dentine which has been decalcified produce a curious felted mass of threads; and several other well-known organisms when grown in conditions of either increased quantity of certain salts, or under certain conditions of atmospheric environment, tend to produce strange degenerative forms known usually as involution forms. Much care, therefore, should always be exercised before any organism be defined as a Leptothrix because it happens to produce threads, whilst the "Leptothrix of tooth decay" is a mythical organism, no doubt holding a similar position in the bacteriology of the mouth to that of the dragon in the realms of zoology.

(2) **The Bacillus maximus buccalis.**—*Bacillus maximus buccalis* of Miller is another organism that is often present, especially in dirty mouths, and is the largest of the bacilli of the mouth. The *Leptothrix buccalis maxima* of Miller in description only differs from the *Bacillus maximus* in two points —that the threads do not give the iodine reaction, and that they have segments of greater length.

During an extended investigation of the organisms of the mouth I have constantly met with the large-jointed forms of the *B. maximus*, and after considerable trouble succeeded in isolating them for the first time.[1] The first culture was obtained by plating agar cultures which had been obtained by streaking broth cultures on to agar slants. A large number of slants from a

[1] *Trans. Odonto. Soc.*, June, 1898, p. 180.

single broth tube were made, and those tubes were selected which showed the organism sought for in fairly large numbers, and a second slant being made from this or from a subsequent tube the organism was plated out. A somewhat less tedious method is that described for the culture of the *Spirillum sputigenum*; but whichever method is adopted, considerable trouble is experienced in obtaining a pure culture, the bacillus seeming to require some time before it grows freely in artificial culture media.

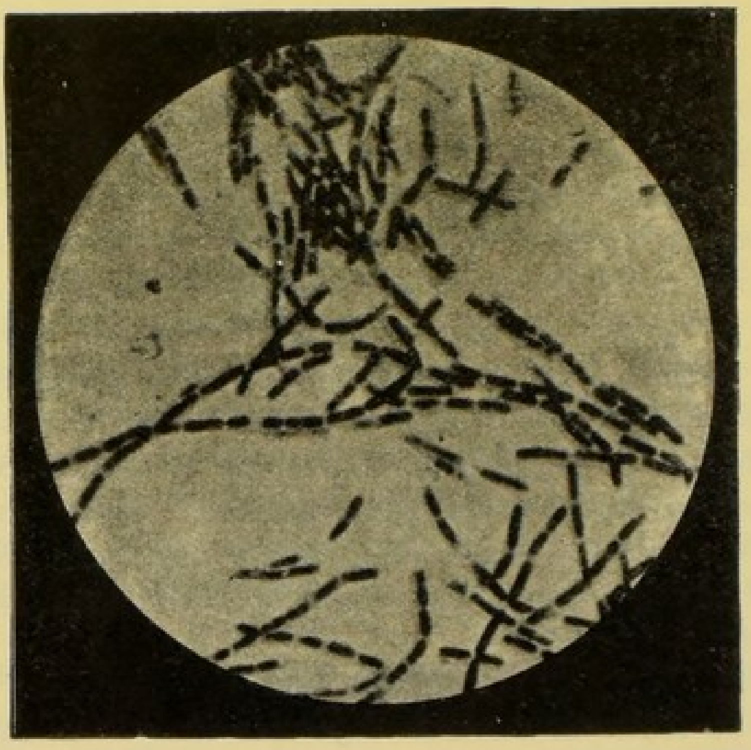

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Fig. 418.—*Bacillus maximus buccalis.* Twenty-four hours' agar cultivation; stained Gram.

The *B. maximus* obtained in pure culture corresponds closely with the morphological form described by Miller, with the exception of the iodine reaction, which is only given by a few of the oldest threads. The organism is not pleomorphic, it forms spores and has no differentiation of the extremities. Upon the ordinary laboratory media the bacillus grows out into long articulate threads, which in old cultivations are often twisted and contorted. In these old cultures involution forms make their appearance and alteration and shrinkage of the cell-plasm occur,

giving an appearance of vacuoles, the cytoplasm staining irregularly with methylene blue, and red granules are to be seen in it.

The organism is motile, and forms endogenous spores, which resist a temperature of 75° C. for half an hour.

(3) **Streptothrix buccalis.**—A streptothrix, as has been already stated, is not at all uncommon in the mouth. In the last edition of this book this organism was classed as Cladothrix. At that time a certain amount of confusion existed between the group of Cladothrix and Streptothrix; further research has shown that the organisms belongs to the genus *Streptothrix*. In films

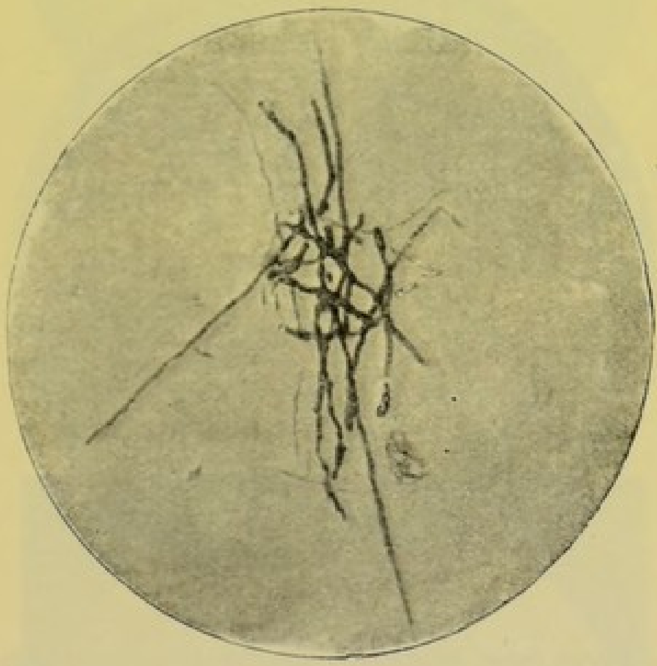

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FIG. 419.—*Streptothrix buccalis.* Mouth direct; stained Gram, showing

made from the gum margins direct, and stained by Gram's method, masses of threads may be found showing considerable irregularity of staining, true branching, and thickening of the terminal portions of the mycelium (see fig. 419). On cultivation on agar, hard nodular transparent gelatinous colonies are formed which later become covered with a whitish efflorescence. If a small amount of this efflorescence be removed and transferred to another tube, the same change takes place, and hard colonies are formed, later becoming covered with the same flour-like dust,

the colonies themselves growing deeply into the agar surface, but no staining takes place. The colonies are extremely difficult to remove from the surface, and generally bring away a portion of the medium in so doing. On liquid media a felted mass of growth is formed on the surface, and an abundant deposit falls to the bottom of the tube; large masses are seen floating in the medium, each one of which is a cluster of threads. In the younger cultures of forty-eight hours or less, well-marked branching mycelium is found (see fig. 420), the lateral branches of

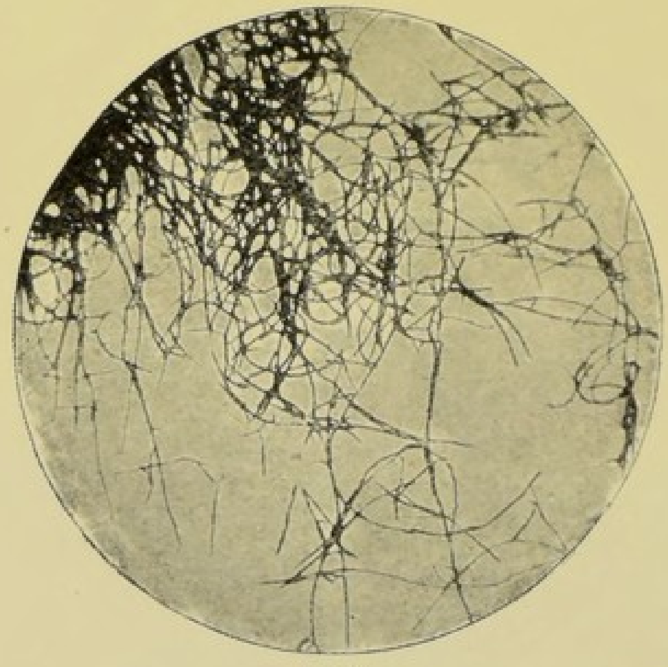

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Fig. 420.—*Streptothrix buccalis.* Twenty-four hours' agar cultivation; stained Gram.

which are short and often club-shaped. As development progresses the mycelium undergoes what is known as fragmentation, and on making smears the branching character of the organism is found to have disappeared, and to have become replaced by a mass of bacteria-like bodies, cocci, diplococci, threads, bacilli, diplobacilli, curved and straight (see fig. 421), the appearance being suggestive of a mixed culture of several organisms. This is still further simulated by the fact that many of the portions of the fragmented mycelium decolorize by Gram's method. Films made at a later stage of development, when nothing but the

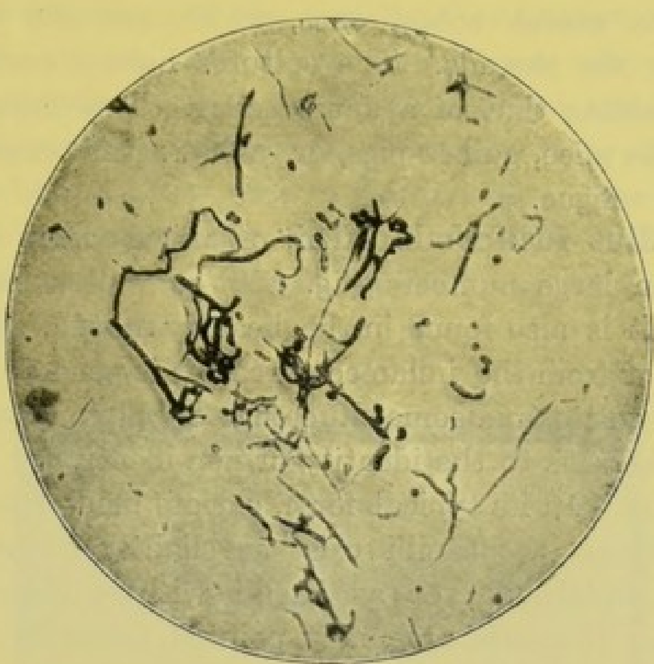

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FIG. 421.—*Streptothrix buccalis*. Seven days' potato culture; stained Gram.

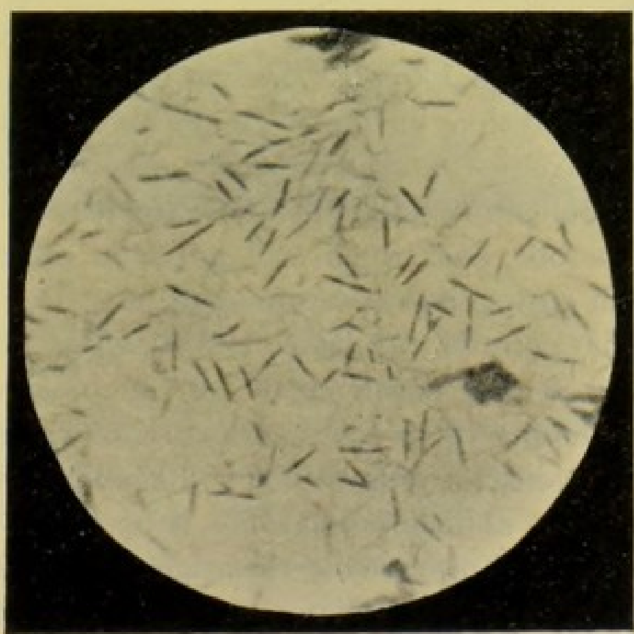

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FIG. 422.—*Bacillus fusiformis*. Smear preparation from ulcerative stomatitis; stained Romanowski (Leishman).

white efflorescence is to be seen, show an almost entire absence of any forms except coccal ones, which are the arthrospores produced by the threads. The cultures have a curious mouldy smell, resembling that of a damp cellar. This organism is not pathogenic for mice, guinea-pigs, or rabbits; it is occasionally met with on the tongue.

(4) Bacillus fusiformis.—This organism occurs in ulcerative stomatitis in large numbers (fig. 422) as well as in pyorrhœa alveolaris. It is also found in the healthy mouth. In pus from the mouth, or from the inflamed throat, it is generally associated with a spirochæte, and some difference of opinion exists between various workers as to the identity or non-identity of the bacillus and spirillum. In its typical form, smears made from ulcerative stomatitis direct, the bacilli exist as slightly curved rods, frequently as diplobacilli, or as bacilli with a clear, unstained central area; the ends are finely pointed, frequently they seem to have spirilla attached to the ends. There is no question that this appearance is artifact. The organism is non-motile and does not stain by Gram's method. In old cultures, and occasionally in degenerated pus, curious swollen forms are found; the centre of the organism being swollen to some 5 or 6 μ, and even 10 μ in width, and the two extremities fading away into a semi-curve or twisted thread. Occasionally two organisms appear to be jointed end to end and with larger thickened club extremities in apposition, having the appearance of two tadpoles.

Two chief varieties of this organism may be found, the one which is an obligatory anaerobe and the other which is a facultative anaerobe, and which will grow on ordinary alkaline agar, but which grows best on serum agar.

Veszepremi (*Centralbl. für Bakt.*, I. Abt., Orig., Bd. 38, Heft 2, p. 136) described the development of an anaerobic variety obtained from the pus of an acute periostitis of the right maxilla. The abscess contained a quantity of evil-smelling pus, which on inoculation into an animal produced a gangrenous abscess with a smell similar to that observed in the original pus. The organism was pleomorphic; even gradation between cocci and long thread forms, somewhat swollen in the true fusiform type, were found. The organism rapidly died out on sub-culture. The ordinary morphological variety of the *Bacillus fusiformis* was described

first by Vincent, and in conjunction with the spirochæte he considered it as the cause of the variety of angina generally known as Vincent's angina. Pure cultivations are very difficult to obtain, but impure cultures on serum medium are not difficult. The organism grows in the depths of a stab made upon nasagar or agar, to which a third part of normal horse serum has been added. The stab frequently shows gas-bubbles along the lower end, and associated with these bubbles may be found typical forms of the *B. fusiformis*.

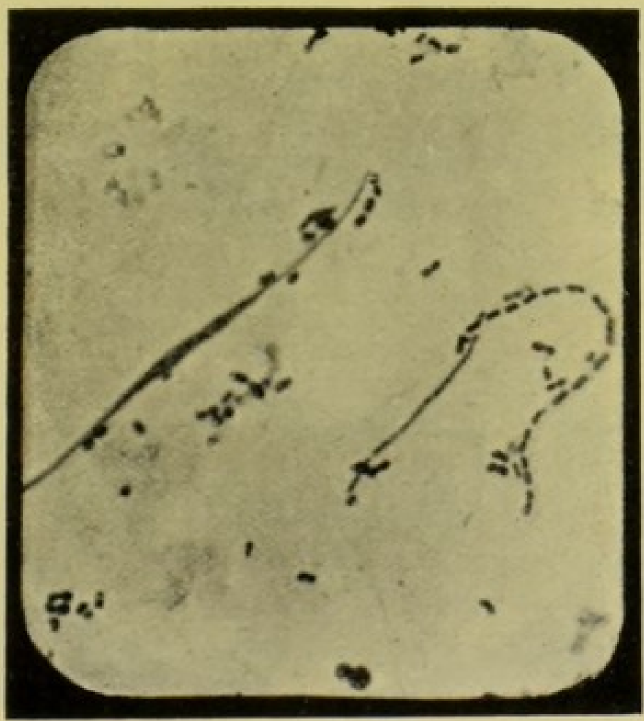

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FIG. 423.—*Bacillus fusiformis* (Goadby). Forty-eight hours' ascitic agar culture; stained aniline gentian violet.

The second variety of the *B. fusiformis* is one which has not been hitherto described, and is one which I have met with constantly in pus from the gum margins and the antrum of Highmore. It is also to be found in the normal mouth and upon the tonsil. The accompanying photograph (fig. 423) shows the typical fusiform variety extremely well, together with the vacuoles and partial staining that are common. The organism grows best on serum agar, made by adding one part of normal

horse serum to two parts of melted agar cooled to 40° C.; the colonies are quite typical, although at first sight they appear to resemble those of the staphylococcus, but by transmitted light they are seen to be iridescent, and marked by a number of fine lines radiating from the centre to the periphery. The organism does not ferment carbohydrates, but liquefies gelatin, grows slowly on the surface of potato, forming a dirty, yellowish smear; broth is rendered uniformly turbid, no indol

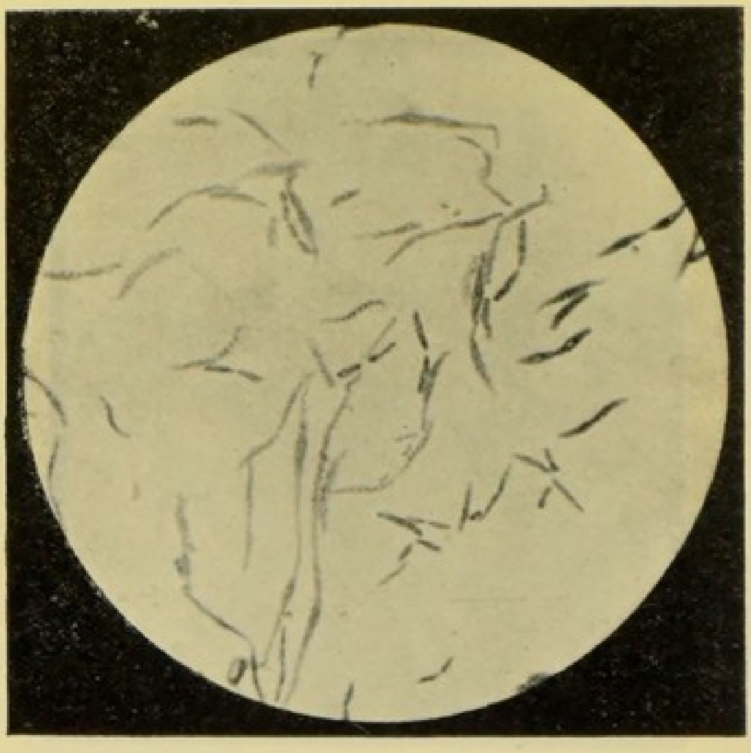

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FIG. 424.—*Bacillus fusiformis* (Goadby). Five days' ascitic agar culture; stained aniline gentian violet.

is formed, and nitrates are reduced to nitrites; no smell is produced and no gas. The organism is feebly pathogenic to the usual laboratory animals, 0·5 c.c. of an emulsion of a fresh agar culture producing a localized tissue necrosis, or occasionally a considerable abscess at the site of inoculation. In guinea-pigs wasting and loss of hair may occur, but this is rare. The morphology of the organism is exceedingly interesting; on first isolation, short, rather thick diplobacilli are found, with here and

there an occasional thread, rarely swollen, but generally twisted into the form of a spirochæte. In forty-eight hours or somewhat later a number of the bacilli grow out into thickened involuted forms, which still later become vacuolated, as in fig. 424. After further development the threads begin to break up and a number of cocci-like bodies are formed. On ordinary agar the organism frequently does not develop beyond diplococcal or small diplo-bacillary forms. On liquid media, particularly on lactose and inulin broths, long filamentous forms with true fusiform types may be found. It is probable that this organism represents a large number of morphological forms which decolorize by Gram's method and are found in smears made from the mouth in suppurative lesions, but as the organism does not always develop on the culture media it is impossible to state definitely that such is the case. Its slight pathogenicity must cause it to be regarded with suspicion when it is present in pus. Several forms of the organism have been described in various journals, and for further information the student is referred to the various original papers.[1]

(5) **Spirilla of the Mouth.**—In a large number of mouths, healthy and unhealthy, spirochætes may be demonstrated, and in the last few years the spirochætes of the mouth have again come under the attention of bacteriologists, owing mainly to the discovery of the spirochæte, or *Treponema pallidum*, by Schaudinn. Spirilla, or spirochætes, have been found in many other situations than in the mouth ; they are found in the blood in certain infectious diseases, as, for instance, in relapsing fever the *Spirillum obermeieri*, or in tick fever the *S. duttoni*, or in spirillosis of the goose. Spirochætes are also found from time to time in the nose, and have been described as *S. nasalis*, and in the intestinal canal as *S. fæcalis*. Certain spirilla are also to be found in water, besides the well-known cholera spirillum or *Vibrio choleræ* and its allies. The group is, therefore, a very large one, and may for practical purposes be divided into two

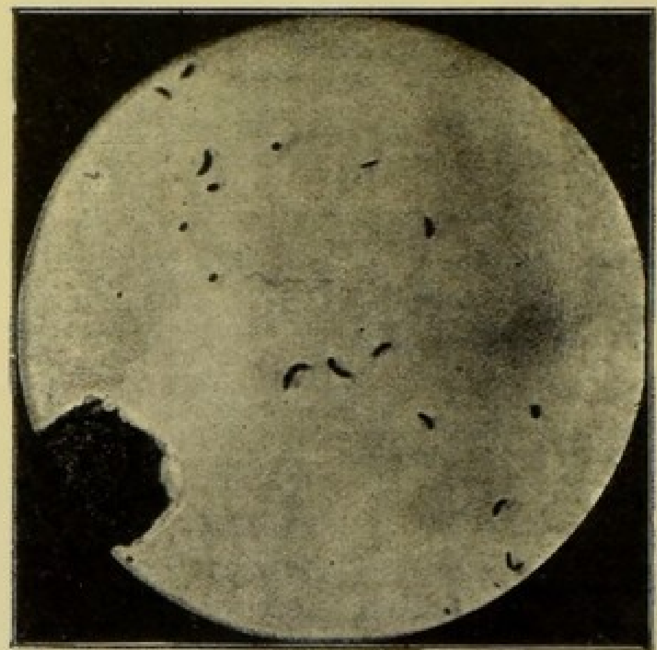
[1] *Comp.-rend. Soc. Biol.*, Paris, 67, 1909, p. 860. *Zeits. für Hyg.*, November, 1906, Muhlins and Hartmann, p. 81. Paton and Hill, *Lancet*, February 17, 1906. Vincent, *Lancet*, May 13, 1905. Priestly, *Public Health*, February, 1906. Ellerman, *Centralbl. für Bakt.*, I. Abt., Orig., Bd. 37, H. 5, p. 729.

main divisions: firstly, those organisms which may be obtained by the usual culture media, and secondly those which either have not been grown, or else are exceedingly resistant to all cultural methods. In some cases the spirillum somewhat resembling the *Spirochæta pallida*, which is found in similar situations, has been termed the *S. refringens*, a name often applied to any other spirochæte somewhat resembling the *pallida*.

Miller describes two morphological varieties of spirilla existing in the mouth:—

(i.) *S. dentium*.

(ii.) *S. sputigenum*.



× 1,000.

FIG. 425.—Comma-shaped bacilli. Mouth direct.

Miller further was able to grow two varieties of spirilla occasionally from the oral secretions; one of them he identified with the *Vibrio Finkler-Prior*, and the other was unknown to him.

In the course of my own investigations I have succeeded in isolating four forms of spirilla from the mouth:—

(i.) *Vibrio Finkler-Prior*, which grows only occasionally.

(ii.) *Spirillum sputigenum* (fig. 426).

(iii.) The spirillum having the characters of the one described by Miller.

(iv.) The *S. dentium* (fig. 428), which is an anaerobic organism.

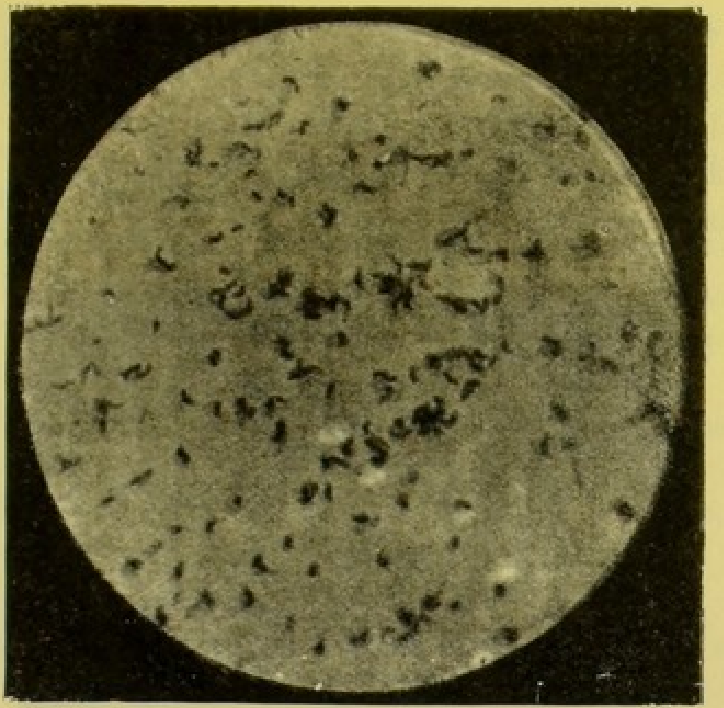


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FIG. 426.—*Spirillum sputigenum.* Twenty-four hours' agar cultivation. Comma forms.

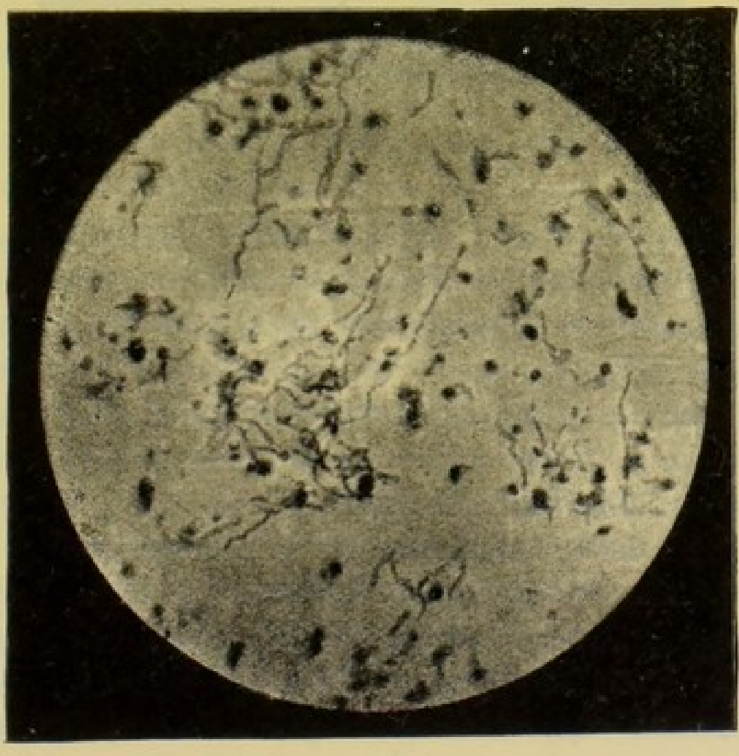

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FIG. 427.—*Spirillum sputigenum.* Four weeks' agar cultivation, showing involution forms.

As I have already stated in describing the *Bacillus fusiformis*, the *Spirochæta dentium* (*S. denticola*) is frequently found associated with the *Bacillus fusiformis* (fig. 422), and Turnecliffe is inclined to regard the spirochæte as a pleomorphic variety of the fusiform bacillus.

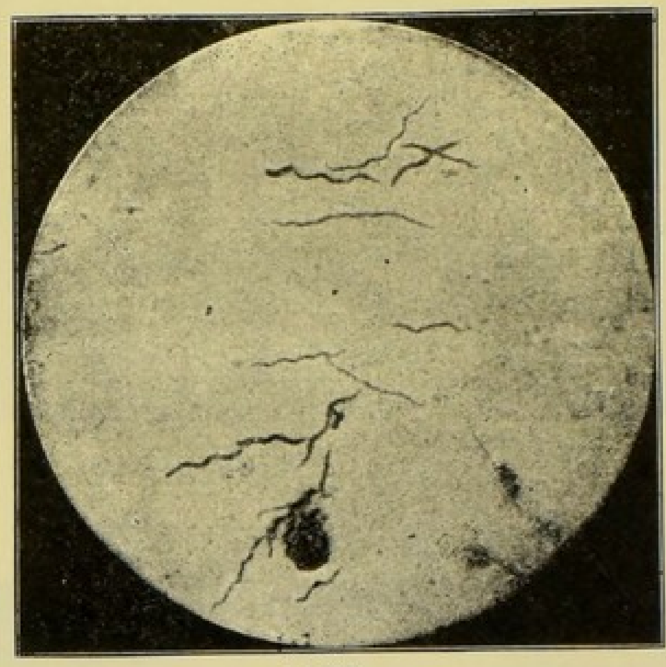

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FIG. 428.—Spirochætes from mouth direct.

Ellermann points out, however, that the spirillum and spirochæte does not stain by Gram's method, whereas the fusiform bacillus in certain circumstances does, and that the fusiform bacillus is non-motile, whilst the spirochæte is distinctly motile. Mühlens and Hartmann also support this view, and consider that the pathogenic effects which have been produced by certain observers by injecting the spirillum and the fusiform bacillus into animals have been caused by an admixture of other organisms, and not by pure cultures of the spirochæte, or the fusiform bacillus itself. This objection does not apply to the organisms which I describe in these pages, as in every case the organisms used were obtained in pure culture, and the culture injected was in every respect a pure culture of only one organism, and which was recovered from the site of inoculation in pure culture.

(i.) *The Vibrio Finkler-Prior* does not grow sufficienly often in the human mouth to warrant its description amongst the organisms peculiar to the mouth; and for detailed descriptions of this organism the student is referred to a text-book on general bacteriology.

(ii.) *The Spirillum sputigenum.*—Stained preparations from the mouth show at least three distinct morphological forms of spirilla or spirochætes, the term "spirochæte" being generally reserved, however, for those organisms which are protozoal rather than bacterial, and it is still a matter of conjecture as to whether the spirochætes of the mouth, of the nose, tick fever, and relapsing fever, should not be placed amongst the protozoa. The three chief forms found in the mouth are:—

(*a*) Distinct comma-shaped organisms, or vibrios.

(*b*) Irregular and slightly undulant forms, which vary from well-marked regular corkscrew-like organisms to almost straight threads.

(*c*) Exceedingly minute spirilla, with six or seven whorls in the length of the thread.

It is quite possible that the comma forms are a stage in the development of the spirochætal forms, just as in the cholera bacillus or in the Finkler-Prior vibrio, young cultivations show curved comma-shaped rods, or even short diplobacilli, but later—particularly on fluid media—grow out into well-defined spiral threads. At any rate, in the organisms I have succeeded in obtaining a pure cultivation of, this fact is undoubtedly the case, early cultivation showing the comma forms, and the older ones spirochætal.

The presence of an undulating membrane is regarded as the special sign of the protozoal type of spirochæte, and is said by some observers to be demonstrable in the mouth spirochæte, but I can by no means agree that this undulant membrane is present. It is true that an appearance closely resembling such a membrane is at times to be seen, but if the preparations be carefully cleared from adherent mucous and albuminous material before staining is effected no sign of any such membrane can be found.

The best way of observing these spirochætes in the mouth is to make a thin preparation from either ulcerative stomatitis or marginal gingivitis; the material is best suspended in distilled

water, the thicker portion allowed to settle, and films made from the supernatant fluid. Such films may be stained either by Leishman's stain, which stains the spirochætes a faint violet, or by dilute carbol-fuchsin for ten minutes or a quarter of an hour. If desired, the silver nitrate method may be employed, or even Pitfield's flagella stain; but for ordinary routine examination staining by means of Leishman's stain is perhaps the easiest. In cultivations made on alkaline serum agar, the spirochætes or spirilla may usually be found at the end of twenty-four hours mixed up with other organisms, but they rapidly die out, and pure cultivations are exceedingly difficult to obtain. Smear preparations on the special potato gelatin which I have described elsewhere, and also upon serum agar, will occasionally allow the spirilla colonies to develop; the colonies are exceedingly minute, being smaller than those of the streptococcus, but having a slight feathery or filamentous appearance under the microscope. Transference of the colony to another media results in growth in only a small percentage of cases, and even then the organism rapidly dies out on sub-culture. With a little care it is possible, however, to obtain pure cultures by these means. The organism thus obtained grows at first as short diplobacilli actively motile (see fig. 426), and decolorizing by Gram's method, but it is only after a certain amount of sub-culture that the typical comma and spirilla forms make their appearance. In the older cultivations darkly stained swellings about the size of a staphylococcus are found in the course of the threads (see fig. 427) similar to the swollen forms of the *Vibrio choleræ* which may be observed in Pfeiffer's reaction. These same swollen forms are also to be found in the smear preparations made from the gum margins direct, and are an involution or degenerative stage of the organism's growth. The spirochætes which I have isolated from the mouth when injected into guinea-pigs produced a fatal septicæmia, and the organisms were recovered in pure cultivations from the bone-marrow: the cultures closely resemble those of the cholera vibrio in their reactions.

(iii.) *Spirillum having the Characters of the one described by Miller, or the* E *bacillus of Miller.*—This organism occurs in a certain number of cases of dental caries, and is not uncommon in the mouth. As a rule the organism exists as

irregular separate bacilli, non-motile, and does not stain by Gram's method. Some of the smaller of the organisms closely resemble cocci, and are not motile, and therefore it should not be described as a spirillum, but rather as a curved bacillus. Vibrios, so far as is known, are motile during some stages of their existence, and the organism is only introduced into this section as it has been described by Miller under the heading of those producing curved rods.

(iv.) *The Spirochæta dentium.*—The *Spirochæta dentium* is an obligatory anaerobe, according to the work of Mühlens and Hartmann, and also of Turnecliffe, and grows only on normal serum agar under strict anaerobic conditions, and even then not in the upper layers of the culture tubes, but only in the depths. The colonies of the organism are minute, finely granular, and a yellowish colour, and send out aborescent processes into the surrounding medium. The best method of obtaining cultivations of this spirochæte is by means of Vignal tubes; a sterilized length of glass tube is taken, and dilution made of the material containing the spirochætes in serum agar; the medium is then sucked up into the sterile glass tube by means of an aspirator, and the ends sealed off and the tube placed in the incubator. After three days colonies of various sorts will be found scattered throughout the tube, and by careful examination with the microscope spirochætal colonies may be identified. A file nick is made in the glass tube near the colony selected, the tube broken, and a small amount of the colony removed, sub-cultured anaerobically in a Buchner tube in an atmosphere of hydrogen. Mühlens and Hartmann obtained their cultures by the direct deep agar-serum method under anaerobic precautions, and have given a full description of the cultures. The organism was non-motile, did not stain by Gram's method, did not liquefy gelatin, rendered glucose broth turbid, and would not grow in other laboratory media except that containing normal serum; it was non-pathogenic for animals (guinea-pigs, mice, and rabbits).

More recently another organism has been described closely resembling this spirochæte, but of the morphological form noted above: exceedingly minute spirilla, not more than 2 μ in length, often not 1 μ, and so exceedingly fine that it is only with great difficulty it can be seen under the microscope. It is probable

that further research will demonstrate that the spirochætal and spiral forms found in the mouth are divisible into a number of distinct species, but the foregoing *résumé* comprises those species that have so far received some amount of description. Others, which so far have only been described under the generic term of *Spirochæta refrigens*, cannot be discussed.

In the list given by Miller of bacteria peculiar to the mouth, the last, *Iodococcus vaginatus*, is not sufficiently differentiated from the other organisms to allow of its description as a special species. A number of the morphological forms which are mentioned above, particularly the thick threads showing jointing into separate elements, which, when the elements are broken off from the larger threads, closely resemble the descriptions given by Miller of the iodococcus, particularly as some of these threads belonging to the saccharomyces give a granulose reaction. The remaining organisms, of which I have only mentioned the morphological form in passing, are as yet undifferentiated, and it is impossible to give any proper description, until they have been cultivated and their morphological form under various conditions closely studied.

Non-pathogenic Bacteria of the Mouth

In the preceding pages I have given a *résumé* of some principal well-known pathogenic bacteria, which are important from the point of view of mouth pathology. All of the species described, together with varieties closely resembling them, are to be found in one or other of the pathological lesions from time to time affecting the oral cavity. But in addition to these organisms a large number of species of other bacteria may be met with from time to time in the oral secretions, and, as has been previously pointed out, owing to food containing bacteria of all sorts and descriptions, to say nothing of the organisms taken in with air, dust, water, and so forth, the non-pathogenic bacteria which may be found infecting the mouth are so numerous that it is impossible within the limits of the present chapter to attempt to describe all the species that have been mentioned as having been cultivated from the mouth.

Although many bacterial species are taken into the mouth, they do not all find the conditions of environment suited to their special needs of growth ; as the late Professor Miller pointed out, bacteriological examination of the mouth made immediately after drinking a fluid containing a number of lactic acid bacilli showed an enormous preponderance of this special form of organism, but at the end of twelve hours practically the whole of the species had disappeared, having been eliminated either by the bacterial action of the saliva, or by the mere mechanical washing away due to the action of saliva and the buccal mucus, or perhaps to the antagonistic effect of the normal mouth inhabitants.

Certain non-pathogenic bacteria are usually met with sufficiently frequently in the oral secretions to be regarded as more or less mouth bacteria, and in addition, certain other organisms are apparently peculiar to the mouth, not having been met with in other situations, except in very rare instances, and even then probably owing their presence in the new environment to direct infection from the mouth.

In perfectly healthy mouths practically the only organism present is the *Streptococcus brevis*, together with perhaps the *Sarcina alba* of the air, and the *Bacillus mesentericus* (fig. 429) generally derived from dust.

The peculiar forms met with in the mouth have been considered, as a number of these organisms are only known by their morphological forms, and so far have resisted all attempts at cultivation, their staining reactions and general morphology being all that can be given concerning them. It is highly probable, however, that a large number of these morphological forms, often of exceedingly curious shape, belong to members of well-known species of organisms, whose residence in the mouth has so far changed their morphological habit that they have been altered into forms unrecognizable. On the other hand, certain bacteria obtained from the mouth and which at first do not show the curious pleomorphism found in slides direct from the oral secretions, may, if continued sub-culture be carried on, show the same curious morphological forms which prove so misleading and mystifying in dealing with direct films of oral bacteria.

In the previous sections of the present chapter, a number of different bacteria have been cited, some of them associated

with special diseases in or about the mouth, others again which occur so frequently in the mouth and rarely elsewhere, that they deserve the name of "bacteria peculiar to the mouth." There are still a large number of bacteria to which short reference is essential, even in a brief *résumé* of mouth bacteriology. Amongst this class of bacteria may be mentioned those organisms associated with dental caries, which, although they cannot be classed as pathogenic organisms in the mouth in the usually accepted sense of the term, are yet so much associated with the disintegration of the special dental tissues, that they are pathogenic so far as the tooth itself is concerned. Certain other organisms, moreover, although not pathogenic and perhaps not even associated with dental caries, and which belong to species widely distributed in nature, yet appear in the mouth under certain special circumstances, and require at any rate a brief reference under the present heading.

A considerable number of observers have investigated the bacteria of the mouth; amongst them may be mentioned Vignal, Gallipe, Miller, Black, and Pansini. Unfortunately, a large number of the organisms which have been studied by the different observers have received special names given by each observer, with the result that a considerable amount of confusion has resulted, some of the organisms having received as many as three different names. Matzuschita gives in his "Bacteriologie diagnostique" at least forty-two non-pathogenic bacteria and eighteen pathogenic bacteria as occurring in the mouth; and to these must be added a considerable number of others, some of which have been described in the present instance. Probably the list I give in the Appendix may be considerably reduced in numbers when the various organisms are compared one with another, while most of the pathogenic bacteria which have received special names are the ordinary pathogenic cocci and bacilli which are found in other pathological conditions than those occurring specially in the mouth.

Of special pathogenic bacteria peculiar to the mouth, few or none are accurately known, although many of the organisms when obtained in pure culture and inoculated into animals will produce an abscess at the site of inoculation, or local tissue necrosis, but there is not enough known about these special organisms to warrant a careful description of the various species.

With regard to the non-pathogenic bacteria which come under the heading at present under discussion, the organisms may be conveniently referred to in their main groups rather than individually, and further description must be sought for in the text-books on general bacteriology.

× 1,000

FIG. 429.—*B. mesentericus.* Twenty-four hours agar cultivation; aniline gentian violet.

The Bacillus mesentericus Group.—Food and water both form a fruitful source of bacteria of all descriptions, particularly non-pathogenic ones; and one of the groups of bacteria frequently present in carious dentine, and probably closely associated with dental caries, is the *B. mesentericus* group, or so-called potato bacilli. The *B. mesentericus* group consist of a number of species of rod-shaped bacilli 4 to 5 μ in length, ·75 μ broad, retaining the stain of Gram's method. They are highly motile, and all of them form spores, the spores resisting a considerable amount of boiling, and being highly resistant to antiseptics. The *mesentericus* group do not ferment carbohydrates, but are capable of producing very strongly proteolytic enzymes, which are able

to digest various proteids with considerable rapidity. They do not clot milk, but peptonize it, and are not pathogenic even when injected in large quantities into animals. The growth of the group is peculiarly characteristic on the surface of boiled potato, but even on other media they form the same curious wrinkled and irregular surface growth. Two of the varieties stain the medium deeply. The three principal varieties are: *B. mesentericus ruber*, *B. mesentericus fuscus*, *B. mesentericus vulgatus*, the organisms of the various groups merging insensibly in one another in their cultural and other characters. When present in cultivations made from the mouth, they rapidly outgrow all other organisms, producing a wrinkled growth over the whole of the surface of the medium. In this they closely resemble the *B. subtilis*, another organism which at times is present in the mouth, but by no means as frequently as the *mesentericus* group.

An organism closely related to this group, and, so far as one can tell from descriptions, identical with the *B. mesentericus ruber*, is the *B. gangrenæ pulpæ*, an organism described by Arkövy, but which I have never found present in the course of my investigations on bacteria in the mouth, although I have commonly met with *B. mesentericus ruber*, and I have little doubt that this organism is merely a variant of one of the mesenteric group.

The Proteus Group.—The second group of bacteria producing a considerable amount of proteolytic digestion is the *Proteus* group. These organisms have the peculiar facility of forming so-called "wandering colonies." When the organism is grown on the surface of media in Petri dishes, the colonies tend to move about the plate, being in fact almost amœboid in their characters. The organism does not stain by Gram's method, and does not form spores, and may in this way be easily differentiated from the preceding group.

Certain varieties of the *Proteus* group may be pathogenic, and a gas-forming variety is well known. The organism is motile, and grows readily on all ordinary laboratory media, but without the curious wrinkled surface growth of the *B. mesentericus* or *B. subtilis*.

The Bacillus lactis Group.—A very large number of organisms capable of fermenting the lactose to lactic acid are now known;

some of them are made use of therapeutically in the treatment of intestinal putrefaction and other allied pathological conditions of the intestine which give rise to auto-intoxication. The organisms are given in milk which has been inoculated with a cultivation of the lactic organisms, and subsequently incubated at blood heat for twelve to twenty-four hours.

The group of the lactic acid bacilli is a very large one. They were originally noted and described by Lister, and later by Hüeppe. They are often found occurring naturally in soil, water, and air, from whence they obtain access to milk, so that the usual London milk frequently contains numbers of these lactose-fermenting bacilli.

Certain numbers of this group have already been referred to (*B. friedlander*, *B. rhinoscleroma*, *B. ozænæ*). Certain others are found in the mouth from time to time, amongst them being the *B. cloacæ* of Jordan, and *B. oxytocus perniciosus*. These organisms differ one from another by their fermentative activity when tested on varieties of carbohydrate media; but they all of them produce gas with rapid fermentation on certain of the carbohydrates, such as glucose used for testing purposes.

The *B. coli communis* is very closely related to the *B. acidi lactici* group, but is by no means common in the mouth. I have found, as the result of extended observations, that in those mouths where rapid caries is in progress, members of the lactose fermenting group are always more numerous than in mouths in which little dental caries is apparent. Associated with them, a yeast is often to be found, and it is highly probable that these two organisms gain access to the mouth through the medium of milk. In the drink called koumiss, which is a sort of fermented milk, and in kephir, another Caucasian drink made from fermented milk, lactose fermenting bacilli, together with yeasts, are invariably present.

The chief interest of these organisms is their rapid fermentation of carbohydrates, particularly forms of carbohydrate likely to be taken as food, namely, milk-sugar or lactose, glucose, and starch, and their therefore presumable association with the process of dental decay.

A considerable number of bacteria belonging to the class of cocci are to be found in the mouth, many of them not

conforming to the usually accepted biological characters of known organisms, but differing in sometimes major, though for the most part only in minor, particulars. Only one of these deserves mention in passing, namely, the *Staphylococcus viscosis*, an organism which forms colonies of a curious sticky consistency; so hard in fact are these colonies that in attempting to remove them from the surface of agar upon which they are growing the whole of the colony is brought away intact on the end of the platinum needle. The organism forms curious irregular cocci, for the most part arranged in irregular tetrads, closely simulating the *Sarcinæ* on the one hand, and the *Micrococcus tetragenus* on the other. It differs entirely from the two, both in its mode of growth, the curious gelatinous colonies, which under the microscope have a brownish appearance with a darker mottled, reddish-brown structure, and from the fact that it rapidly produce quantities of gas when grown on nitrate broth. Carbohydrates are not fermented; the organism, however, is capable of living in symbiotic activity with various organisms capable of fermenting carbohydrates, and for this reason is probably of considerable importance in the early stages of dental caries, as its removal from the surface of teeth is an exceptionally difficult one, the curious plaque-like masses remaining firmly adherent in the interdental spaces. For further particulars of this organism the student is referred to "The Mycology of the Mouth."

As has already been stated, the majority of the organisms belonging to the last group described, that is to say, the "Non-pathogenic Bacteria which occur in the Mouth," are probably found associated with dental caries, and for the most part in the superficial layers of dentine. Among them, however, one organism deserves mention, as its presence in dental caries is so frequent that it may be almost looked upon as one of the chief organisms producing destruction of dentine.

Bacillus necrodentalis.—The *Bacillus necrodentalis* is found in the deeper layers of carious dentine, generally in association with the *Streptococcus brevis*, which it closely resembles both in its growth and its microscopical appearance. It is facultative, anaerobic, in fact grows best in an atmosphere in which oxygen in the free state is excluded. It thrives best on media containing

glucose and maltose. The bacilli are 0·75 μ broad, and 1 to 5 μ long, generally associated in pairs and chains. In the separate bacilli the ends of the bacilli are square or rounded. In anaerobic cultures threads are often produced. Oval forms are also common, the organism then taking on the appearance of a grain of barley. The organism stains by Gram's method. The colonies on agar are somewhat typical under the microscope. They differ from the streptococcus in their irregular and crenated edge and the slightly rayed appearance, the rays passing from the central

× 1,000.
FIG. 430.—*Bacillus necrodentalis.* Forty-eight hour, agar cultivation; stained Gram.

nucleus, in this way differing from the colonies of the streptococcus, which are entire and hyaline or faintly granular. Fermentation of most of the ordinary carbohydrates is rapid, including glucose, lactose, and cane-sugar; and as it is generally found deep in dentine, it is probable that it plays a considerable part in the production of dental caries. For further particulars of the cultural characters the student is referred to "The Mycology of the Mouth."

(D) PIGMENT-PRODUCING ORGANISMS OF THE MOUTH.

One other group of bacteria deserves attention, namely, those organisms capable of producing pigment. Some of the organisms already described in the previous sections produce coloured growths, such, for instance, as the *Staphylococcus aureus* and the *Bacillus mesentericus*, &c. Some organisms, as the *B. friedlander*, although not producing pigment in themselves, are able to produce sulphuretted hydrogen, thereby forming a dark sulphide with any of the heavy metals, such as iron, present in food. The dark staining seen upon the teeth is often due to *B. friedlander*. Some other organisms, though not producing active chemical changes such as sulphuretted hydrogen, produce actual pigments. The pigments are for the most part of a yellow or dirty yellow colour, and almost all the colours are formed only when the organism is growing at its lowest optimum, namely, at about 22° C., so that, for the most part, coloration is not produced in the mouth itself. Two organisms in particular, the *B. luteus* and the *Micrococcus citreus granulatus*, produce pigments at blood heat; they are frequent inhabitants of the mouth—in fact, so far as is known, occur only in the mouth. Both produce a well-marked saffron-yellow colour at blood temperature, and to them may be attributed the yellowish-brown staining seen sometimes on the anterior surfaces of the teeth, and the yellow pigmentation of some varieties of tartar. Other pigment-producing organisms are found commonly in the mouth, such, for instance, as the *Bacillus roseus*, or *Micrococcus roseus*, saccharomyces producing a red colour, as well as a streptothrix producing a red coloration; but for the most part these chromogenic bacteria do not develop their pigments until they are grown on artificial media, and at a much lower temperature than they find when growing in the oral secretions. Most bacteria, in fact, do not produce pigment at the temperature of the body, the *Bacillus pyocyaneus*, *Staphylococcus aureus*, and a few others cited, being exceptions to this rule.

In the preceding pages I have endeavoured to epitomize the most important features of the bacteriology of the mouth; the cultural characteristics and technical bacteriological descriptions have been omitted as unnecessaries in a brief survey of oral

bacteriology. Should the student desire fuller information of a technical nature for isolating and identifying any of the bacteria he is referred to the author's text-book on the subject.

The following list of books may also be consulted :—

GENERAL TEXT-BOOKS ON BACTERIOLOGY

KOLLE AND WASSERMAN. "Handbuch der pathogenen Mikroorganimen."
CHESTER. "Descriptive Bacteriology."
MUIR AND RITCHIE. "Manual of Bacteriology."
LEHMANN AND NEUMANN. "Text-book of Bacteriology."

A number of periodicals are devoted to bacteriology entirely; others contain bacteriological papers in addition to other matter.

The following periodicals may be referred to for original papers :—

Centralblatt für Bakteriology. "Originale and Referata."
Zeitschrift für Hygiene.
Annales de l'Institut Pasteur.
Comp.-rend. Société de Biologie de Paris.
Journal of Bacteriology and Pathology.
Journal of Hygiene.
Journal of Experimental Medicine.

The *Indexus Medicus* and *Baumgarten's Jahrsbuch* are useful for finding references.

K. W. G.

CHAPTER XI

Injuries of the Teeth arising from Trauma: Concussion, Dislocation, and Fracture

(A) CONCUSSION

THIS injury may give rise to slight or severe periodontitis, and may be complicated by pulpitis, which may subsequently lead to death of the pulp. The pulp may be ruptured from its connections at the apical foramen at the time of injury. In these cases, the pulp often remains quiescent, but marked discoloration of the tooth substance supervenes.

(1) **Causes.**—Concussion of the teeth may arise from direct or indirect violence. Examples of the former occur from a blow of the fist or from a cricket ball, while a fall, a blow on the chin, jumping upon the heels instead of the toes, will be examples of the latter.

(2) **Signs and Symptoms.**—Most patients presenting themselves with this injury will be found suffering from periodontitis more or less severe. In cases where the pulp has not been ruptured at the apical foramen or the inflammation of the periodontal membrane has not extended to the pulp, the tooth will be found sensitive to pressure and will respond to thermal changes in the same way as the normal tooth. Should the inflammation spread to the pulp, the tooth will become exquisitely sensitive both to pressure and to slight variations of temperature, the periodontal pain being dull, constant, and restricted to the tooth, while the pain arising from the inflamed pulp will be of a sharp lancinating character, and will be referred at times to other teeth and adjacent parts. When suppuration in the pulp occurs, the tooth will no longer be sensitive to changes of temperature, but the periodontal inflammation will increase in severity owing to

the suppuration having spread to the periosteum. The pain will be of a throbbing character.

(3) **Treatment.**—The treatment will depend upon whether or not the pulp is involved in the injury. **When the periodontal membrane only is affected,** local depletion will be found efficacious; in mild cases, counter-irritation, with capsicum plasters, tinct. iod., will be sufficient. **When suppuration of the pulp has taken place,** the pulp chamber must be opened in that direction which will render removal of the pulp most easy; the dead pulp must be removed and the canals treated and filled. In cases where concussion has caused pulp irritation, and at the end of two or three days no improvement is apparent, the pulp should be removed, as prolonged endeavours to save the pulp are nearly always followed by periodontitis of an intractable type. The following case is instructive: A patient, aged 12, fell and fractured a tooth, the right maxillary central, and lacerated the pulp. The left central was implicated by concussion. The pulp from the right central was removed, and attempts made to save the pulp in the left central, which was irritable. The periodontitis around the right tooth rapidly cleared up, but continued with the left tooth. As the pulp condition failed to disappear at the end of three weeks, the canal was cleared of the morbid pulp, sterilized and filled. Chronic periodontitis continued in spite of repeated and various treatments for four years, so that removal of both teeth was decided upon. A radiograph of the teeth showed that the root of the tooth originally fractured had been attacked by rarefying periodontitis on the aspect adjacent to the left tooth, and the root of the latter had, to a great extent, disappeared from a similar periodontal condition. If the pulps of the teeth had been removed within a few days of the injury it is probable that the periodontitis would have passed away and the teeth would have been permanently saved.

(B) DISLOCATION

(1) **Erupted Teeth.**—By dislocation is understood accidental displacement of a tooth from its normal position in its socket. Dislocation may be partial or complete. In the former, the tooth may be forced into or loosened in the socket. In the latter, the tooth is totally displaced from its socket.

(*a*) **Causes**.—Dislocation, like concussion, is the result of violence, but the injury causing dislocation is usually of a more severe nature.

(*b*) **Treatment.**—The treatment of this accident **when the dislocation is partial,** is to replace the tooth, mould the broken alveolus around it, and apply counter-irritants to the gum. In all dislocations, precautions should be taken to keep the tooth fixed, either by ligatures of silk or wire, or by a splint made of a suitable metal. **If the tooth is driven into the socket,** it should be grasped with a fine-bladed pair of forceps and carefully drawn into place. When a tooth is driven upwards towards the antrum, it is probably a safer plan to leave it alone rather than attempt its removal. If removal is considered advisable care must be taken not to completely displace the tooth into the antrum during the attempt at removal.

If the displacement is complete, the treatment will vary according to the age of the patient and the time at which the case is seen subsequent to the accident. In the young, if seen directly after the accident (as, for example, when the tooth is displaced in the operating room), the tooth should be at once replaced, as under these conditions union of the structures entering at the apex may take place (see Diseases of the Pulp, p. 504). If the patient is an adult, or is seen some hours after the accident, the pulp of the injured tooth must be removed and the canals sterilized and filled before the tooth is replaced.

(2) **Unerupted Teeth.**—The permanent teeth may be injured in their crypts from traumatism, the portion of the tooth already calcified being partially separated from the portion developing. The condition is analogous to forcible separation of the epiphysis from the shaft in a growing bone.

The calcified portion of the tooth is usually dislocated in such a manner as to form an angle with the developing portion (see figs. 431 to 433). In the case of premolars the calcified portion occasionally appears to be forced into the developing part, causing a kind of impacted dislocation (see figs. 434 to 436). It is quite possible that this condition is at times due to careless removal of the deciduous teeth. Dislocation of unerupted teeth is more common in the anterior teeth, since they are more liable to injury. Injury to the developing maxillary canine is rare owing to the position it occupies in the bone.

The injury may occur in the crown or root, the position depending upon the time of the receipt of the injury.

When erupted these teeth often present a marked bulging at the neck, and marked mobility, and it is at times possible to trace the root through the alveolar wall. Teeth which can be felt high up in the alveolar wall, and which fail to erupt, may be suspected of having been the subjects of this form of injury.

FIG. 431.—Mandibular incisor.

FIG. 432.—Mandibular incisor.

FIG. 433.—Maxillary central incisor.

FIG. 434.—Maxillary first premolar.

FIG. 435.—Mandibular premolar.

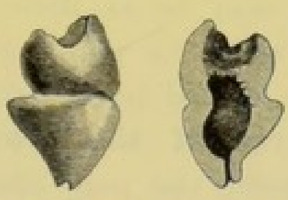


FIG. 436.—Mandibular premolar, from specimen in possession of Mr. G. G. Campion.

(C) FRACTURE

The maxillary front teeth are more frequently fractured than any of the others.

(1) **Causes.**—The causes of fracture are generally direct or indirect violence, such as a blow from a cricket ball, a kick from a horse, blow on the chin, &c. Biting upon hard substances in food, such as shot in game, frequently causes fracture in the back teeth, especially when they are weakened by caries.

(2) **Degree of Fracture.**—The fracture varies considerably in degree. There may be :—

(*a*) Slight cracks or fissures involving the enamel only, without loss of substance.

(*b*) Various degrees of chipping of the enamel alone, or of the enamel and dentine, without exposing the pulp.

(*c*) Transverse fracture involving the pulp chamber: (i.) in the crown; (ii.) in the root.

(*d*) Longitudinal fractures.

(*e*) Oblique fractures.

(3) Treatment.—Group (*a*) does not require treatment.

In group (*b*), if the fracture involves only enamel, it will be necessary to smooth the rough edge or edges with suitable instruments and polish the surface. Should the dentine be exposed, it may be found hyper-sensitive, especially in young patients. There will also be hyperæmia of the pulp, characterized by extreme sensitiveness to heat and cold, and pain on pressure owing to the congestion extending to the periodontal membranes around the apex. The treatment is to employ counter-irritants or local depletion, at the same time applying to the exposed dentine local applications, such as absolute alcohol, nitrate of silver, or chloride of zinc. The symptoms usually subside, and at a later period the tooth and its neighbour should be trimmed in such a way that the disfigurement may be as little noticeable as possible. Should suppuration occur in the pulp from continued irritation, the pulp cavity must be opened and treated in the usual way.

Transverse fractures of the crowns of the anterior maxillary teeth, involving the pulp chambers. The treatment will depend upon:—

(i.) The age of the patient.

(ii.) The sex of the patient.

(iii.) The presence or absence of a crowded condition of the teeth.

(i.) *Age of the Patient.*—The formation of the root of the central incisor should be complete at about the age of ten years and of the lateral incisor at about ten and a half years. With fractures, previous to this age, the prospects of retaining the teeth with a view to subsequent crowning are unfavourable. The prospects of successful treatment diminish with the youthfulness of the patient. The problem to be decided in these cases is whether it is better to remove the tooth, allow the space to close and dis-

regard the æsthetic question, or to regard the question of personal appearance as of more importance and retain the space, a denture with all its attendant disadvantage to the other teeth being inserted at a later period. When fractures occur after the completion of the root, the pulp should be removed and the canals treated; crowning can then be carried out at a future date.

(ii.) *The Sex of the Patient.*—The loss of an incisor to a boy is of less æsthetic importance than to a girl.

(iii.) *The Presence or Absence of Crowding of the Teeth.*—In cases of doubt as to the advisability of saving or removing the fractured tooth, the question of crowding is important. If the teeth are crowded there is a reasonable probability that the space created by the loss of the tooth will close up completely, but, if there is no crowding, it is highly probable that the space will remain permanently. Each case must be treated on its merits. The following illustrative cases may be useful.

In **fracture of a maxillary central incisor in a boy** under the age of nine, removal of the tooth is to be recommended. In a boy the æsthetic question does not outweigh the advantages of avoiding a denture.

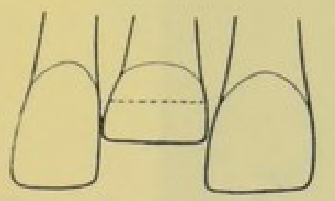


Fig. 437.

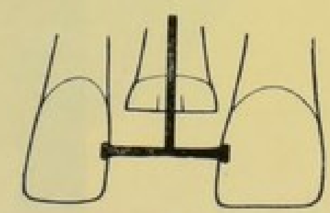


Fig. 438.

Fracture of a maxillary central incisor in a girl under the age of nine. The pulp of the tooth should be removed and the canal packed with a suitable filling. If the fracture is in the position shown in the diagram (fig. 437), the neighbouring teeth will not tend to approximate. If the fracture is near the region indicated by the dotted line, there will be a tendency for the neighbouring teeth to approximate. Steps must therefore be taken to keep them apart by means of a stay fixed in the pulp chamber of the injured tooth, as shown in fig. 438. If periodontitis occurs around the fractured tooth, the tooth should be removed and measures adopted to prevent the approximation of the adjacent

teeth. If a crowded condition of the teeth in the future seems possible, the tooth or space should still be retained and steps taken at once to treat the crowding by removal of the unerupted premolars.

Fracture of lateral incisors in boys or girls under the age of ten should be treated by removal. In the case of a girl, the appearance of the slightest crowding of the teeth on the opposite

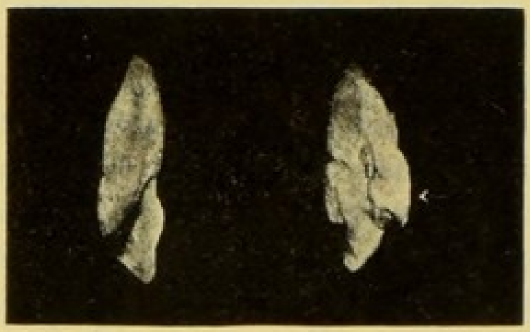


FIG. 439.[1]—The two outer surfaces of tooth from which the section (fig. 441) was removed.

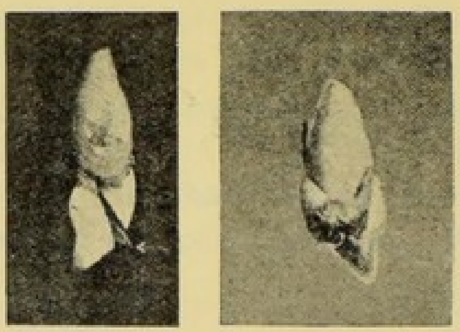


FIG. 440.[1]—The inner surfaces of the preceding figure (fig. 439).

side of the mouth should be relieved so as to prevent as far as possible the centre of the mouth shifting (see p. 148).

In fractures occurring subsequent to the period at which the growth of the root is completed, the patient should be anæsthetized, the pulp removed and the canal filled, and, at about the eighteenth year, the tooth crowned. In cases of fractured

[1] From *Trans. Odonto. Soc.*

upper lateral incisors in crowded mouths, the removal of the tooth may be advisable. The decision must be based upon the sex of the patient and the direction of the root of the canine.

Fractures of the Mandibular Incisors.—In nearly all cases removal is best. The space, even if it does not completely close, is not very noticeable.

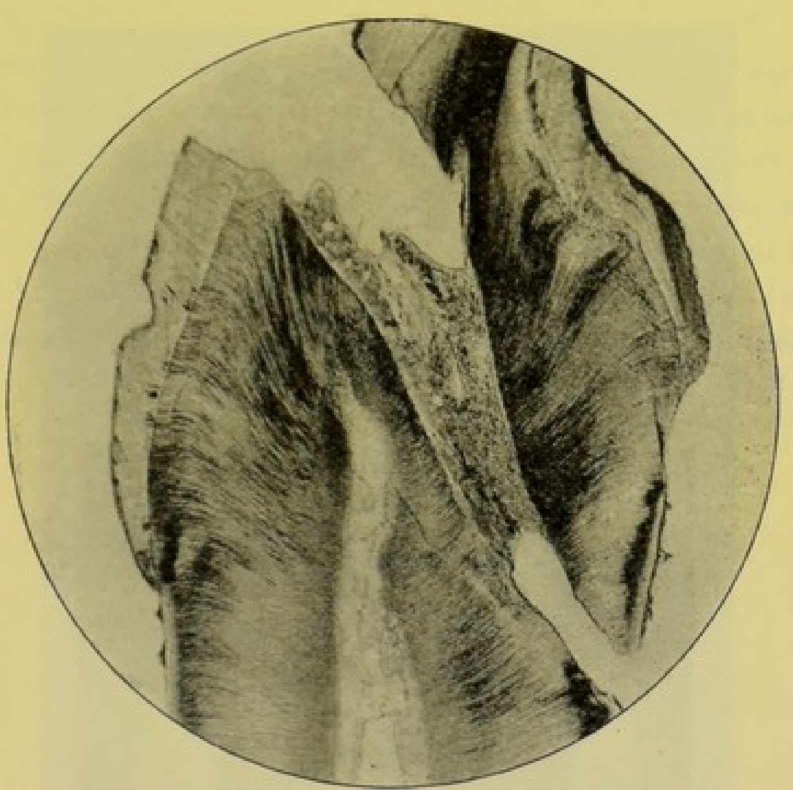


FIG. 441.—From a photomicrograph lent by Mr. F. J. Bennett.

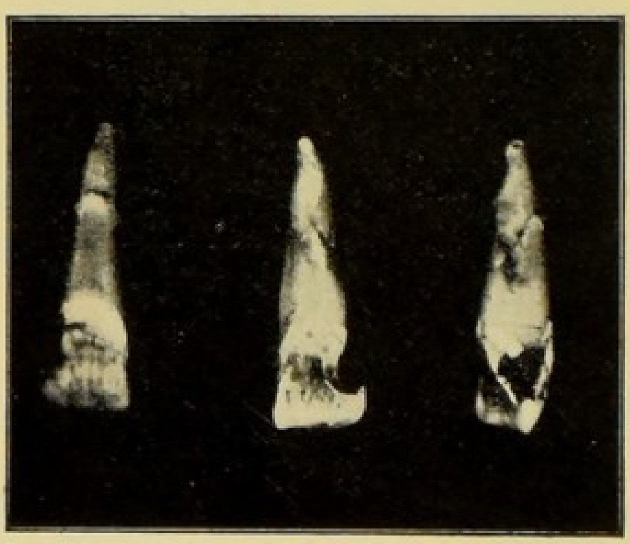
Transverse fracture of the root and oblique fractures, if high up, will be best treated by extraction, but if the fracture does not involve much of the root it can be treated upon the same principles as transverse fracture of the crown. When near the apex of the root, the fracture is at times difficult to diagnose. In all suspected cases a radiograph should be obtained. In fractures running in a longitudinal direction the tooth should be extracted.

Fractures of the posterior teeth occur usually in adults; the treatment resolves itself into one of two courses. If the fracture is transverse and in such a position that the roots are involved, extraction must be resorted to; but in those cases in

which the root is uninjured restoration of the crown should be carried out.

(4) **Healing of Fractured Teeth.**—Union of fractured teeth may take place, and a few cases have been recorded. The union is similar in character to that which takes place in bone. In a case quoted by Wedl, and shown in his "Atlas of Pathology," union was effected by means of the periodontal membrane and the pulp.

A rare example of union of a fractured tooth was recorded by Mr. Storer Bennett.[1] A maxillary incisior had been fractured across the crown. The patient was 17 years of age, and ten months previously had fallen down, struck the tooth and dislocated it upwards, when it became impacted and remained until removed owing to pain. The tooth is shown in figs. 439 and 440. The bond of union is of a cavernous character, with numerous spaces for blood-vessels (see fig. 441).



Front. Posterior surfaces. Distal.

FIG. 442.[2]

In longitudinal fractures or separation of the roots in multiple-rooted teeth, where the movement of the fractured parts is slight, the application of a tightly fitting band around the neck of the tooth may be tried with a view to aid healing.

Fractured roots are more likely to unite when the fracture is

[1] *Trans. Odonto. Soc.*, vol. xxviii, p. 181.
[2] From *Dental Record*.

near the apex, because the fragments are kept in fairly accurate apposition by the socket of the tooth. An excellent example is recorded by Mr. G. W. Watson.[1] The right maxillary central incisor of a man, aged 24, was loosened by a blow from a cricket ball. The tooth remained loose and painful for a month after the injury and was slightly misplaced inwards, but eventually became firm and serviceable again. About six years subsequently the

FIG. 443.[2]—Showing groove on surface of root.

tooth was removed, and it was then seen that the blow had fractured the root and repair had followed. The appearance of the tooth was as follows: "About a quarter of an inch from the apex of the root on its labial surface there was a deep, somewhat irregular crescentic groove, continued halfway round the median and distal surfaces. Radiating from these two points and extending round the lingual surface of the tooth was a series of comminuted fractures running in all directions." Illustrations of the tooth are shown in figs. 442 and 443.

[1] *Dental Record*, May, 1906, p. 216.
[2] From *Dental Record*.

CHAPTER XII

Caries of the Teeth

Prevalence of Caries—Frequency in Individual Teeth—Morbid Anatomy and Pathology—Spontaneous Arrest of Caries—Experimental Reproduction of Caries—Susceptibility and Immunity to Caries—Etiology—Symptoms

OF all the diseases to which human beings are subject, caries is by far the most prevalent. It is found in all races of mankind past and present, but more particularly in civilized races.

(A) PREVALENCE OF CARIES

(1) ANCIENT RACES

Mr. J. R. Mummery[1] examined skulls from "the ancient tumuli of Wiltshire and other parts." In 68 skulls from the older Wiltshire tumuli, which date back to the Stone Age, only two cases of caries were discovered, one on an approximal surface and one on an occluding surface. These people were a pastoral and not an agricultural race. They lived by the chase and their customs were barbarous. Among 44 skulls of a similar race inhabiting more northern districts of England, 9 cases of caries were found, 4 on occluding and 5 on approximal surfaces. In 32 skulls of a later race (Bronze Period,) there were 7 cases of caries, 6 on approximal and 1 on occluding surfaces. (This race was probably the agricultural population of the maritime districts referred to by Cæsar in his "Commentaries"). The skulls of Romans found in England also furnish ample evidence of caries.

[1] *Trans. Odonto. Soc.*, vol. ii, N.S. Over 3,000 skulls were examined, and, of these, 1,658 were tabulated, the remainder being rejected either in consequence of their doubtful authenticity, or because too many teeth were missing. This work of Mr. Mummery entailed a vast amount of labour, and is one of the most valuable contributions to the dental literature of the sixties.

In 143 examples, about 32 per cent. showed signs of caries, and in one instance the disease was extensive. Passing to the Anglo-Saxon period, we find that in 76 skulls caries was present in 12 cases.

Egyptian mummies to the number of 36 were examined, and, in 11, signs of approximal decay were present.

(2) EXISTING PRIMITIVE RACES

In an examination of existing primitive races, Mr. Mummery found evidence of caries in all of those of which statistics are given. His statistics also bring out the fact that caries is more prevalent in races existing wholly or mainly on vegetable food than in races whose diet consists chiefly of meat.

The following is a *résumé* of the section of Mr. Mummery's paper dealing with existing primitive races:—

The Esquimaux, a people of nomadic habits inhabiting the littoral in the extreme north, living almost entirely on a meat diet, of which huge quantities —10 to 14 lb. per person—are consumed daily. In 69 skulls examined, only one case of caries was found. In another instance, two molars had been removed.

The Indians of the North-west Coast of America, whose diet is chiefly dried fish. In 51 skulls two cases of caries were found.

North American Indians (interior). Diet—meat, with occasional addition of roots. Often subject to great privation. Twenty-one skulls showed two cases of two carious teeth in each.

The Gauchos, a mixed race of Indian and Spanish blood in the Argentine Republic, occupied on ranches and living mostly on horseback. Diet—entirely "roast beef," with Paraguay tea taken without sugar as their sole beverage. No record of skulls examined is given, and only one case of toothache could be traced.

In Indians of the same race inhabiting the towns and indulging greatly in artificial diet (acid confectionery and inferior wines, &c.), caries was prevalent.

Arabs of the Nubian Desert, living on a diet consisting almost wholly of the milk and flesh of camels, possess, according to observers, sound and well-formed teeth.

The Fiji Islanders, a robust race, addicted to cannibalism. In 38 skulls there were only two instances of caries, in one case two teeth being affected and caries being extensive in the other case.

The New Zealanders, whose habits resemble the Fijians. In 66 skulls there were two cases of caries, in one of which two teeth and in the other four were affected.

The Inhabitants of Eastern Polynesia. Diet—vegetable products and fish. In 70 skulls there were eight cases of caries, a large proportion of them being extensive.

The Sandwich Islanders. Diet—mainly vegetable with small amount of meat. In 21 skulls there were four cases of caries, two of which were very extensive.

The Australian Races. "For the most part improvident savages, and spending their lives in alternate feasting and famine." Diet—mainly meat, 132 skulls showed 27 cases of caries, some being extensive.

The Tasmanian Race closely resemble the Australian in habits. In 33 skulls examined nine cases of caries were found, and, in the majority of these, a considerable number of the teeth were affected.

The Zulu Kaffirs. Diet—milk and vegetables, meat being consumed on special occasions, as in the training of their warriors. In 49 skulls there were seven instances of caries, five of which were of very limited extent.

The African Tribes which supply the Slave Markets. The most feeble of the African tribes, mainly inhabiting unhealthy districts. Diet—mixed, principally vegetables. The skulls of 268 slaves who had died of disease or exhaustion were examined. In 66 caries was present, many of the cavities being in approximal surfaces. In no less than 16 of the cases the whole of the molars and premolars were carious.

The Bushmen. Dwarfs inhabiting the deserts of South Africa. Diet—chiefly meat, but in times of scarcity edible roots, locusts, &c. In 29 skulls six cases of caries were found, the majority being extensive.

The Natives of Southern India. Diet of a varied character, frequently of an unwholesome nature. Rice forms the staple food, sweetmeats are much indulged in. In 71 skulls ten cases of caries, in three of which six teeth were involved.

The Natives of Northern India. Diet—vegetables of a simple and wholesome character, staple food being wheat. In 152 skulls nine cases of caries, and in no instance more than two teeth affected.

An interesting report on the examination of old human crania deposited in the principal museums of the United States is published in the *Transactions of the American Dental Association*, 1894, and is well worthy of perusal by those wishing to investigate the subject.[1]

[1] The following is a *résumé* of the results obtained :—

Total number of teeth examined	46,657
,, ,, ,, diseased	11,338
Percentage of diseased teeth	24·3

The crania were grouped geographically as follows :—

Country	Number of teeth examined	Number of teeth diseased	Percentage of diseased teeth
South America	6,719	2,462	36·6
Central America	930	250	26·8
North America	27,362	5,811	21·2
Europe (including Anglo-Americans)	3,422	1,373	40·4
Pacific and Sandwich Islands	2,738	417	15·25
Egypt	3,306	689	20·8
Asia	2,180	336	15·4

(3) MODERN CIVILIZED RACES

Among modern civilized races the percentage of mouths containing carious teeth has increased to an alarming extent. The collective investigations of the British Dental Association have shown that out of 10,500 English and Scotch girls and boys, averaging 12 years of age, there are no less than 37,000 unsound teeth (deciduous and permanent). In all, 86 per cent. of the mouths showed that caries was present in one form or another.

The subjoined table shows the relative ratio per hundred of children with unsound teeth, defective deciduous teeth, and defective permanent teeth. The figures afford an illustration of the early age at which the decay begins, and also of the progressive increase of the disease as children grow older.

Age period	iv.-vi.	vii.-ix.	x.-xii.	xiii.-xv.	xvi.-xviii.
Number examined	744	1,716	3,071	2,376	268
Sound (no decay)	23·8	14·2	16·1	14·1	6·4
Defective temporary teeth only	67·4	43·3	18·3	5·1	0·1
Defective permanent teeth—					
1–4	8·8	41·5	55·9	51·9	37·3
5–8	—	1·9	8·5	22·9	32·6
9 or more	—	—	1·2	6·0	23·6
	100	100	100	100	100

The foregoing figures relate to children attending the Poor Law schools, workhouses, and reformatories. Equally unsatisfactory conditions have been shown to exist among children in better circumstances; for example, in 560 boys, average age 13 years 7 months, belonging to one of our large public schools, 701 of the permanent teeth had been lost, while 3,521 were carious. In the mouths of 87 per cent. of the boys caries was present. In America, Germany, Hungary, and other countries, similar investigations have yielded much the same results. The investigations of Unghvari (Hungary) and Berten (Wurzberg) show the

[1] Memorandum in regard to the condition of the teeth of school children. Published by the British Dental Association, p. 64, showing the relative ratio per hundred children having unsound teeth, defective temporary teeth, and defective permanent teeth.

percentages of carious teeth to be 87·2 and 83; while Röse, in an extended inquiry in Baden and Thuringia, and Fenchel (Hamburg) showed caries present in 98·75 per cent. and 96·4 per cent. respectively. The statistics of the latter observers would tend to show that as regards caries the teeth of English children compare favourably with those of German children.[1]

The foregoing figures are sufficient to illustrate the appalling ravages of dental caries among modern races. It is satisfactory to know that other investigations have brought forth results which show more hopeful conditions. For example, Mr. C. M. Cunningham[2] found that in the inhabitants of the Arran Islands fifty-four children showed thirty-three perfect dentures, and clinical experience undoubtedly shows that in the children of the more intelligent sections of the community the number of perfect dentures is increasing.

Caries in Animals.—In the horse, caries is by no means a rare disease, and in an examination of 484 skulls caries was met with in 66.[3] In some cases the condition was slight,

[1] The following communications on this subject are of interest:—

The various reports of the School Children's Committee appointed by the British Dental Association.

Voerckel and Weber. "On the Care of the Teeth of Children in the National Schools of Elberfeld and Witten," *Deutsche Monatsschrift für Zahnheilkunde*, translated in Ash's *Quarterly Circular*, December, 1899, and March, 1900.

Röse. "On the Decay of Teeth in the National Schools of Germany," *Oesterreich-Ungarische Vierteljahrsschrift für Zahnheilkunde*, translated in Ash's *Quarterly Circular*, March and June, 1895.

Unghvari. *Oesterreich-Ungarische Vierteljahrsschrift für Zahnheilkunde*, translated in Ash's *Quarterly Circular*, September, 1896, p. 353.

Berten. *Aus den Sitzungsberichten der Würzburger physik. med. Gesellschaft.*, 1894, xv. Sitzung, November 17.

Fenchel. "Die Caries Frequenz Hamburger Schulkinder," *Correspondenz-Blatt für Zahnärzte*, October, 1893.

Ottofy. Addendum in Parreidt's "Compendium of Dentistry," Chicago, 1889, p. 57.

Cunningham, C. M. "An Examination of Teeth in the Arran Islands, co. Galway," *Journ. Brit. Dent. Assoc.*, vol. xviii, p. 652.

[2] "An Examination of Teeth in the Arran Islands, co. Galway," *Journ. Brit. Dent. Assoc.*, vol. xxiii, p. 652.

[3] "Variations and Diseases of the Teeth of Horses," J. F. Colyer, *Trans. Odonto. Soc.*, vol. xxxviii, p. 42.

whilst in others extensive destruction of the teeth had occurred (see fig. 444). Owing to the arrangement of the dental tissues, the carious tissue is removed in a great measure during mastication, so that more or less cup-shaped depressions, lined with a thin layer of softened tooth tissue, are formed. Caries is met with in the dog (fig. 445) and certain animals in captivity, such as the monkey and rodents.

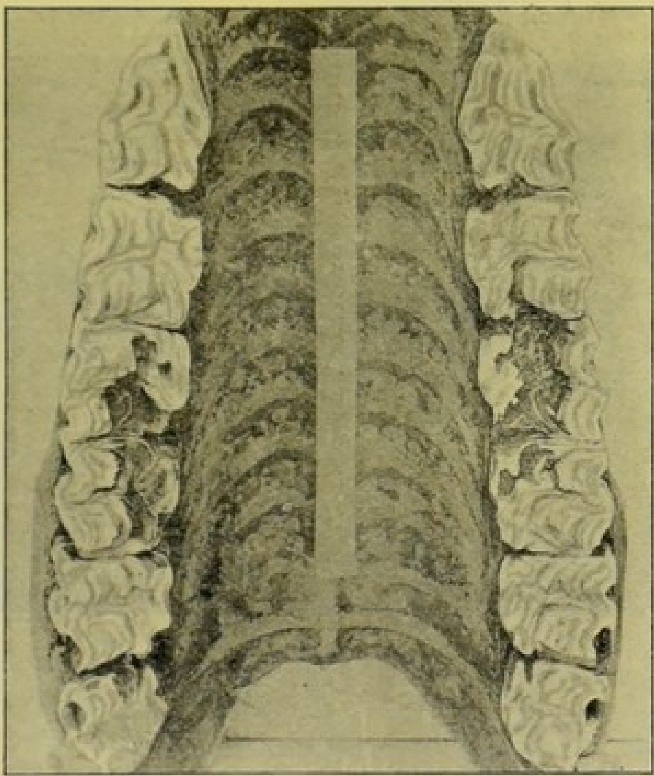


FIG. 444.[1]—Maxillæ of a horse showing extensive caries of the teeth.

(B) FREQUENCY IN INDIVIDUAL TEETH

The various groups of teeth are subject to caries in different degrees. The statistics bearing on this question are nearly all derived from records of extractions, and it is needless to say that statistics so obtained will not correctly indicate the relative tendency to caries in the different teeth. The first permanent molars are more subject to caries than other teeth, and the mandibular more than the maxillary. These teeth are erupted early, and the liability to caries is due to the unhygienic conditions in the mouth at this period rather than to any inherent

[1] From *Trans. Odonto. Soc.*

structural defect. The caries nearly always commences on the occluding surface. These teeth are probably less liable to approximal decay than the maxillary premolars. The second molars probably follow the first molars in their liability to caries, the mandibular being attacked more frequently than the maxillary. It is extremely difficult, without trustworthy statistics, to place the incisors and premolars correctly as regards their liability to caries. From experience, there seems

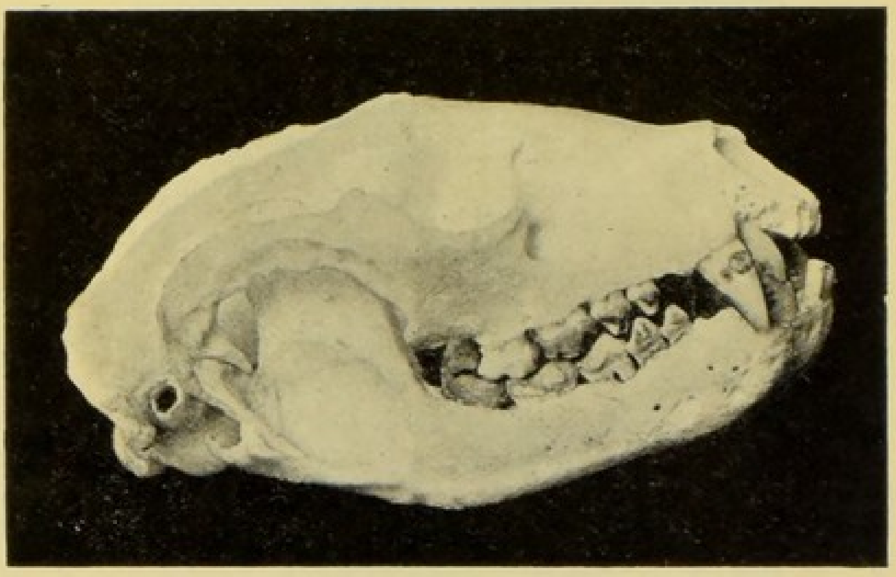


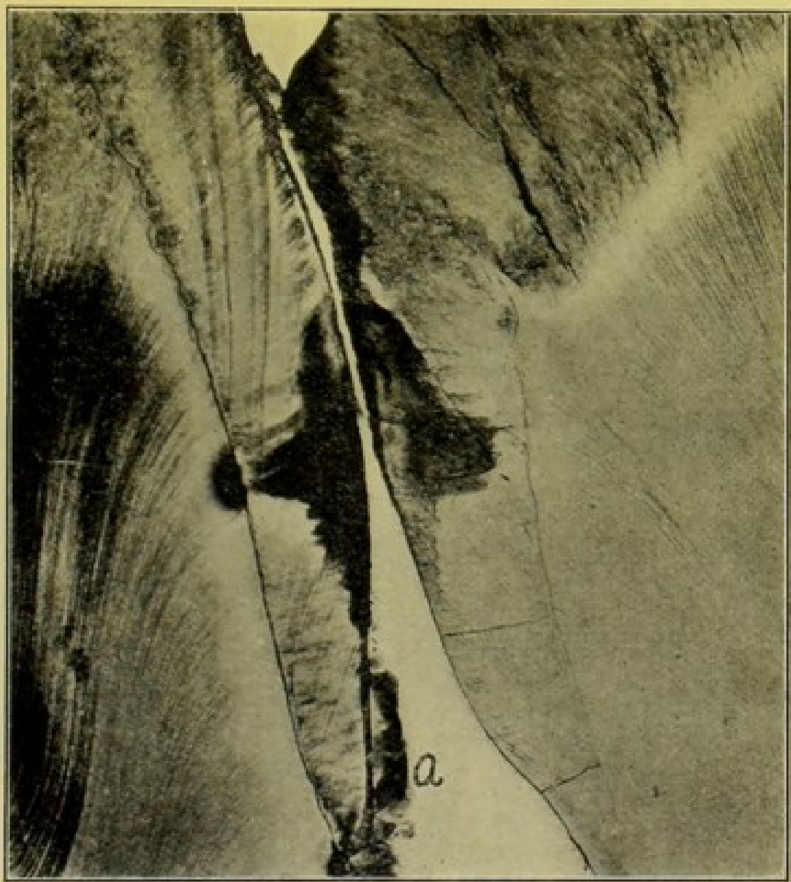
FIG. 445.—Skull of a dog showing caries on the labial aspects of the tooth.

little to choose between the first and second maxillary premolars in this respect, but with regard to the mandibular premolars the liability to caries is more marked in the second than in the first. The mandibular incisors are comparatively immune to caries, and this is due as much to their shape as to the constant mechanical cleansing action of the tongue and lips. The liability of the third molars to caries in mouths where all the teeth are present is attributable to difficulty in keeping them free from the lodgment of food *débris*.

Frequency in Relation to Sex and Age.—It is generally supposed that caries is more common in females than males. The observation of Röse[1] on 6,280 children, boys and girls

[1] Röse: "On the Decay of Teeth in the National Schools of Germany," *Oesterreich-Ungarische Vierteljahrsschrift für Zahnheilkunde*, translated in Ash's *Quarterly Circular*, March and June, 1895.

being about equally divided, showed the percentage of caries in boys to be 26 and girls 26·2. Caries is more active during the period of growth of the individual than subsequently. A fresh period of activity often appears with conditions which lead to exposure of the roots of the teeth, the caries commencing in the cementum.



× 35.

FIG. 446.[1]—Decalcification of the enamel without loss of substance (Miller).

(C) MORBID ANATOMY AND PATHOLOGY

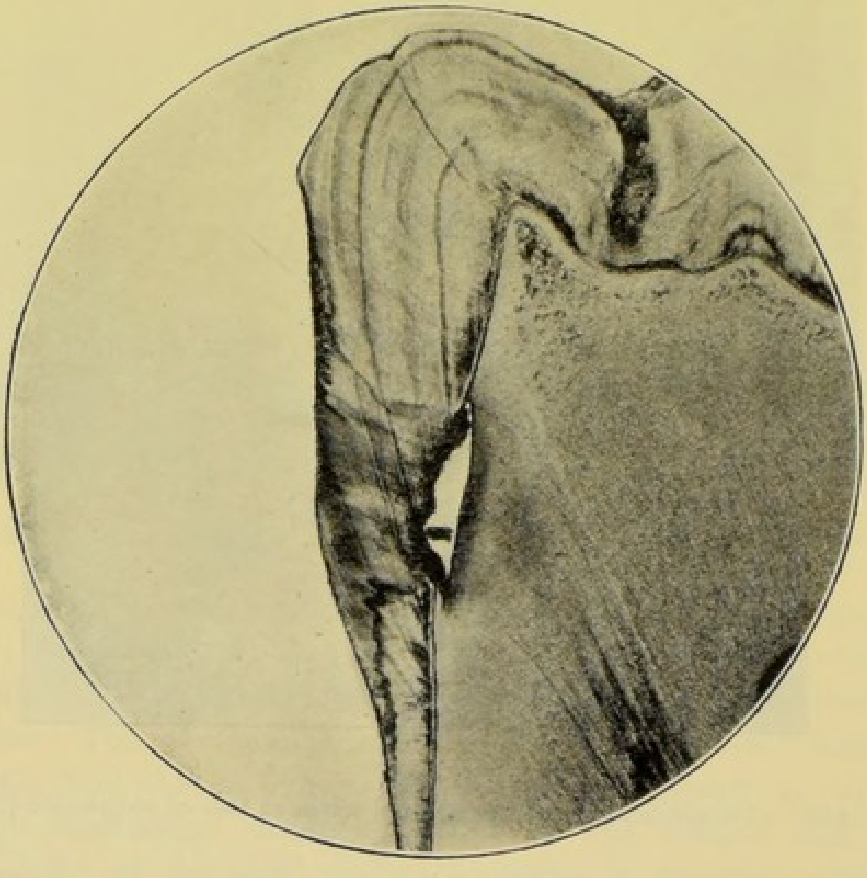
(1) MACROSCOPICAL APPEARANCES

(*a*) **Enamel.**—In the enamel, the naked-eye appearances of caries can best be observed upon the approximal side of a molar or premolar. The first sign to indicate the presence of caries is that the enamel loses its normal polish and translucency.

[1] From *Dental Cosmos*.

Following this, a whitish spot appears which gradually becomes darker. When the process is slow, the discoloration is more marked than when the process is rapid. As the enamel prisms become disorganized, they are mechanically washed away and a cavity is left which varies somewhat in form, being sometimes broad and shallow with indistinguishable margins, at other times deep with sharp, rugged margins. The destruction advances until the dentine is reached.

At times decalcification may have attacked the dentine before any disintegration of the enamel has occurred (see fig. 446).



× 25.

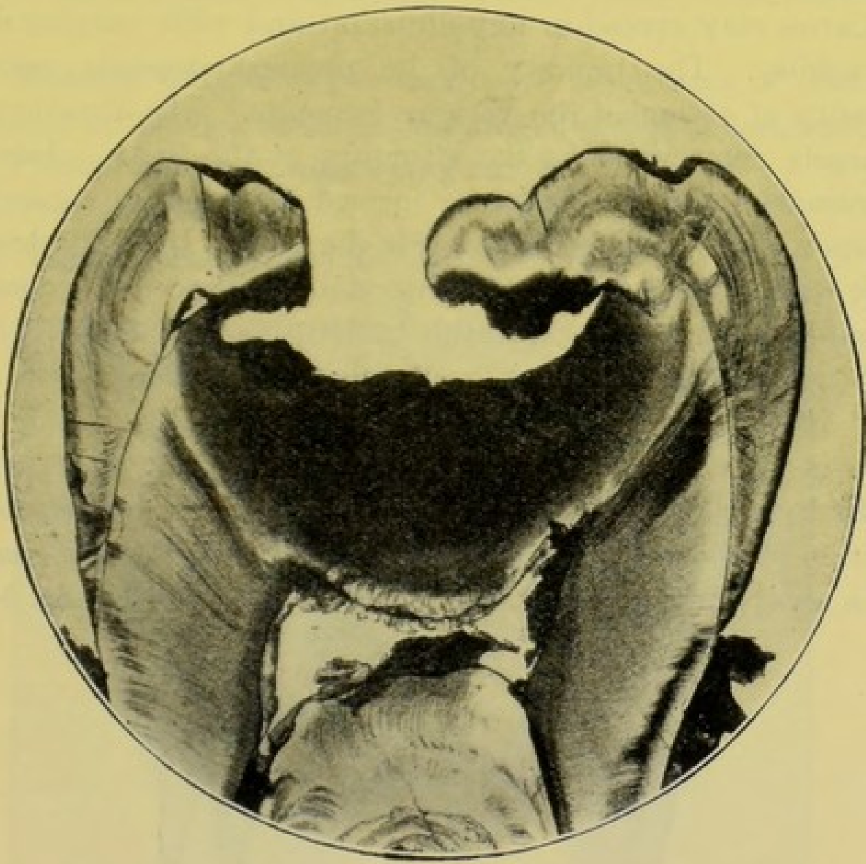
FIG. 447.[1]—Primary and secondary caries of enamel, showing marked difference in their character (Miller).

In caries commencing on the interstitial aspects of the teeth, the actual point of contact is not always decalcified, but around it is a zone showing decalcification. This zone corresponds

[1] From *Dental Cosmos*.

to area on the tooth where fluid would be held by capillary attraction.

When the decay which has started on an approximal surface reaches the under surface of the enamel of the crown (as is frequently the case in molars and premolars), the enamel at that part appears bluish-white and translucent, especially by artificial light. This appearance is produced by the decalcified



× 10.

FIG. 448.[1]—Secondary caries of enamel. The acid destroys the enamel as it advances. Apparent increased transparency of the enamel (Miller).

tissue which has not been removed by the saliva. As the caries reaches the surface, the enamel appears whiter, and eventually becomes so thin that mastication fractures it, and the under surface is found to be of a soft, cheesy consistency. Caries commencing on the dentinal aspect of the enamel and proceeding to the surface is known as "secondary enamel decay" (figs. 447 and 448).

[1] From *Dental Cosmos.*

(*b*) **Dentine.**—The appearances of caries in dentine differ considerably from those in enamel. This tissue becomes of a tough cartilaginous consistence, and not soft and cheesy as with the enamel. After softening, the tissue undergoes disintegration and a cavity is formed. Pigmentation accompanies the process and, as in caries of the enamel, the discoloration depends to a great extent upon the rate of progress of the disease.

Caries may spread in any direction and with varying degrees of rapidity. The rapidity of its progress depends upon the intensity of action of the various ferments. The direction taken is largely determined by the structure of the tooth. In a tooth of ordinary structure the cavity formed is somewhat cone-shaped, the apex of the cone being towards the pulp. In badly developed teeth with a large number of interglobular spaces, the decay will extend laterally and considerably undermine the enamel, whilst in teeth where the dentine is well calcified the decay will extend more in the direction of the pulp than laterally, giving rise to what is known as "penetrating caries."

In hypoplastic teeth the caries often extends rapidly near the junction of the enamel with the dentine, and causes the enamel to break away, producing an appearance as illustrated in fig. 449.

FIG. 449.

In "rapid caries" the dentine can be removed in large leathery masses, the action of the acid being more rapid than that of the peptonizing organisms. This condition is called **"caries humida."** When the carious process is slow, the action of the peptonizing organisms almost keeps pace with the action of the acids.

(*c*) **Cementum.**—Caries of the cementum is less common than caries of the dentine or of the enamel. It generally starts

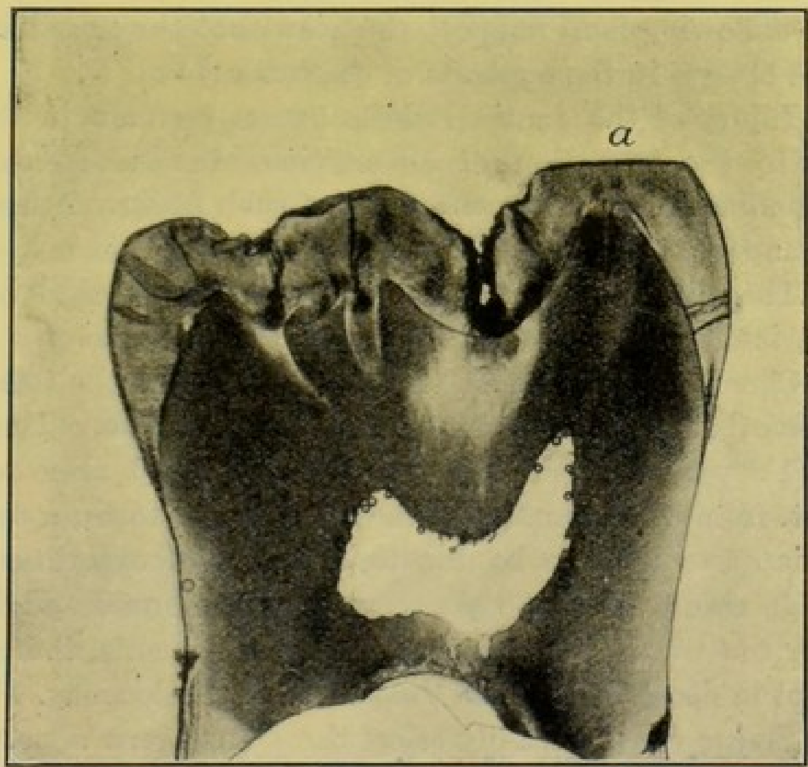
at the neck of the tooth, though it may attack any part of the root when the roots are exposed through loss of the periodontal membrane. The cemental tissue first becomes softened, and disintegration follows, leading to the formation of shallow cavities. The cavities become widely extended, but owing to there being no circumscribed points of retention or foci of decay, they are seldom deep. An exception, however, occurs at the angle formed by two roots of a molar, the cavity at these points often becoming deep.

(*d*) **Enamel Cuticle.**—The naked-eye appearance of decay of the enamel cuticle is a more or less pronounced discoloration.

(*e*) **Phenomena accompanying caries**:—

(i.) Translucency.

(ii.) Pigmentation of the disintegrated parts.



× 10.

Fig. 450.[1]—Section of molar showing typical transparency. At (*a*) transparency, resulting from abrasion of the cusp (Miller).

(i.) **Translucency.**—If the dentine of a tooth in which caries is in progress be examined, it will be found that in the part

[1] From *Dental Cosmos.*

situated between the pulp and the caries the tissue appears translucent (fig. 450). The translucent zone is best observed in those teeth where the enamel only is attacked and the dentine is perfectly sound. The affected area assumes the shape of a cone with its apex towards the pulp, and on either side of this area two opaque lines will usually be seen.

There is a difference of opinion as to the cause of this translucency. The opacity of normal dentine is due to the fact that the matrix and the contents of the tubes have different refractive indices. If from any cause these indices are approximated the dentine becomes translucent. The difference in the refractive indices would be removed: (1) If the matrix were transformed so as to resemble the contents, *i.e.*, by *decalcification of the matrix*; (2) if the tubes became filled with materials resembling the matrix, *i.e.*, by *calcification of the tube contents*.

The following facts support the view that the translucency is due to a change in the contents of the tubes:—

(*a*) Injury of the dentinal fibrils causes reaction in the pulp, leading to the formation of adventitious dentine at the point corresponding to the commencement of such fibrils on the surface of the pulp.

(*b*) The diameter of the tubes, according to Walkhoff and Baume, is distinctly lessened in the translucent zone.

(*c*) Chemical analyses of the dentine forming the translucent zone have been carried out by Miller and Jeserich. The former found 71·9 per cent. ash from translucent zone dentine and 72·1 per cent. from the normal dentine of the same teeth, a difference which is quite likely to be due to an error of experiment. Dr. Jeserich's results gave 68 per cent. for the normal and 69·5 per cent. for the translucent dentine. The experiments, therefore, do not point to decalcification as the cause of translucency.

(*d*) Stains do not readily affect the translucent zone. Partially decalcified dentine is readily stained with eosin, but the stain has little effect on the translucent zone.

(*e*) Mr. Charters White has found that in specimens in which the dentinal tubes are permeated with coloured collodion the tubes in the translucent zone are only slightly permeable.

(*f*) If the translucent zone were the result of decalcification we should expect to find it in all sides of the carious cavity, but

this was not the case, the only portion of the dentine affected being that containing fibrils which have been injured by the carious process.

(*g*) In artificial caries the translucent zone is absent.

(*h*) In caries progressing in pulpless teeth the translucent zone is not present. Miller examined sixty teeth which had been worn in the mouth on plates. Most of the teeth showed various stages of decay, but translucency was only present in one. Even in that one it was impossible to say that the translucency had not originated when the pulp was alive.

The theory that translucency is due to decalcification of the matrix depends mainly on the statements of certain observers that the translucent zone is present in teeth used as artificial substitutes.

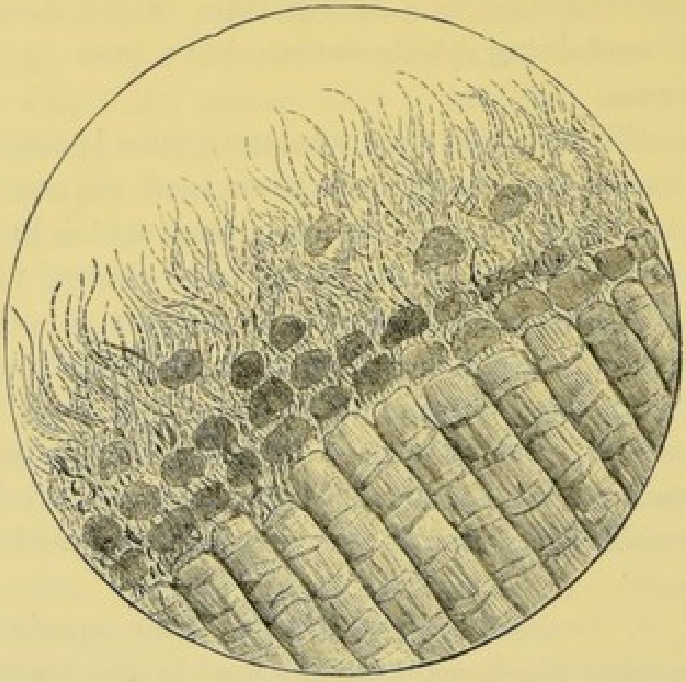
Mr. F. J. Bennett[1] states that in some specimens he has noticed the tubes thickened and enlarged in the translucent zone. He is of the opinion that in a specimen of a maxillary central incisor which had been mounted on a plate and afterwards affected by caries he found a translucent zone. It would, however, be exceedingly difficult to prove that the translucency was not present in this tooth prior to its use as a substitute.

(ii.) Pigmentation.—The pigmentation accompanying caries varies from a pale yellow to a black; the more acute the process, as a rule, the lighter the colour. As the discoloration in carious teeth is produced solely by outside agency and is also seen in dentine free from caries it may be safely assumed that it is merely an incidental phenomenon of the disease and not an active agent in producing the disease. The discoloration is in all probability produced by the action of chromogenic bacteria.

(2) CHEMICAL CHANGES

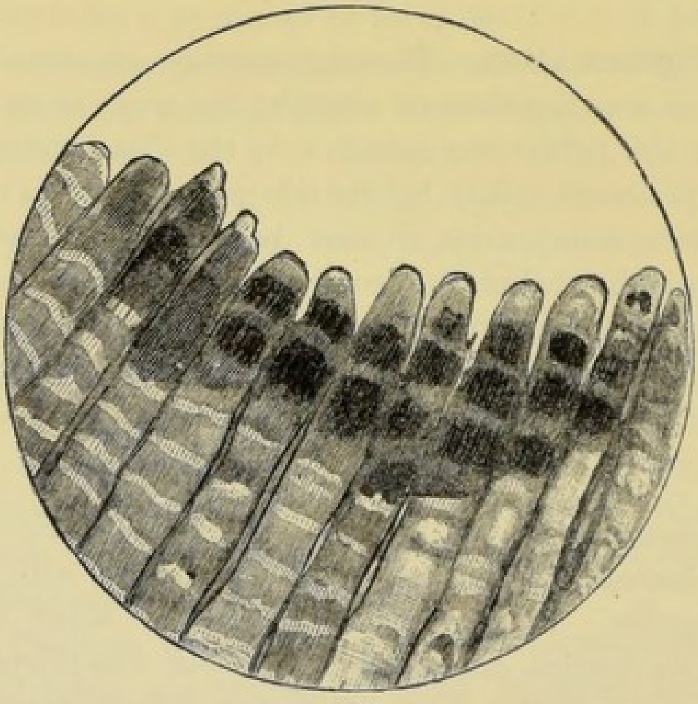
The chemical changes which take place in carious teeth consist in a decrease in the amount of lime salts, with loss also of organic matter. In analyses undertaken by Miller it was found that carious dentine contained only about one-thirteenth of its original amount of lime salts while the organic material was also reduced by two-fifths.

[1] *Trans. Odonto. Soc.*, vol. xxvii, 1895, p. 155.



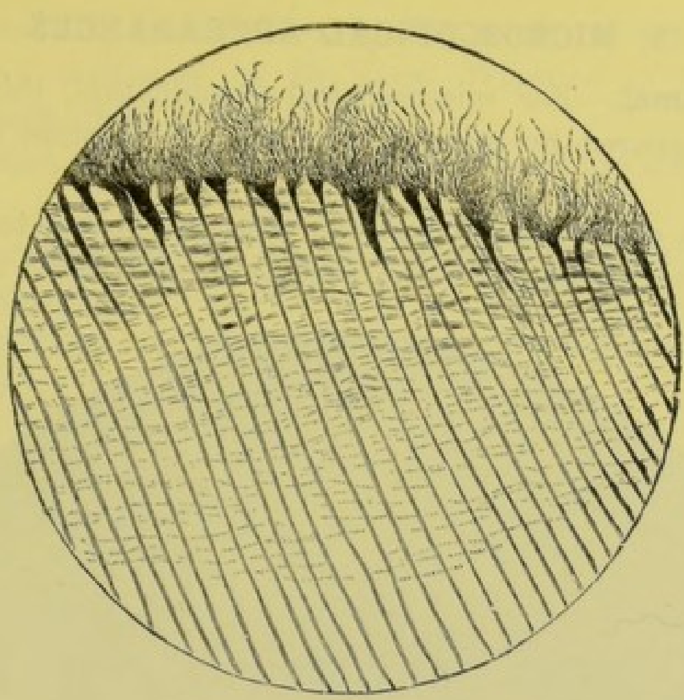
× 1,500.

FIG. 451.—The *modus operandi* of the process of caries, according to Dr. Leon Williams, vary somewhat in different specimens. In this specimen, the sectional masses of the enamel rods are being set free by the solution of the cement substance which unites them.



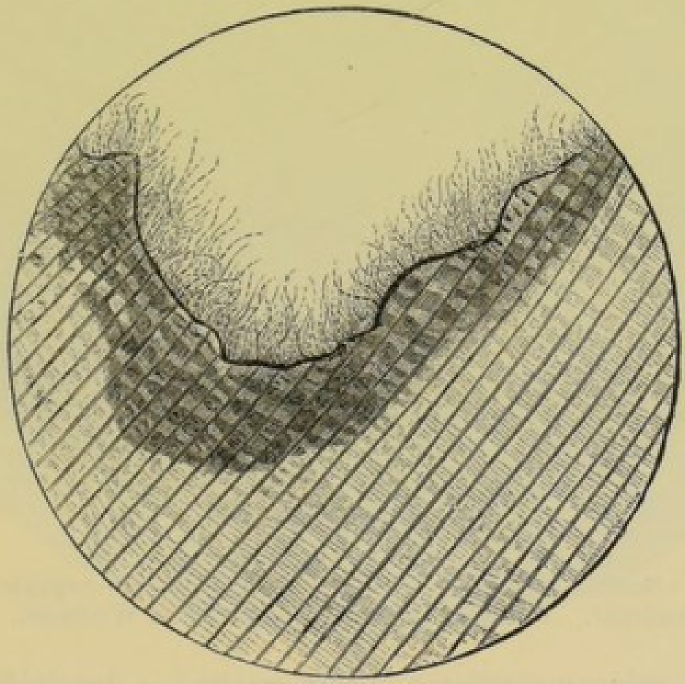
× 1,500.

FIG. 452.—The felt-like mass of micro-organisms has been removed to show the action of the acids on the ends of the enamel rods at the decaying surface.



× 800.

FIG. 453.—Showing commencement of the carious process. The felt-like mass of micro-organisms is seen attached to the surface. The cone-shaped cavities between the enamel prisms, produced by solution of the cement substance between the enamel rods, are also shown.



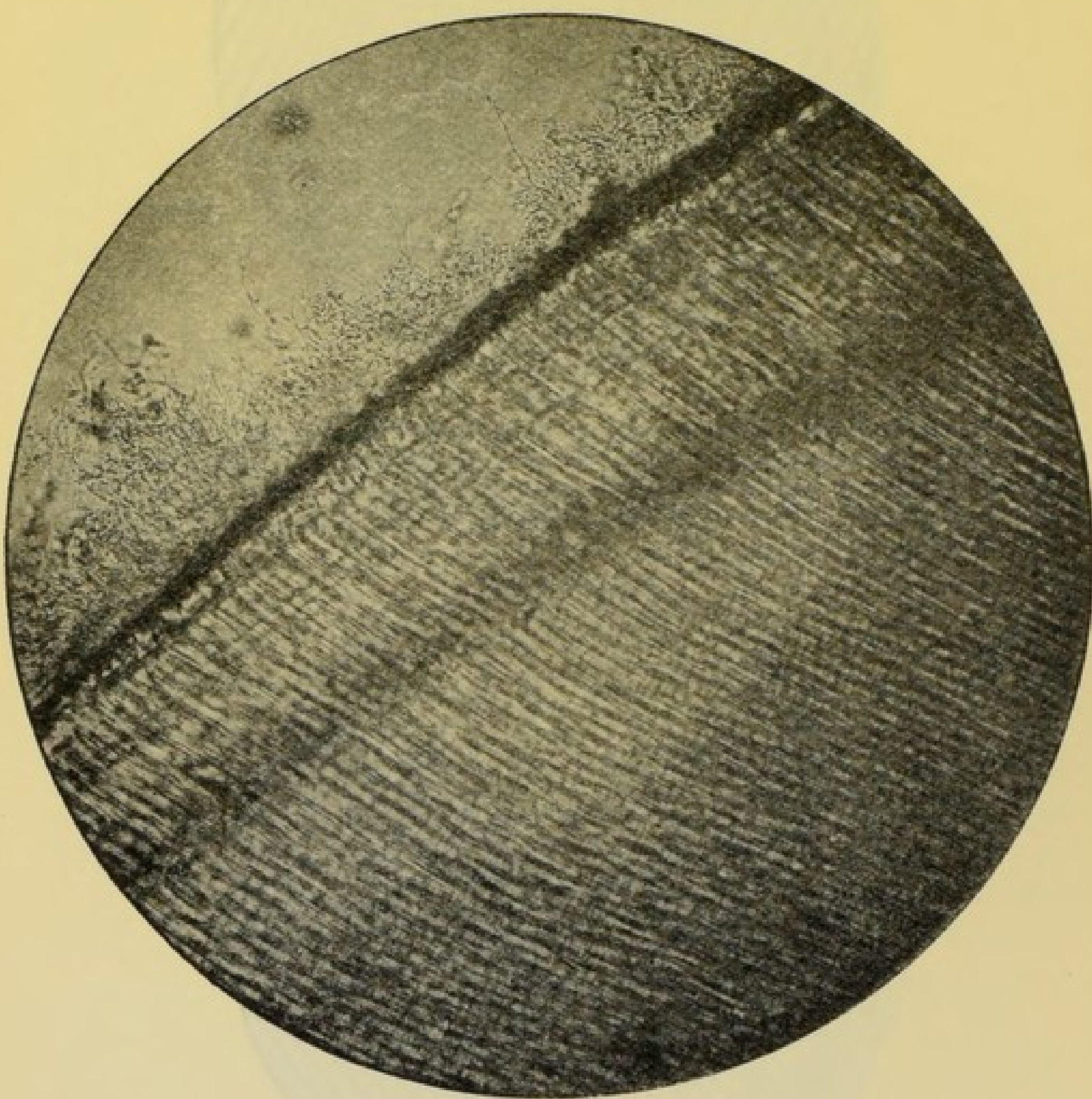
× 800.

FIG. 454.—Showing the commencement of the formation of a carious cavity in the enamel. The cavity is seen to be lined with the felt-like mass of micro-organisms similar to those seen on the surface of the enamel at the commencement of decay.

(3) MICROSCOPICAL APPEARANCES

(*a*) **Enamel.**—For microscopical examination, thin sections must be prepared by grinding, and stained to show the micro-organisms.

Sections of carious enamel (fig. 455), according to Dr. Leon Williams and others, show the surface to be covered with a felt-



× 300.

FIG. 455.—Section showing felt-like mass of micro-organisms attached to surface of enamel. Photomicrograph by Dr. Leon Williams.

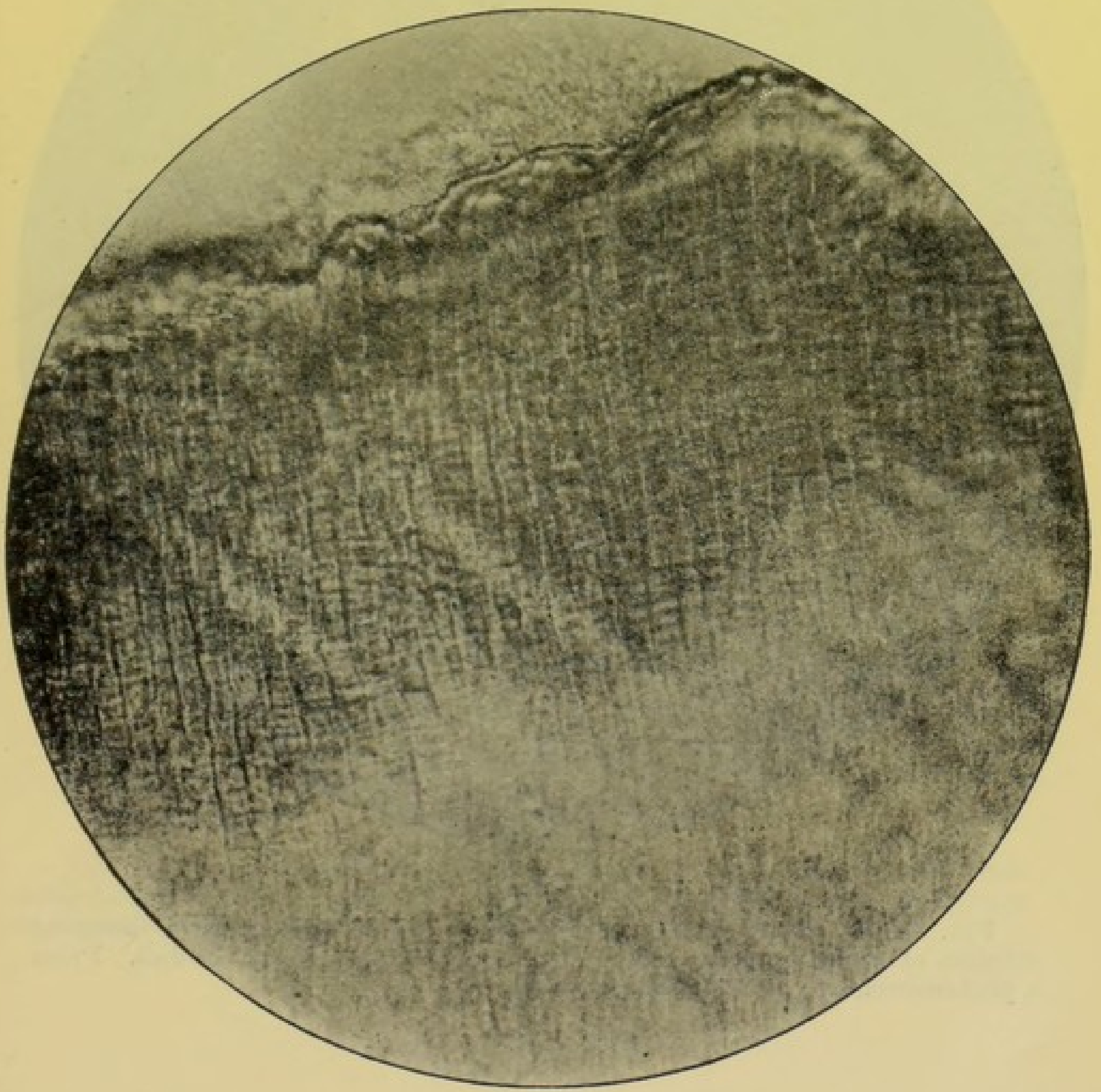
like mass of micro-organisms. The enamel is decalcified between the rods and the interstitial cement substance; the enamel globules thus unbound being either dissolved or washed away. The enamel may be penetrated to a considerable depth before any breaking down of the tissue occurs.

An interesting contribution to the study of caries of the enamel was published by Dr. Leon Williams in the *Dental Cosmos*, March, 1897, *et seq.*

The various stages of caries of the enamel are shown in figs. 451 to 461.

The four diagrams figs. 451 to 454 are from drawings by Dr. Leon Williams.

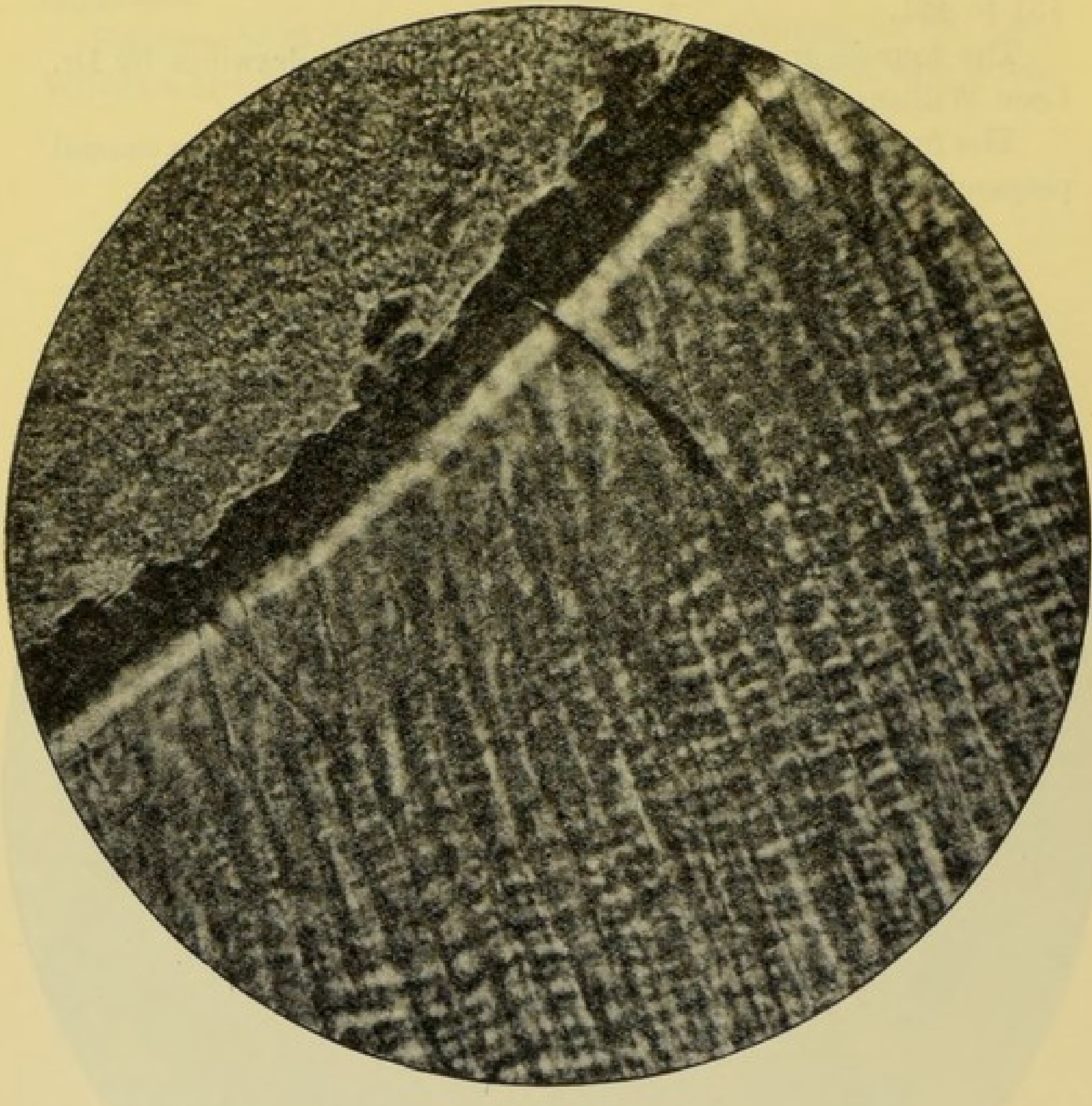
The five figures 455 to 459 are from sections of carious enamel prepared by Dr. Leon Williams.[1]



× 800.

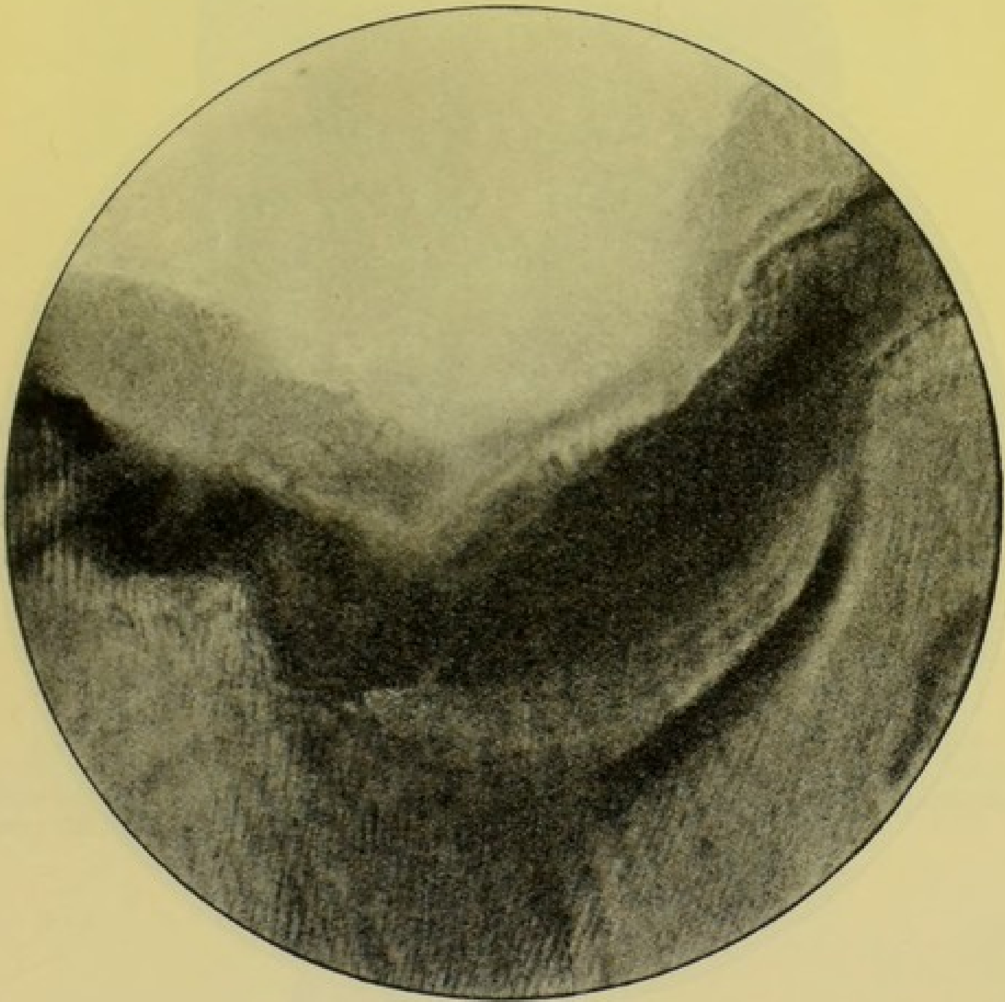
FIG. 456.—Showing commencement of caries. Enamel rods separated by solution of cement substance and discoloured by action of acid. From a photomicrograph by Dr. Leon Williams.

[1] I am indebted to Dr. Leon Williams for the use of the blocks of figs. 451 to 454, and also for the photomicrographs reproduced in figs. 455 to 459.



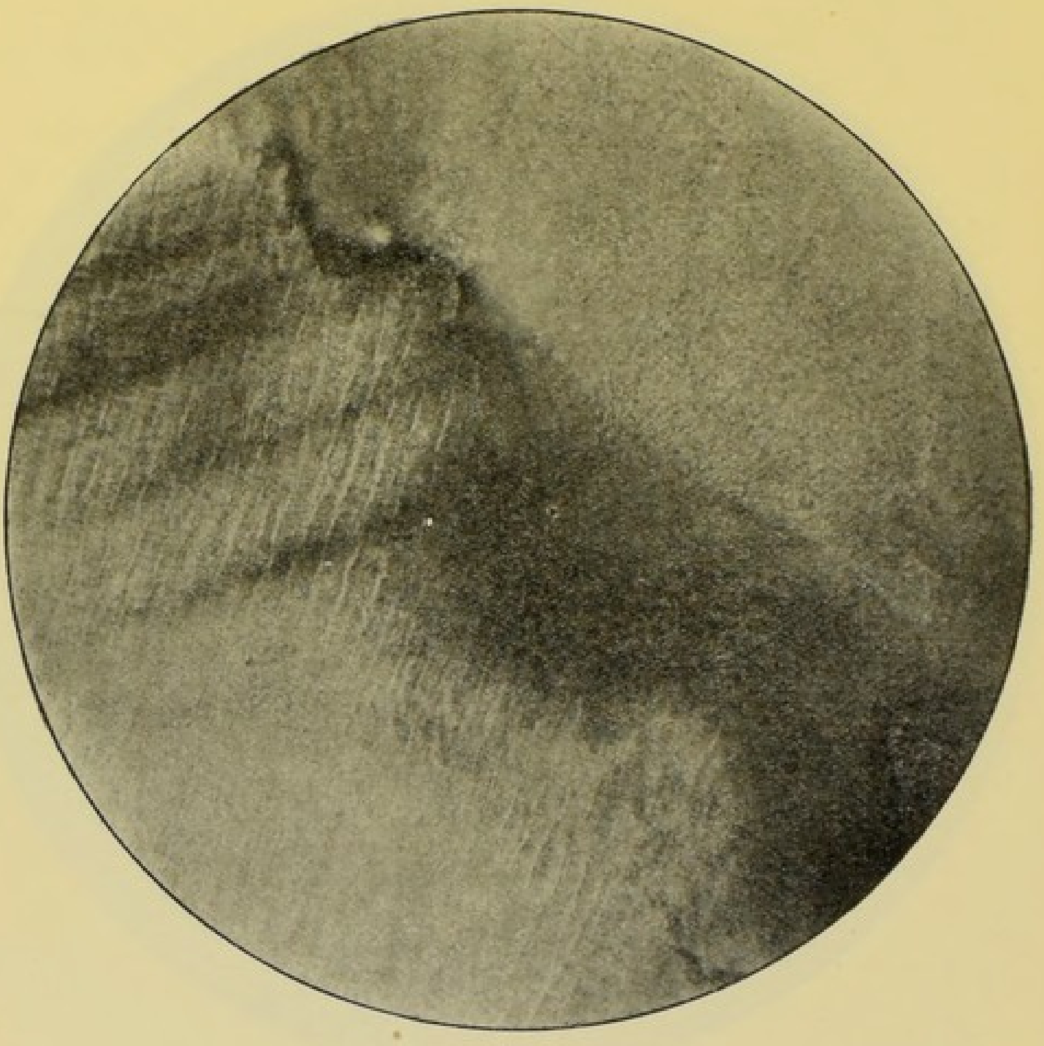
× 1,200.

Fig. 457.—Section of carious enamel, showing destruction of tissue by solution of cement substance around enamel rods and globular bodies. From a photomicrograph by Dr. Leon Williams.



× 300.

FIG. 458.—Section showing progress of slow decay marked by deep discoloration of the tissue. The felt-like mass of micro-organisms on the surface is also seen. From a photomicrograph by Dr. Leon Williams.



× 800.

Fig. 459.—Similar to the section shown in fig. 458, but under a much higher power. At the upper left-hand corner, the ends of the enamel rods are seen projecting, which show that the cement substance is first acted on by the acid of decay. From a photomicrograph by Dr. Leon Williams.

In several of the preceding figures a felt-like mass of micro-organisms is seen adhering to the surface of the enamel. Drs. Williams and Black attach considerable significance to these

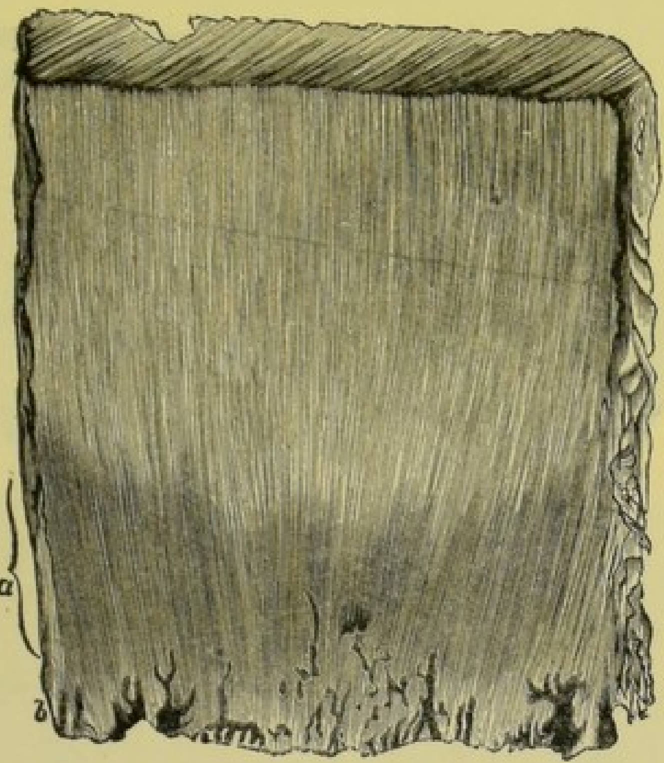


FIG. 460.—Secondary enamel decay. (*a*) Partially decalcified enamel, which has slightly taken the staining material; (*b*) zone of infected enamel, showing masses of micro-organisms working their way into the decalcifying zone (Miller).

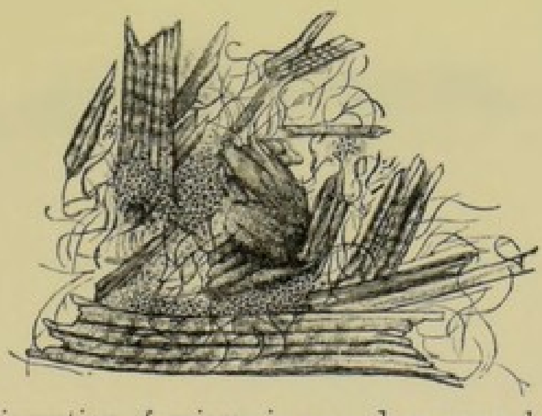


FIG. 461.—Disruption of prisms in secondary enamel decay (Miller).

"bacterial plaques." These "plaques" are not a necessary accompaniment of the carious process, and they can, moreover, be demonstrated in teeth without a trace of caries. (See figs. 462 and 463).

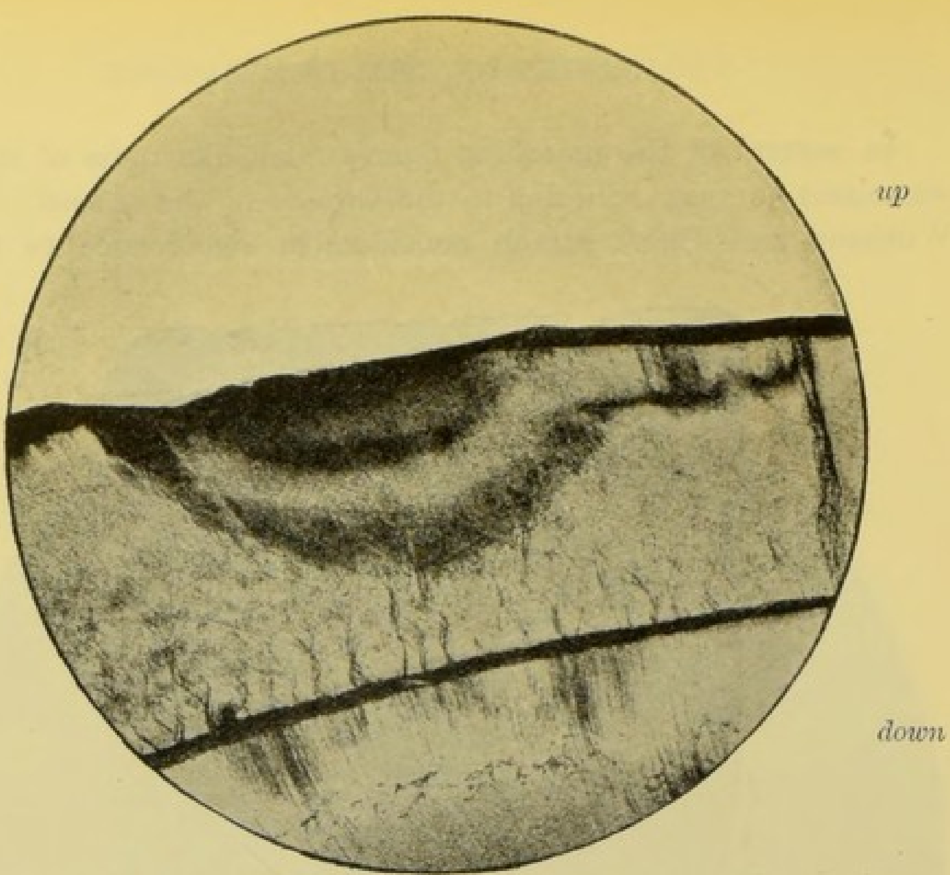


Fig. 462.—Extensive caries without bacterial plaque (Miller). From *Dental Cosmos.*

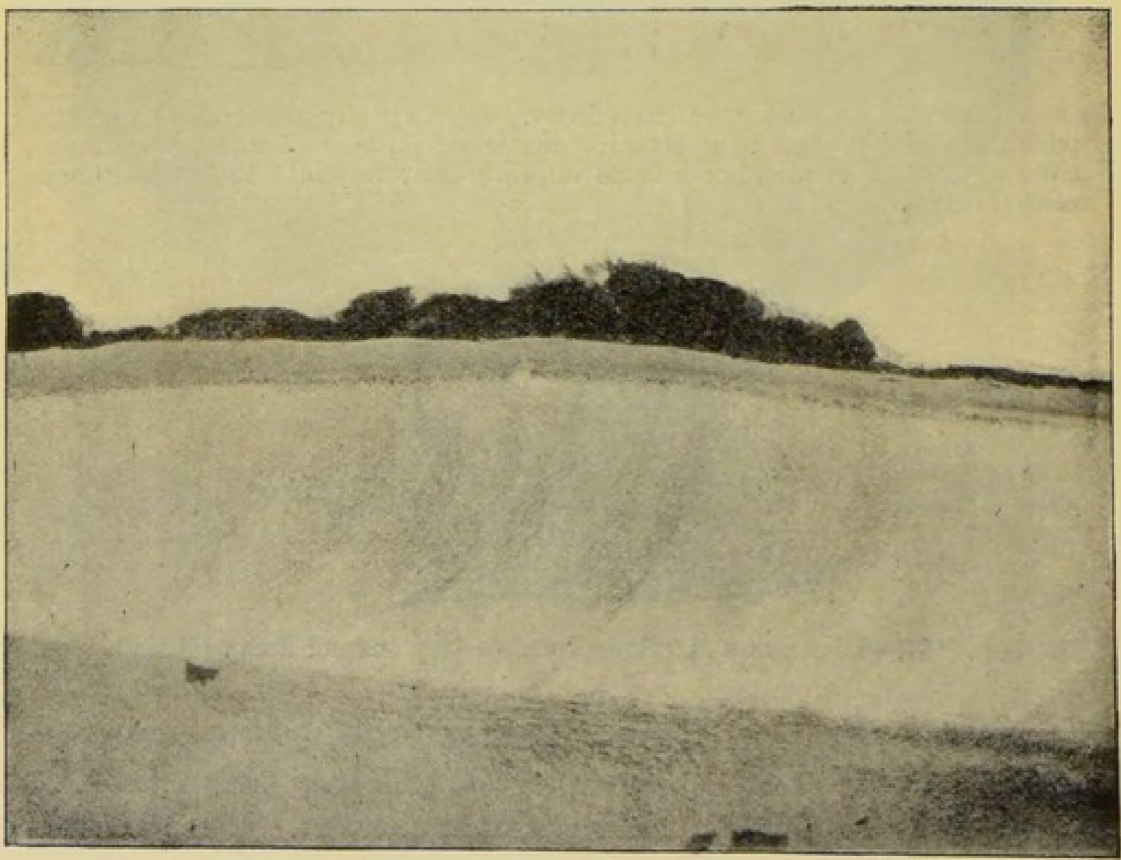
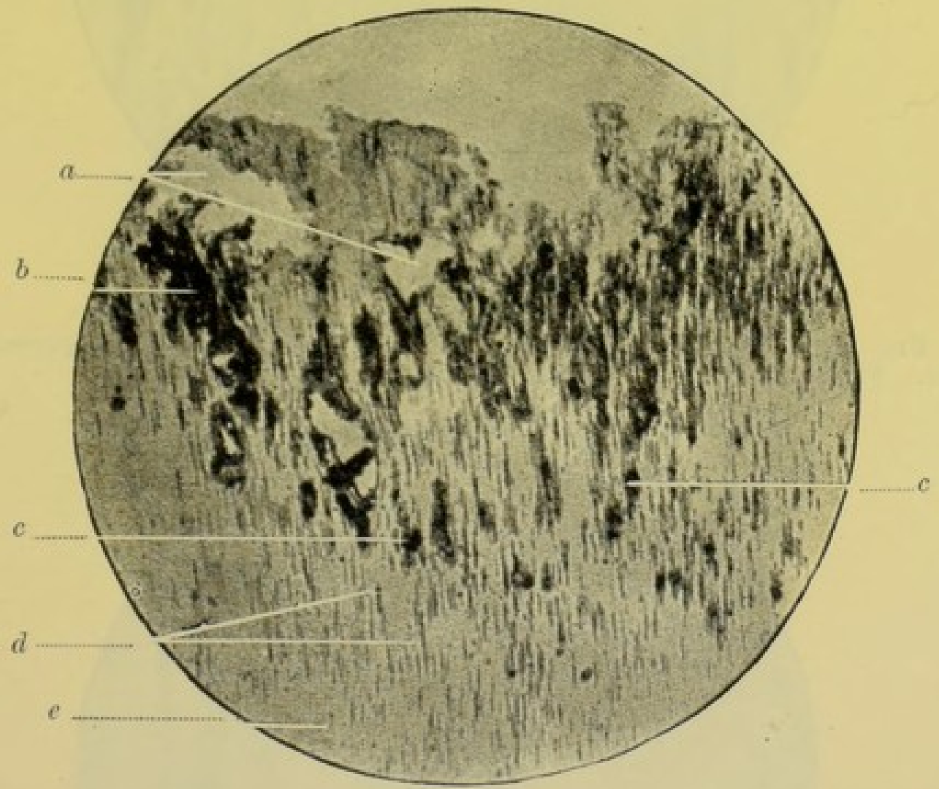


Fig. 463.—Extensive bacterial plaque without a trace of caries (Miller). From *Dental Cosmos.*

(*b*) **Dentine.**—If longitudinal sections of carious dentine which have been stained to demonstrate micro-organisms be examined microscopically, the following points will be observed.

Under a Low Power (80 mag.).—Bordering the surface (fig. 464) the dentine is hollowed out in an irregular manner, the cavities presenting no definite shape (*a*). A little deeper in the substance of the dentine irregular masses of stain can be detected (*b*), and, in places, the stain presents a globular appearance (*c*). Lower down, streaks of stain are to be seen (*d*), while still further down the dentine is unstained (*e*).



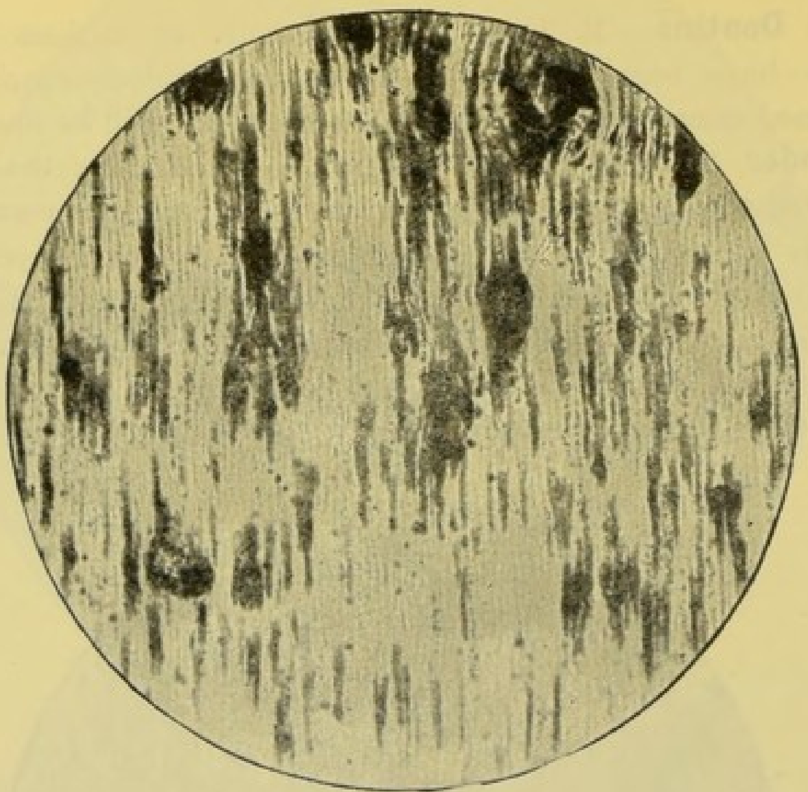
× 80.

FIG. 464.—Longitudinal section of carious dentine. Photomicrograph by Mr. A. Pringle.

Under a Higher Power (150 mag.).—Tracing the process in the reverse order, namely, from within outwards, we notice :—

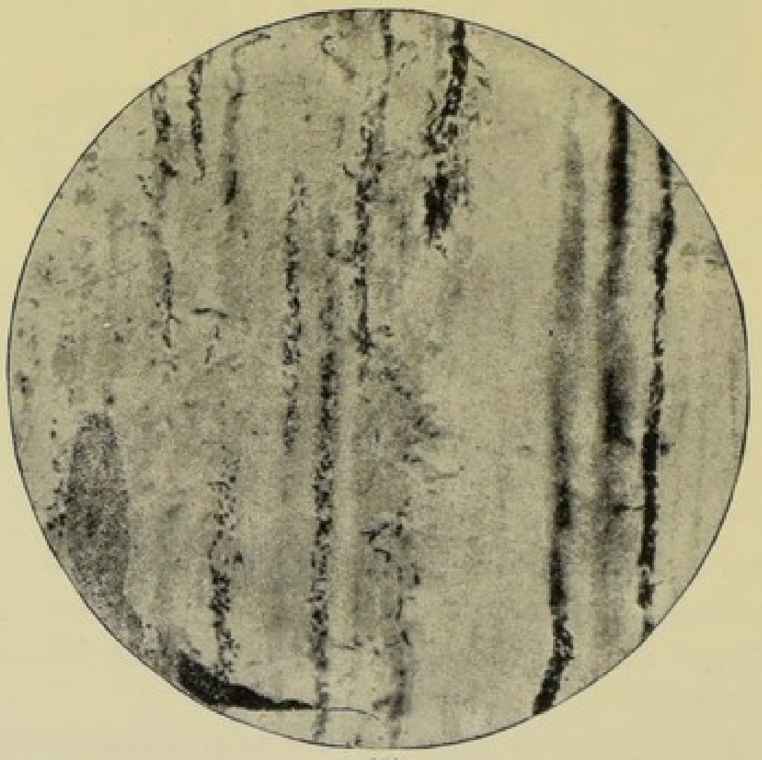
(i.) That the unstained part (*e*) is dentine in a decalcified condition.

(ii.) The streaks of stain (*d*) are micro-organisms occupying the dentinal tubes.



× 150.

Fig. 465.—Longitudinal section of carious dentine, showing liquefaction foci. Photomicrograph by Mr. A. Pringle.



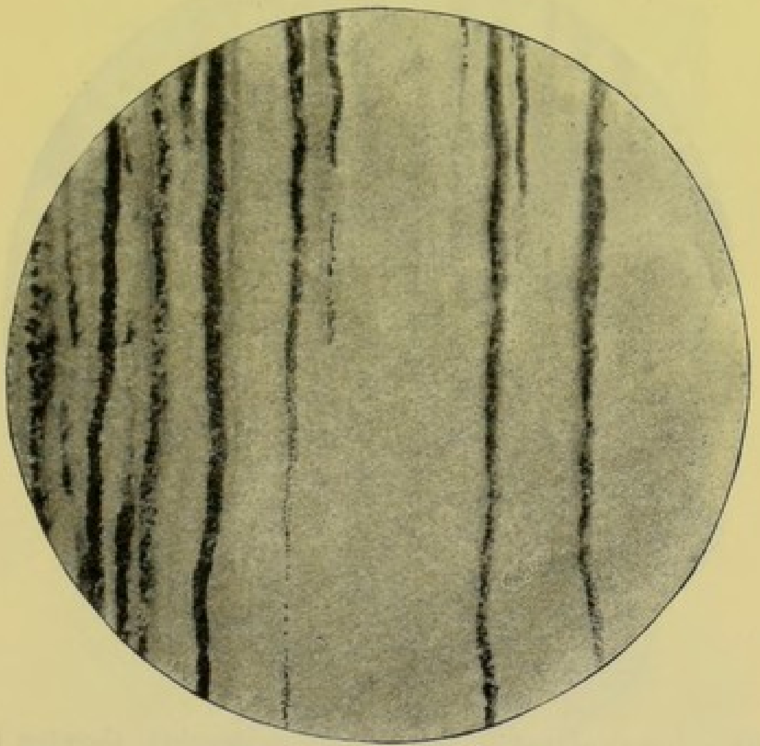
× 650.

Fig. 466.—Longitudinal section of carious dentine, showing rod-shaped organisms in tubes. Photomicrograph by Mr. J. Howard Mummery.

(iii.) The globular masses are micro-organisms occupying the tubes and the structure between the tubes. In other words, the dentine matrix has disappeared and micro-organisms have taken its place. These globular masses have been termed **"liquefaction foci"** (fig. 465).

(iv.) The irregular masses are formed by the fusion of "liquefaction foci."

In sections containing interglobular spaces, the spaces are generally seen to be filled with masses of organisms, although



× 650.

FIG. 467.—Longitudinal section of carious dentine, showing tubes filled with micrococci. Photomicrograph by Mr. J. Howard Mummery.

occasionally they appear to be quite free from infection. Figs. 466 to 468 are longitudinal sections through carious dentine stained to demonstrate the micro-organisms.

If sections of carious dentine are stained to demonstrate the micro-organisms only, it can be shown that the softening of the dentine precedes the infection. Examine such a section, and it will be seen that the softened parts towards the cavity are stained, and towards the healthy dentine unstained, which clearly shows

that the softening precedes the infection. Miller has termed the unstained portion the **"non-infected zone."** The micro-organisms show a greater tendency to spread towards the pulp than in a lateral direction, but this is not always the case where a large number of interglobular spaces are present. The dividing line between the infected and the non-infected zones is often well marked (fig. 469), and though the majority of tubes near the surface are infected, the infection is not noticeable in the deeper

× 650.

Fig. 468.—Longitudinal section of carious dentine, showing tubes filled with leptothrix. Photomicrograph by Mr. J. Howard Mummery.

parts. Near the margin, leptothrix is mainly found, while the tubes are generally filled with micrococci or simple bacilli.

The Infection is often of a Mixed Character.—Micrococci and bacilli are usually present and generally in separate tubules, but a single tubule may contain a mixed infection.

In addition to micro-organisms, *rod-shaped fragments or elements can usually be demonstrated in the tubules* and are also seen in artificially produced caries. These elements, the source of which is not definitely known, are conjectured to be either

(i.) portions of consolidated fibrils; (ii.) pieces of the sheaths of Neumann; or (iii.) casts of the enlarged fibrils. Miller finds that these elements disappear immediately they are brought into contact with inorganic acids (dilute sulphuric acid), but become more distinct when organic acids are used, and he therefore thinks it probable that they are lime formations. *Rows of shining irregular granules* are also met with generally in the area, in advance of

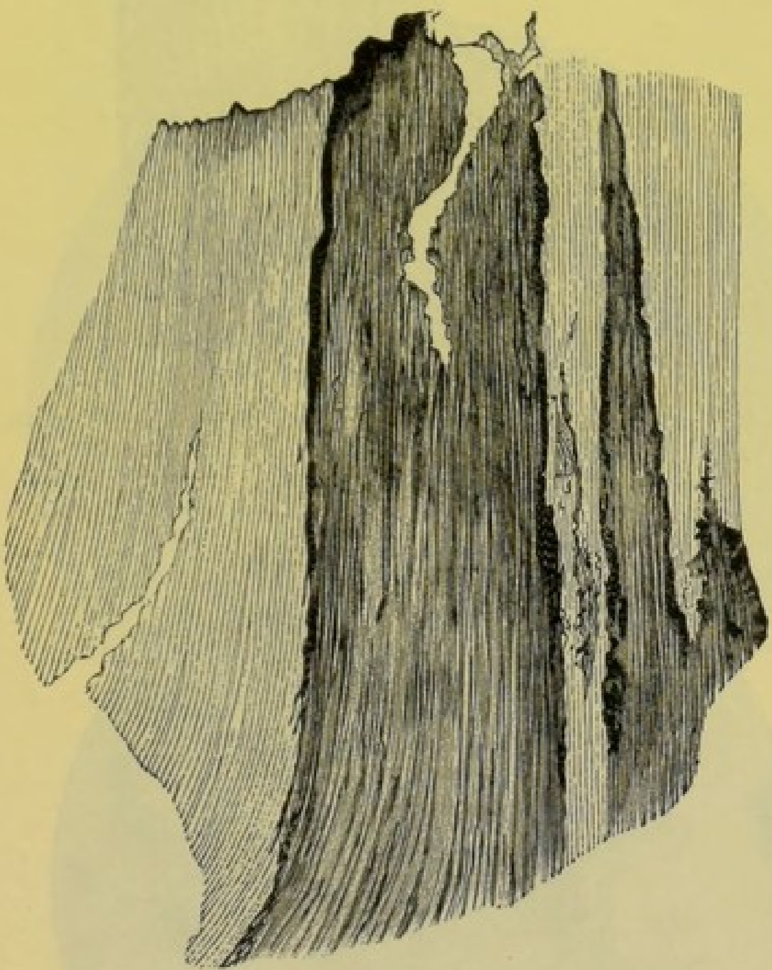


Fig. 469.—Carious dentine, showing that, laterally, the boundary between the infected and non-infected parts may be very regular (Miller).

the caries (fig. 470). It is possible that these granules have the same origin as the rod-shaped elements, for, if the latter be crushed, granules can be produced.

Transverse sections near the cavity show the tubes enlarged and filled with micro-organisms (fig. 471). In transverse sections taken nearer to the normal dentine, it is found that the

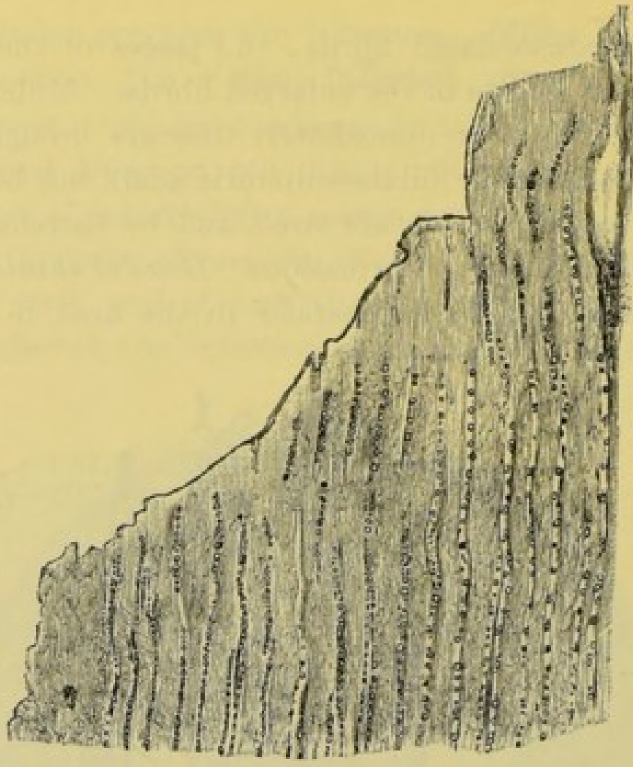
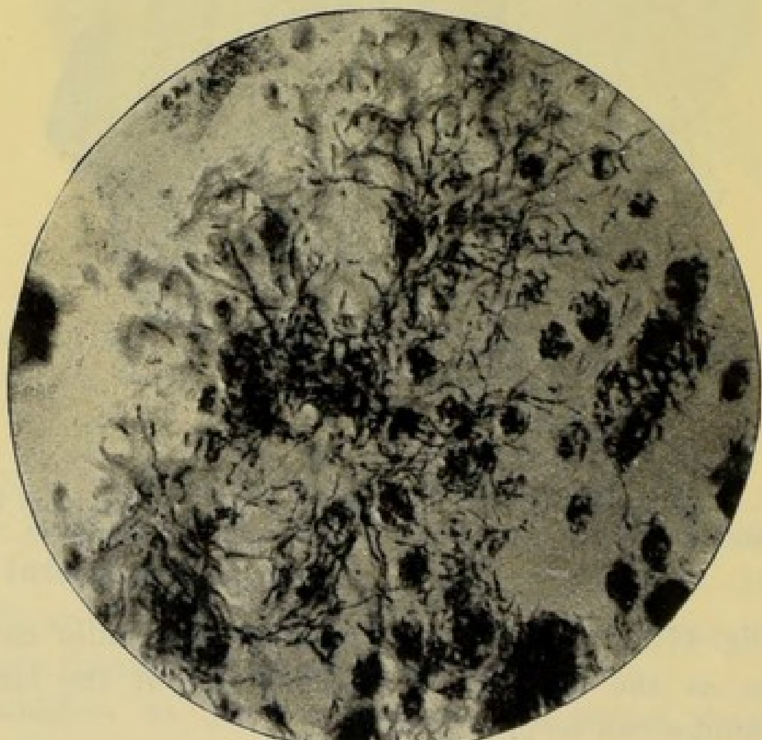


FIG. 470.—Row of shining granules in the tubules from a tooth used as an artificial substitute (Miller).

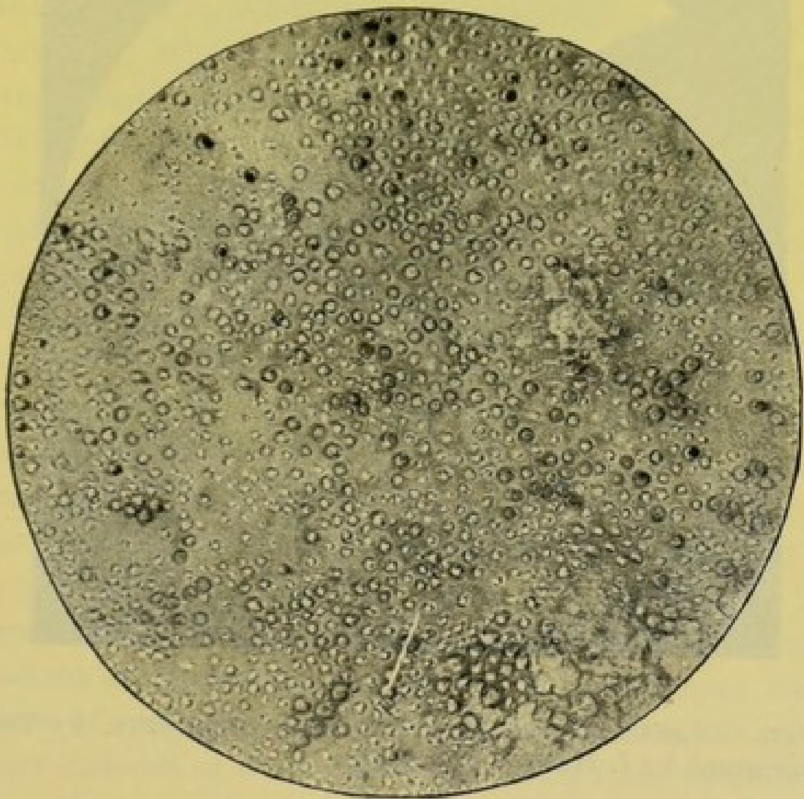


× 650.

FIG. 471.—Transverse section of carious dentine, showing enlarged tubes filled with micro-organisms, principally leptothrix forms.

sheath of the dentinal tubes is considerably enlarged, owing, probably, to decalcification. The appearance of the dentine in this condition has been termed the *tobacco-pipe* appearance (Tomes). This is shown in fig. 472.

The tobacco-pipe appearance is also seen in caries occurring in teeth used as substitutes, and in caries produced by artificial means.

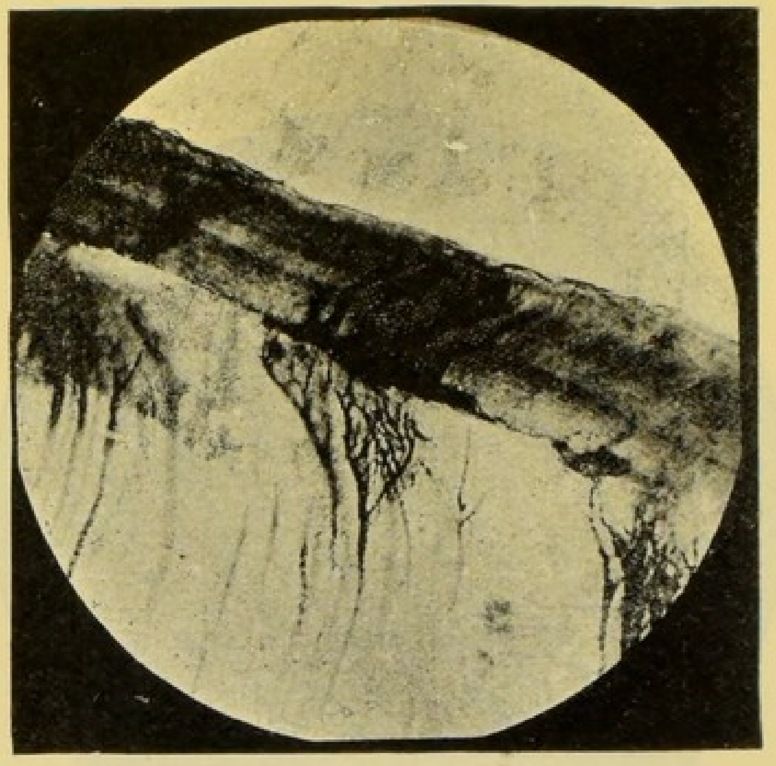


× 200.

Fig. 472.—Photomicrograph by Mr. A. Pringle.

In the *Trans. Odonto. Soc.*, vol. xxiv, p. 90, Mr. Tomes has figured a tooth found in the graveyard of an old church. The cementum and dentine of this tooth have been bored in many directions by a fungus, probably the *Saccharomyces mycoderma* (Miller). The penetration of the dentine by *Saccharomyces mycoderma* is, according to Miller, frequently seen in teeth used as artificial substitutes. It is not at all improbable that other fungi may possess the power of penetrating dentine.

(*c*) **Cementum.** — Caries of cementum resembles caries of dentine in some details, especially when the micro-organisms penetrate, as they commonly do, along the lines of Sharpey's fibres. The decalcified tissue is destroyed in precisely the same manner as in caries of the dentine.



× 600.

FIG. 473.[1]—Caries in cementum. From a preparation by Dr. Miller. Photomicrograph by J. Howard Mummery.

(*d*) **The Effect of Caries on the Pulp.**—This portion of the subject is dealt with in detail in a later chapter treating of the pathology of the dental pulp.

(4) BACTERIOLOGY [2]

The organisms concerned in the process of dental caries have been divided by Mr. Goadby into two groups :—

(*a*) Acid-forming bacteria, or bacteria capable of producing acids by the fermentation of carbohydrates. The weak acids

[1] From *Journ. Brit. Dent. Assoc.*

[2] For the notes of this section I am indebted to Mr. Goadby.

formed from the decomposition of proteids are incapable of attacking the lime salts of the tooth.

(*b*) Liquefying bacteria which, either by their own action or the production of proteolytic enzymes, cause digestion of the decalcified dentine.

Mr. Goadby has also shown that certain other organisms, which neither produce acid nor proteolytic enzymes are also concerned in the initial stages of the process. He finds these organisms produce colonies of a gelatinous consistency which adhere firmly to the enamel of the tooth, and where there is no mechanical removal or cleansing of the surface, these organisms form gelatinous plaques which act as an osmotic membrane; the carbohydrate fermenting organisms are able to grow symbiotically with them, acid is produced which diffuses through the surface covering, producing disintegration of the tissues underneath, the dissolved lime salt diffusing out again, and its place taken by fresh acid.

The numbers and varieties of bacteria on the surface of a carious cavity are more numerous than in the deeper layers; the species on the surface of carious dentine are mostly aerobic liquefiers, many of them liquefying gelatin with great rapidity, and in addition coagulated blood-serum. Most of the organisms liquefying coagulated blood-serum will digest decalcified dentine. A small fraction are anaerobic liquefiers. The organisms from the deeper layer of caries are rarely liquefying bacteria, but nearly all of them are capable of the production of acid from carbohydrates, especially glucose, maltose, and lactose. The organisms on the surface of carious dentine often possess the power of discolouring the medium upon which they are originally grown, whilst those from the deeper layers rarely possess this power.

Mr. Goadby has shown that not all organisms capable of liquefying nutrient gelatin also possess the power of digesting the decalcified tooth cartilage or chondrinogen. From the deeper layer of the carious dentine he has frequently isolated an organism for which he suggests the name *Bacillus necrodentalis*, and he seems to think that this organism may stand in some casual relationship to caries, inasmuch as its characteristics fit in with the process of decay. In sixteen out of twenty cases he obtained the *S. brevis*, and as this organism and the *B. necrodentalis* are

facultative anaerobics and are both acid producers, he considers that they may be largely instrumental in decalcifying the matrix prior to its disintegration by other organisms.

Another organism, hitherto unrecognized in the mouth, has been found by Mr. Goadby constantly associated with organisms from the surface of carious dentine, and in two out of twenty cases with organisms from the deeper layers. This organism, he considers, belongs to the *Streptothricæ*, and has been termed by him the *Streptothrix buccalis*. The following is a list of the bacteria of dental caries as given by Mr. Goadby :—

Acid-forming Bacteria.

Streptococcus brevis	Deep layers of carious dentine.
B. necrodentalis (Goadby)	
S. albus	
S. brevis	Superficial layers of carious dentine.
Sarcina lutea	
,, *aurantiaca*	
,, *alba* (Eisenberg)	
S. albus	
S. aureus	

Bacteria which liquefy Dentine (decalcified).

None isolated as yet.	Deep layers of carious dentine.
Bacillus mesentericus ruber (*vulgatus*), Gisen.	Superficial layers of carious dentine.
B. mesentericus vulgatus.	
B. mesentericus fuscus.	
B. septus (*B. furvus*).	
B. liquefaciens fluorescens.	
B. subtilis.	
Proteus zenkeri.	
B. plexiformis (Goadby).	
B. maximus buccalis (Goadby).	

(5) THE SOURCE OF THE ACID

The **principal acid formed is lactic**, from amylaceous and saccharine substances, which find a lodgment on the tooth, and undergo fermentation. In the case of sugars, those belonging to

the grape-sugar group, namely, dextrose, levulose, galactose, and maltose, are directly fermentable according to the equation

$$C_6H_{12}O_6 = 2C_3H_6O_3$$

Cane-sugar and milk sugar are only fermentable after hydrarization—

$$\underset{\text{(Cane-sugar)}}{C_{12}H_{22}O_{11}} + H_2O = \underset{\text{(Dextrose)}}{C_6H_{12}O_6} + \underset{\text{(Levulose)}}{C_6H_{12}O_6}$$

The dextrose and levulose are then acted on by the lactic acid ferment.

In the case of starch, the ptyalin transforms the starch into grape-sugar, which is then directly fermentable.

Experiments have proved that, when fermentable albuminous materials are combined with saliva, little acid is formed, which soon disappears; while, when the putrefaction of albuminous substances, such as meat, takes place in the mouth, acids are formed, but they are more than neutralized by the various alkaline products which appear, so that the reaction of the medium is distinctly alkaline. Vegetable food is less likely to ferment when raw than when cooked.

When once decalcification by means of the acids has taken place, the remaining organic portion of the tooth substance is dissolved by the action of bacteria, which perform their work by acting upon the dentine in much the same way as the pepsin of the gastric juice acts upon albuminous materials. The view that the acid is formed directly from the fermentation of food is not held by all observers.

The table on next page, suggested by Mr. Mummery and the late Dr. Miller, shows the part that the different classes of food-stuffs play in the direction of caries.

Miller[1] and, indeed, the vast majority of writers believe that the acid is formed from solid food. It seems doubtful, however, whether, in forming this opinion they have attached sufficient importance to the fermentation of food in a fluid state.

It has been shown that the *primary decalcification of the enamel often starts around, and not at the point of contact*. This fact would seem to indicate that in such cases the food is in a

[1] "Micro-organisms of the Human Mouth," p. 205.

[2] See "The Problem of Dental Caries," S. Colyer, *Dental Record*, vol. xxiv, p. 301.

fluid condition, and is maintained around the point of contact by capillary attraction. Again, in mouths kept absolutely free from solid food, caries is often found progressing in pits, fissures, &c., which clearly shows that the disease must arise from the action of fluids, and not solids.

FOODSTUFFS

- Proteids (nitrogenous foods) — Their decomposition by bacteria gives rise to a large number of different products resulting in an alkaline reaction.
- Carbohydrates
  - Cellulose — The action of bacteria on this substance in the mouth (probably but slight) has not been determined.
  - Starch — Acted upon by ptyalin produces — Dextrose or maltose / Dextrine[1] — Acted upon by bacteria produces — Lactic acid (and traces of other acids).
  - Sugar
    - Fermentable — Acted upon by bacteria produces — Lactic acid (and traces of other acids).
    - Non-fermentable — Converted into fermentable sugar by a hydrolytic ferment contained in many bacteria, *e.g.*, $C_{12}H_{22}O_{11} + H_2O$ (Cane-sugar) $= C_6H_{12}O_6 + C_6H_{12}O_6$ (Dextrose) (Levulose) — Acted upon by bacteria produces — Lactic acid (and traces of other acids).
- Fats — ? Fermentation in the mouth may result in traces of fatty acids, but so far undetected.

[1] Regarding the action of mouth bacteria on dextrine very little is known.

Solid food cannot ferment at the same rapid rate as liquid food, and, moreover, with solid food a certain degree of solution is necessary in order that the organisms may produce any appreciable change. The reason for the slower fermentation of solid or pulpy substances is that the particles 'cannot move so freely about as they can in a fluid. In solid substances, the acid formed by the microbe in its immediate neighbourhood cannot

disperse, and consequently when the acid has been raised to a certain percentage the action of the organism is inhibited.

A full recognition of the fact that food in a fluid state ferments more rapidly than in a solid condition, will help to clear the way to an understanding of the etiology of the disease, and points to the more easily soluble carbohydrates being the principal source of the acid.

In the section describing the microscopical phenomena of carious enamel, it was pointed out that a felt-like mass of micro-organisms was constantly present on the surface of the tooth. Leon Williams says: "This mass of fungi is so dense and adhesive as to make it highly improbable that the enamel is affected, except in rare or special instances, by any acid other than that which is being excreted by the bacteria at the very point where they are attached to the enamel." This felt-like mass, however, is present in enamel not undergoing caries, and is at times absent in cases where caries is active, facts which do not support the theory advanced by Williams.

Dr. A. Lohmann[1] considers that the mucin is the agent which brings about the decalcification of the enamel, the mucin being set free from its combination with salts by the action of some acid. He states that: "On account of the short stay of carbohydrates in the mouth, but a very slight transformation of the same can take place, whereby only maltose is formed. The production of lactic acid, however, presupposes the formation of grape-sugar, since cane-sugar undergoes no changes whatever in the saliva. Consequently, lactic acid cannot be formed in the mouth." This question was fully dealt with by Miller,[2] who considers that, theoretically, logically, and experimentally, the hypothesis of Lohmann is not in accordance with known facts.

Clinically, there is evidence to show that mucus bears a causal relationship to caries. Children who, in consequence of being mouth-breathers, have developed a marginal gingivitis around the anterior teeth, show a marked tendency to caries on the approximal and labial aspects of the anterior teeth, and this tendency exists even in mouths where every care is taken to cleanse the teeth by artificial means.

[1] *Archiv. für Zahnheilkunde*, June, 1904.

[2] *Dental Cosmos*, November, 1905, p. 1293.

Mucus secreted by the glands of the mucous membrane often has an acid reaction which, according to Kirk, is due to the presence of acid phosphates of lime and soda, and it seems probable that this acid reaction may in some way be related to the rapid caries seen in these cases, especially in view of the fact that, in mouth-breathers, the natural cleansing of the teeth is interfered with.

(D) SPONTANEOUS ARREST OF CARIES

Spontaneous arrest of the carious process is occasionally seen. The teeth under such conditions show an extensive loss of tissue, the enamel of the masticating surface and often of the sides having disappeared. The exposed dentine is darkly stained and presents to the eye a polished appearance. An examination with a probe will show that the dentine is as hard, if not harder, than in the normal condition. Spontaneous arrest of caries may be found in both the deciduous and permanent teeth; in the latter, the condition is most frequently met with in hypoplastic first permanent molars. The appearance of the teeth in this condition indicates that the carious process, when active, was general and rapid in character. Spontaneous arrest of caries only occurs in teeth with living pulps. Microscopical examination shows that the dentine retains the colour of carious dentine, or is perhaps rather darker. The surface is irregular, the dentinal tubes, which can easily be seen in the discoloured part, apparently ending abruptly on the surface.

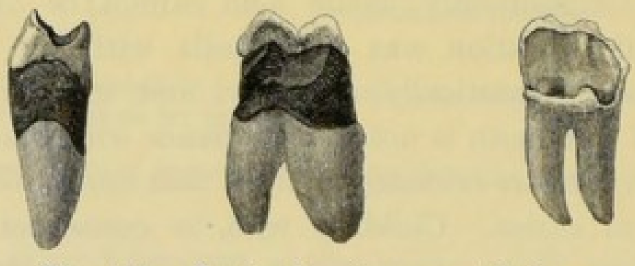


FIG. 474.—Teeth showing arrested decay.

In four sections examined, staining failed to show any micro-organism except at those spots where caries was recommencing. (See fig. 475.)

It is not clear how the arrest in the carious process is brought about. Clinical experience shows that when the normal functional

activity of the mouth is restored and care is taken to prevent the lodgment of foodstuffs on the teeth, rapid caries may often be arrested. It has been asserted that the hardening of the dentine is due to dehydration, but this seems improbable in view of the fact that the teeth are constantly bathed in moisture. It seems

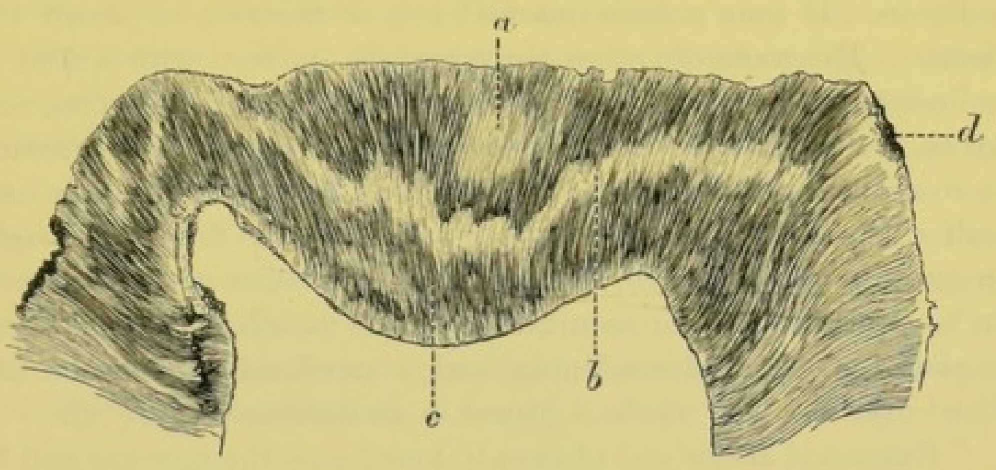


FIG. 475.—(*a*) Portion of dentine in which the decay has become arrested; (*b*) translucent zone; (*c*) normal dentine; (*d*) a softened patch of dentine showing micro-organisms.

far more likely that the arrest is due to some vital action on the part of the tooth. In support of the latter view it is to be noted that the carious process is never arrested in pulpless teeth. Arrest of caries is met with in pulpless teeth, but the death of the pulp is always subsequent to the arrest of the caries.

(E) EXPERIMENTAL REPRODUCTION OF CARIES

The production of caries in teeth artificially was first successfully accomplished by Miller. Teeth which were perfectly sound, but of various degrees of density, were cut into pieces of different sizes and placed in a mixture of saliva, meat and bread. This mixture, which was repeatedly renewed, was kept for three months at 98° F. With artificial caries there is no translucency, but translucency probably forms no essential part of the carious process, as it is found in other pathological conditions in the mouth. If the reaction of the solution in which the teeth are placed becomes alkaline, or if the teeth are exposed to the air or to the action of different articles of food, such as coffee, tea, tobacco,

fruit, &c., shades of colour are produced similar to those found in the mouth.

The following method is suggested by Mr. Hopewell-Smith:[1] "Sound teeth, whole or in part, are placed in a mixture of mixed human saliva, a small quantity of glucose, and a fragment of bread and uncooked meat. The teeth are first washed in saline solution. If they possess marked pits or fissures, so much the better. The roots of two or three may be covered with a film of collodion, or the whole teeth may be enveloped in this film, and spots, laying bare the hard tissues made in places. The mixture is contained in a sterilized Ehrlenmeyer's flask (a fairly large one, half a litre, is useful). About four ounces of the fluid is the right proportion for four teeth. On testing the mixture it may be found to be faintly alkaline or neutral. Into the mouth of the flask there is placed a sterilized wool plug, and a sterilized caoutchouc cap fitted over it. The whole is placed in an incubator at 37° C.

"Examined at the end of twenty-four hours the mixture will be found to be slightly acid. This acidity is marked at the end of forty-eight hours, and not until the lapse of several weeks are there any signs of the fluid becoming again alkaline.

"In five days, as already stated, the enamel becomes disorganized, and cover-glass films can be made. At the end of seven or eight weeks the teeth should be removed and broken into small fragments, the film of collodion being of course removed. The fragments are decalcified in a 10 per cent. solution of hydrochloric acid, then neutralized, washed, imbedded in gum mucilage, and cut on a microtome. The very thinnest sections, after well washing, are to be stained by Gram's method, or in any other way, as the fancy of the student may dictate. In this manner, then, the periphery of the hard parts of the teeth becomes carious.

"In order to obtain further disintegration, the teeth should be washed and placed in a fresh mixture under like conditions. Ultimately "liquefaction foci," and the formation of cavities, to a limited extent, occur, the process being identical with caries produced naturally, and the resulting microscopical specimens differing in no particular when similar methods of staining have been pursued."

[1] "Dental Microscopy." Second Edition, p. 170.

It is questionable whether the sterilization precautions suggested by Mr. Hopewell-Smith are essential to the process, since all the materials used in the production of artificial caries contain various kinds of organisms. Such precautions are probably only necessary when experimenting with pure cultures.

M. Choquet has recorded[1] an interesting experiment in which he submitted normal dentine to the action of a pure culture of a micro-organism. From three carious teeth which had been filled he isolated five species of micro-organisms. From one of these he obtained a pure culture and applied it to a small cavity drilled in the incisor of a sheep, the culture being retained in position for nine months. The dentine at the end of this period was found to have undergone certain changes, namely, softening and alteration in colour. The appearances, however, were in no way typical of carious dentine, and it cannot be claimed that artificial caries was produced in this experiment.

(F) SUSCEPTIBILITY AND IMMUNITY TO CARIES

Under this heading will be considered various questions connected with the susceptibility and immunity of individuals to caries.

The Teeth.—Experiments were undertaken by Miller to determine whether defects in the form and structure of the tooth influenced the process of caries. He found that abrasions, bruises, cracks, and any other defects very sensibly diminished the resistance of the enamel. Deep fissures and all the defects in the enamel which furnish a lodging-place for food naturally render the tooth at these points more susceptible to caries.

Dr. Leon Williams,[2] in his paper, "The Pathology of Enamel," states that defects in structure, such as pits, grooves, fissures, pigmentations, granular and amorphous enamel, are often found in the lower animals, whose teeth we know are comparatively free from caries. This, however, is no argument against such defects rendering the teeth more susceptible to caries, providing the necessary pabulum exists for the production of lactic acid. In the majority of the lower animals this pabulum does not exist. Take

[1] International Medical Congress, Paris, 1900, reported in *Brit. Journ. Dent. Sci.*, November 15, 1900.

[2] "The Pathology of Enamel," *Dental Cosmos*, March, 1907.

for example the question of caries in the horse. In the maxillary teeth there is constantly a defect in the structure of the cemental tissue occupying the anterior and posterior "lakes." The defect takes the form of a canal which persists right through the tooth (fig. 477). When caries attacks the teeth of horses it invaribly commences on the occluding surface, and starts on these defects. L. A. Merillat[1] states that "the entrance of food into these pits

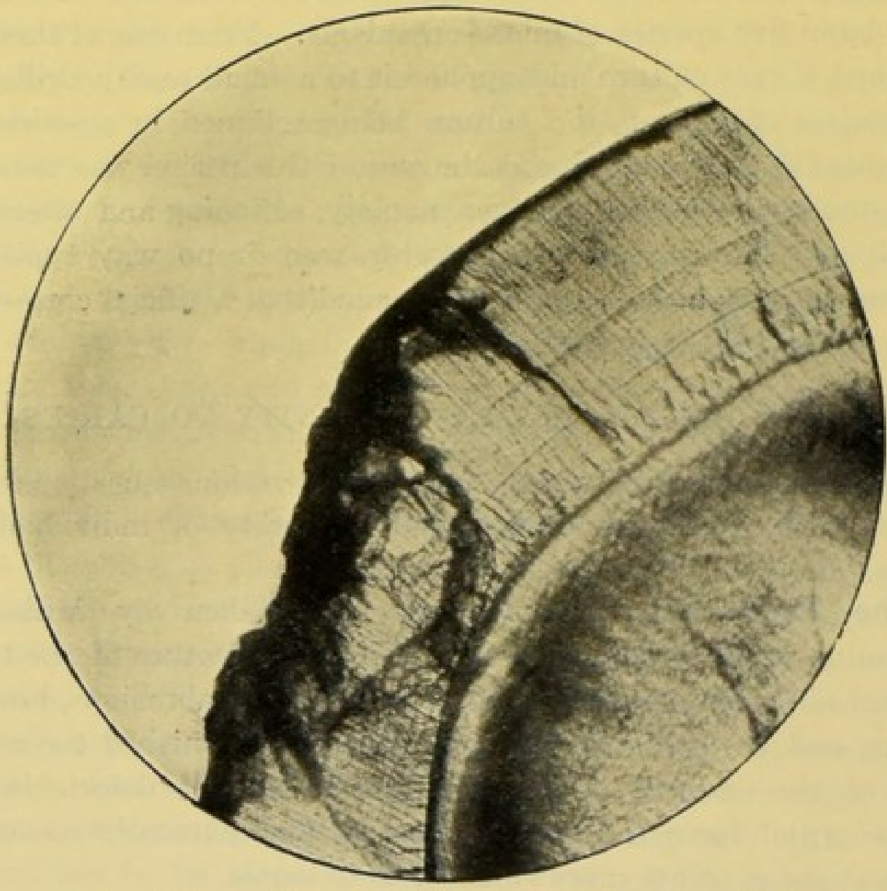


FIG. 476.[2]—Action of acid upon bruised surface (Miller).

causes more than 95 per cent. of the decayed molars of the horse." Horses kept on a diet of hay or grass are free from caries because the mouth bacteria have but slight action on cellulose material and lactic acid is not formed. With the introduction of corn and other cereals into the diet a material is present from which lactic acid is formed, and caries is liable to occur, and starts as stated above in the defective part of the tooth.

[1] Animal Dentistry.
[2] From *Dental Cosmos*.

Opinons differ as to the part played by the structure of the tooth in relation to caries. Dr. Black[1] and Mr. Tomes[2] have shown that teeth, clinically known as soft, are not deficient in lime salts, although hitherto supposed to be deficient, and that the molars contain more inorganic material than the incisors. Mr. Tomes's figures are as follows:—

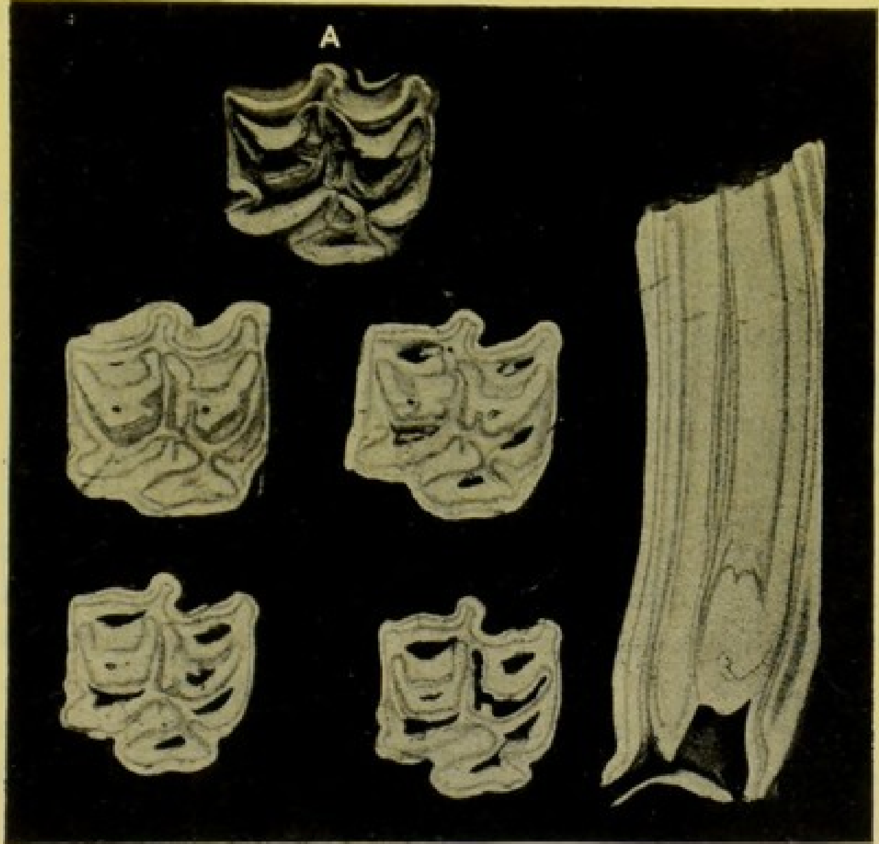


FIG. 477.[3]—In the section (A) the opening of the canal is shown with the tissue surrounding it in the early stage of caries; the other sections show that the canals exist throughout the tooth.

Incisors:	71·2 per cent. inorganic salts.
,,	28·8 per cent. organic and combined-water.
Molars:	73 per cent. inorganic salts.
,,	27 per cent. organic matter and combined-water.

Dr. Black's figures, reduced to percentage of dry dentine, give 71·7 for incisors and 72·3 for molars.

[1] *Dental Cosmos*, 1895.
[2] *Journ. Brit. Dent. Assoc.*, October, 1895.
[3] From *Trans. Odonto. Soc.*

An examination of two sets of teeth was made by Mr. Tomes.[1] In one set the third molars were barely in place, the two premolars were largely affected by caries, and incipient decay existed between many of the teeth, an analysis gave 71·4 per cent. of salts. In the second set the teeth were much worn by attrition, but quite free from caries, the analysis gave 71·4 per cent. of salts. In both, therefore, the percentage of salts was below the general average. Mr. Tomes has also shown that the dentine and also the enamel probably contain water in chemical combination with the various lime salts.

Dr. Black lays great stress upon his own investigation, and considers "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." The question, however, is not so much the percentage of lime salts in the teeth, but the stability of the compound which these salts form with the organic matrix of the tooth. The analyses of Black and Tomes are unfortunately in no respect qualitative and do not bring out the varying proportion of the different salts.

Experiments on the resistance of dentine to acids were carried out by Miller.[2] The results he obtained force one to the conclusion that there is a very great difference in the resistance which dentine from the teeth of different animals offers to the action of acids. Experiments with yellow teeth, and weak bluish teeth showed "that there is a difference in the rapidity with which dentine from different teeth is acted upon by weak acid under the same conditions, and that this difference will usually be found to be in favour of so-called hard dentine. The difference is not sufficiently great, however, to confer immunity upon the one tooth, while the other falls a prey to caries. It is only one of the factors, which again must not be completely lost sight of."

The main difference between teeth which are chemically known as "hard" and "soft" may be, after all, in the enamel. Some have assumed that this is improbable because the enamel contains practically no inorganic matter, but with the enamel, as with the dentine, marked differences may exist in the amount of

[1] *Journ. Brit. Dent. Assoc.*, October, 1895, p. 270.
[2] *Dental Cosmos*, September, 1903, p. 696.

water chemically combined with the lime salts and the proportion of the various salts. Until these points are determined, we certainly shall not be justified in assuming that teeth do not differ in hardness. The resistance of the enamel was investigated by Miller, and his experiments show that "the external intact smooth enamel surface offers a most stubborn resistance to the action of weak acids and far greater resistance than the internal surface" (fig. 478). This special power of resistance appears to be

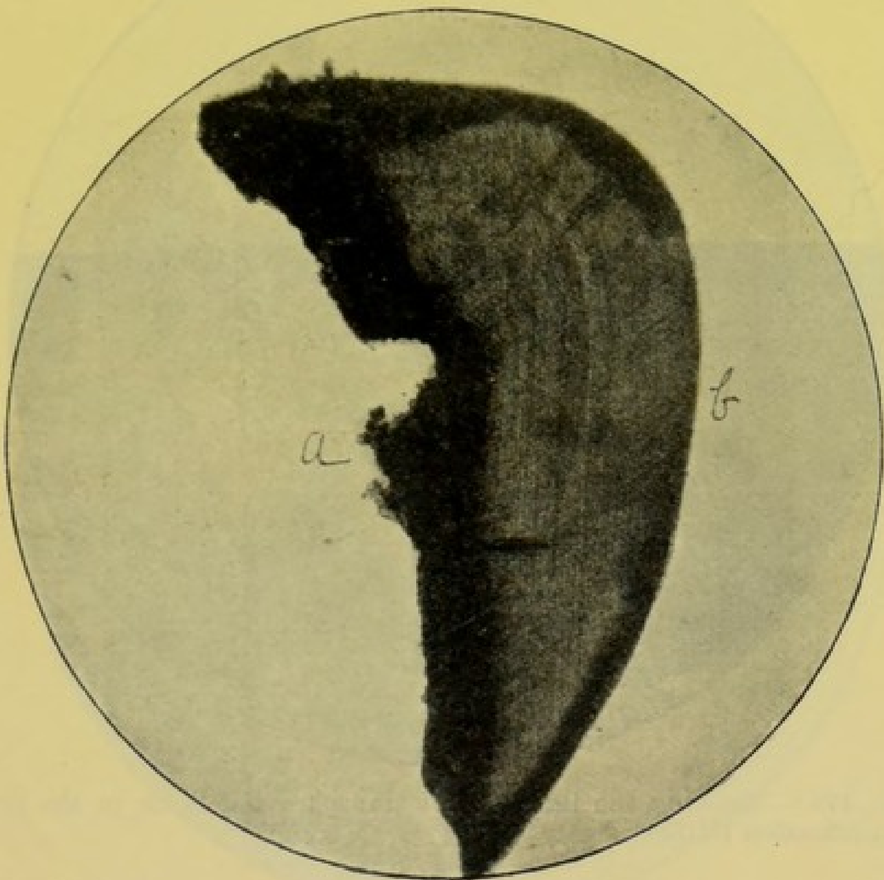


FIG. 478.[1]—Unequal action of acid upon internal (*a*) and external (*b*) surfaces (Miller).

due in part to the protective action of the enamel cuticle. Abrasions, bruises, cracks, and any other defects sensibly diminish the resistance of the enamel.

The amount of reaction which takes place in teeth with living pulps probably influences the progress of the caries. The reaction of the tooth to the carious process shows itself in the

[1] From *Dental Cosmos.*

formation of secondary dentine and in a change in the contents of the dentinal tubes, giving rise to the "translucent zone." Experiments show that the dentine of the "translucent zone" and secondary dentine "offer a greater resistance to advancing caries than normal dentine" (figs. 479 and 480).

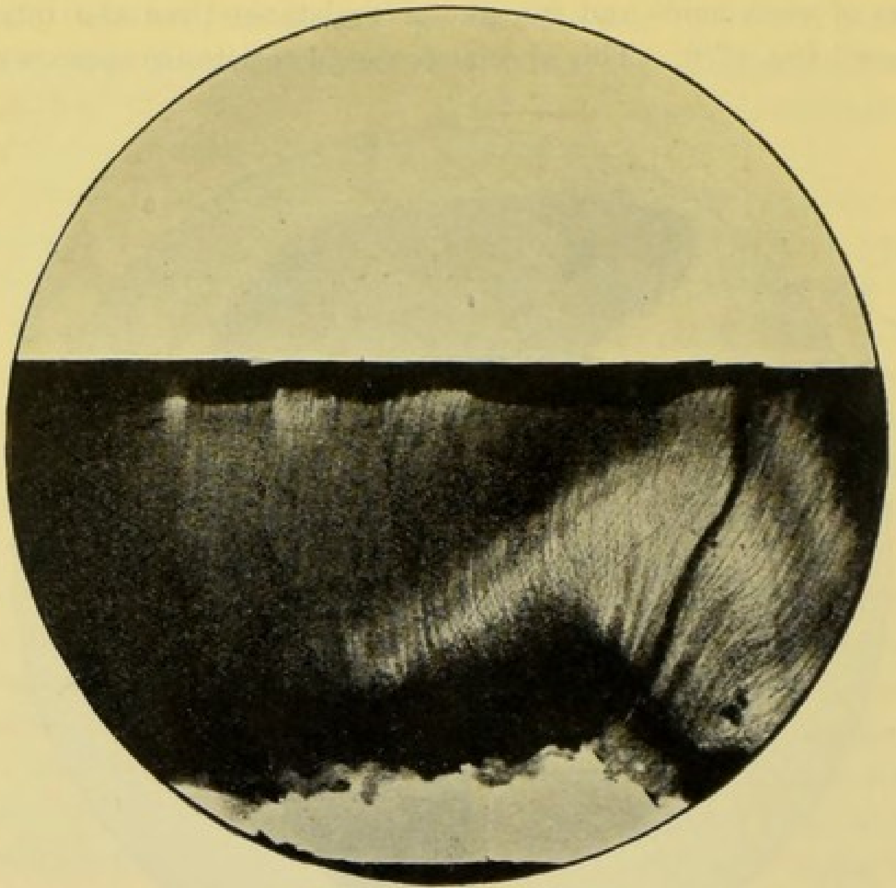


FIG. 479.[1]—Showing the influence of transparent dentine in the process of decalcification (Miller).

The Influence of Lime Salts in Food.—Dr. Röse, of Freiburg, has made extended investigations as to the influence on the teeth of lime salts in food and water. His inquiries have been pursued in many countries, and he has arrived at the conclusion that in districts where the soil and drinking water contain a good supply of lime the teeth are sounder than in districts where the lime is deficient. The following figures show the results he obtained from Baden and Thuringia :—

[1] From *Dental Cosmos*.

(1) **Country Places Poor in Lime.**

	Percentage of Children with Caries.	Percentage of Diseased Teeth.
In Baden ...	98·7	35·3
In Thuringia	92	34·9

(2) **Country Places Rich in Lime.**

In Baden ...	79	16·1
In Thuringia	82·8	16·7

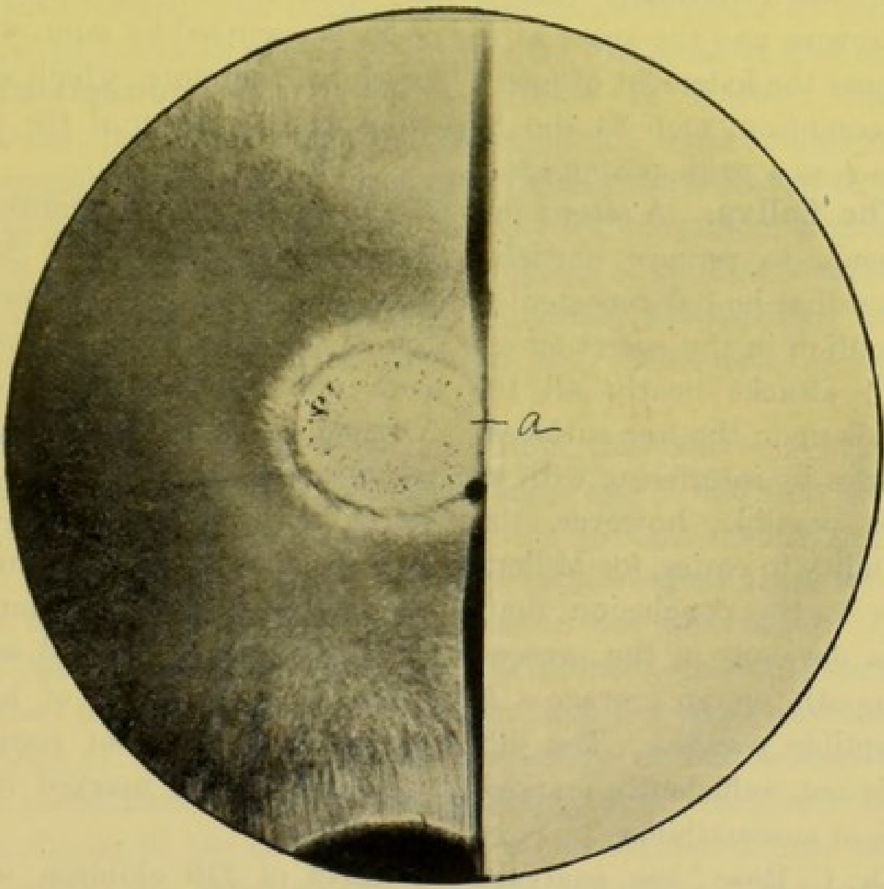


FIG. 480.[1]—Evident superior resistance of secondary dentine to decalcification (at *a*) (Miller).

In two villages, Guntersthal and Uffhausen, distant only about three kilometres, he found a remarkable difference. At the former, where the geological formation is gneiss and the water 1·7 to 2·8 degrees of hardness (German calculation), in 118 children 34·6 per cent. of the teeth were carious, while at Uffhausen, where a

[1] From *Dental Cosmos.*

Jura-lime formation exists, and the water was 14 to 19 per cent. of hardness, in 162 children the percentage of carious teeth was 20·7.

The position of the teeth in relation to one another has an important bearing on their liability to caries. When they are in regular position the surfaces are easily kept clean by the action of the tongue and lips, and such artificial aids as the tooth-brush, silk and tooth-pick, but when they are placed irregularly crevices are formed which are inaccesible. Again, the teeth, when normally placed, only just touch one another at the crowns, and the space at the necks is occupied by gum, which prevents the lodgment of food. Anything, therefore, which alters this condition, such as the loosening and recession of the gum, will act as a predisposing cause.

The Saliva.—A strong flow of saliva flushes the mouth and so tends to remove particles of food from the teeth. Miller affirms that he has repeatedly found that a cessation or a marked diminution in the secretion of saliva is followed by acute caries, which attacks nearly all the teeth simultaneously and often extends upon the free surfaces. A viscid saliva may also conduce to caries by interfering with the self-cleansing of the mouth. It seems possible, however, that saliva may influence the susceptibility to caries, for Miller,[1] as the result of many experiments, came to the conclusion that "the saliva of those immune to caries develops in the presence of carbohydrates, in and out of the mouth, on an average a little less acid than that of highly susceptible persons. The difference is, however, not constant, and is not sufficiently marked to account for the marked differences of susceptibility."

Dr. C. Röse[2] has analysed the saliva of 219 children, whose average age was 13 years, and he concludes that a distinct relationship exists between dental caries and the alkalinity of the saliva. He finds that a high alkaline reaction constitutes the best means of checking caries in its early stages and hindering its progress. He has carried out a considerable number of experiments to determine the means by which slightly alkaline or acid saliva may be modified so as to render its reaction decidedly

[1] *Dental Cosmos*, 1903, p. 689.

[2] *Deutsche Monatsschrift für Zahnheilkunde*, December, 1905.

alkaline. He finds that a diet consisting of foodstuffs rich in calcium salts increases the alkalinity and quantity of the saliva and he believes that such a diet favourably influences the quality of the teeth. In this connection it is interesting to note that Miller, in comparing experimentally equine and human saliva, found that in equine saliva no acid was produced during the first twenty-four hours, and that the total amount at the end of nine days was 50 per cent. less than in human saliva. Equine saliva is strongly alkaline, and therefore more readily neutralizes any acid formed. In chapter XX. reference is made to the part played by saliva in relation to immunity to disease in the mouth.

Vaccination.—So careful a thinker as Herbert Spencer hazarded the suggestion that vaccination might increase the susceptibility of the teeth to caries. This view is shared by a few dental practitioners. Dr. D. V. Beacock[1] considers that vaccination is a prime factor in the destruction of children's teeth, his argument being that it leads to imperfect development of the tooth structure. There are, however, no reliable data to support this view.

Pregnancy.—It is a current belief that there is increased susceptibility to caries during pregnancy, and it has been assumed that this is due to the absorption of the mineral matter from the teeth to form fœtal bone. From a physiological point of view there would appear to be no foundation for this belief. Dr. S. Biro[2] has examined the teeth of 200 mothers, and the results he obtained tend to show that pregnancy does not cause any increase in caries of the teeth. During pregnancy certain women often seem more liable to caries, but an explanation may be found in some change of the oral secretions which furnish a more favourable soil for the development of micro-organisms. It is possible that the vomiting of pregnancy may, to some extent, aid the development of caries. This apparent predisposition of the pregnant to caries is by no means constant, and in practice one meets with many instances of women with large families who have excellent teeth, and who develop no increased susceptibility to caries during the pregnant period.

The Influence of Feeding in Infancy.—A difference of

[1] *Dominion Dent. Journ.*, December, 1901.

[2] *Oesterreich. Ungarische Vierteljahrsschrift*, October, 1898.

opinion exists as to the effect of infant feeding on the susceptibility to caries. Dr. Kingston Barton,[1] as a result of twenty years of observation, finds that breast-fed children have the best teeth: those fed on cow's, asses' or goats' milk come next, and that when starch or any patent food is added to or given in place of cow's milk, the teeth, both deciduous and permanent, almost always suffer badly. This subject has also been investigated by M. Michael,[2] who obtained the following data. Out of 11,762 children examined, 7,763 had been breast-fed, and these showed caries to the extent of 11·46 per cent., or about 8 per cent. less than the average frequency. The average time of nursing was about six and a half months. In 122 cases the children had been nursed for ten months, and in these only 9 per cent. showed caries. In those brought up on cow's milk—200—the frequency of caries was 22 per cent., and rachitis 8 per cent.; and of 625 children brought up on oatmeal and water, Liebig's or Nestlé's food, the percentage with caries was 27 and with rachitis 16 per cent.

(G) ETIOLOGY

In the preceding pages caries has been shown to be a process which is started by solution of the inorganic matter of the teeth and continued by the peptonizing action of bacteria on the remaining organic tissue, and that the acid or acids which cause the damage are formed from the carbohydrate food undergoing fermentation in contact with the tooth substance.

We have seen that caries existed as far back as the "Stone Age," though it was probably then very rare. In the early stages of civilization a definite increase in the amount of caries can be traced, and with the spread of civilizing influences the disease has made more and more rapid progress until at the present day it is so prevalent that few are to be found with teeth entirely free from caries.

The phenomenal rapidity with which caries has increased of late years has puzzled those who have studied the subject. Since the last edition of this book was published, considerable light has,

[1] *Medical Press and Circular*, vol. ii, 1899.
[2] *Brit. Journ. Dent. Sci.*, May 2, 1904.

however, been thrown on the problem by those who contend that a solution is to be found in the altered character of the foodstuffs. In a series of valuable papers, Dr. Sim Wallace has drawn attention to the influence which the refinement of food has had on the process of mastication, and he has clearly pointed out the intimate relationship which this change bears to the incidence of caries. To appreciate the standpoint taken up by this writer, reference must be made to the process of mastication of food of a soft character, and of food containing coarse or fibrous material. In the former case "The food is simply taken into the mouth, receives a general squash between the teeth, or between the dorsum of the tongue and the hard palate, and is then swallowed. This method of mastication—if mastication it can be called—is, as a rule, adopted for custards, fine meal porridge, soft puddings, and soft non-fibrous foods generally. When there is a certain amount of coarse or fibrous matter in the foodstuff, the process is essentially different, and mastication is performed in a more thorough manner. The food is crushed and torn between the teeth and heaped on to the masticating surfaces by the muscular contractions of the tongue, cheeks, lips, and motions of the lower jaw. During comminution between the teeth, the juices of the foodstuffs, the saliva which becomes incorporated, and the suspended non-fibrous part are pressed out from the fibres and gradually collect during the process on the middle of the dorsum of the tongue, which is gradually hollowed out for the reception of such food, and this portion of the food is then swallowed. The fibrous part of the food, however, is subjected again and again to the crushing and disintegration between the teeth. If any of the fibrous part passes towards the back of the dorsum of the tongue, it is arrested by the pressure of the anterior part of the tongue against the rugæ of the palate, and while the fluid and finely comminuted part gets sucked or pressed back into the hollow formed at the back of the dorsum of the tongue, the coarse and fibrous parts are thrown between the teeth and subjected again to the crushing, squeezing and comminution. The rough surface of the tip and dorsum of the tongue and the smooth-ridged palate are especially well adapted for separating the food which is prepared for swallowing from that which requires further mastication."

"If this process is carefully observed, it will be found that the food is not, as a rule, formed into a bolus and then swallowed, but that the bolus is continually slipping away to the dorsum of the tongue to be swallowed, only when there is almost or quite no bolus left." (Sim Wallace.)

The recognition of the real nature of the process of mastication is, in this author's opinion, of great importance, for the effect of chewing food of a more or less fibrous nature tends to dislodge the fine particles of foodstuffs which otherwise are apt to lodge between and on the teeth.

If we examine the foodstuffs as prepared for the table at the present day, we find that every care has been taken to eliminate the fibrous element, and that they are usually presented in such a soft condition as to require very little mastication; indeed, it is extremely difficult even with the best intentions to masticate such food. The process of mastication, therefore, remains in abeyance, and the result is that, owing to the pappy character of the food, and the absence of the cleansing operation of mastication, the food tends to cling around the teeth. Dr. Wallace contends that herein lies the true cause of the prevalence of caries. He says: "The cause of the prevalence of dental caries is that the natural foodstuffs are to a large extent ridded of their accompanying fibrous parts and prepared and consumed in a manner which renders them liable to lodge and undergo acid fermentation in the mouth; while from the same cause and the induced condition the micro-organisms of the mouth lodge, multiply and augment the rapidity and intensity of the acid fermentation."

In opposition to these views it is argued that there are numerous examples of races living upon soft food and yet not unduly liable to caries. The Kaffirs of South Africa are given as an instance. The porridge of the Kaffirs, which is their staple food, is prepared by bruising and crushing mealies, no attempt being made to eliminate the coarse and fibrous parts, and experience shows that such food *does* require a considerable amount of mastication.[1]

[1] References to this question will be found in *Lancet*, September 8, 1900, p. 770; November 3, p. 1307; *Brit. Med. Journ.*, March 18, 1905, p. 629; April 1, p. 749.

Although there is much to be said in favour of Dr. Sim Wallace's view, it is very doubtful whether it offers a complete solution of the problem. It is more highly probable that there have been other agencies at work tending to accelerate the progress of caries. The use of carbohydrates has probably had an important influence in this direction. *Carbohydrates as used at the present day are more easily soluble and fermentable than heretofore*, and within the last fifty years have undergone an extraordinary amount of variation. Flour is a typical example. In flour the change has been brought about by the altered method of milling. Milling with the old stone mills excluded no part of the grain except the greater portion of the husk, whereas with roller milling the germ is removed and practically all the bran, the flour consisting almost entirely of starch and gluten. With regard to the question of caries, bread made from stone-milled flour requires more mastication and insalivation than that made from the roller-milled; still further, Mr. T. G. Read[1] is of the opinion that bread made from roller-milled flour becomes acid in the mouth far more quickly than that made from stone-milled. In ten tests it was found that on the average the acidity in bread made from stone-milled flour increased to a very slight extent in the process of mastication; whereas with bread made from roller flour there was an increase of 40 per cent. in the acidity after mastication. The experiments, although instructive, are not sufficiently comprehensive to enable a definite conclusion to be drawn. The subject, however, is deserving of serious attention, seeing that bread and flour form the most important item in the diet of the masses.

Clinical evidence supports the view that there is an intimate relationship between sugar and caries. The use of sugar as a foodstuff has increased enormously during recent years, and this food, it must be remembered, is readily soluble. Dr. Miller[2] would seem to have considered the view that the importance of sugar was over-rated. He remarks: "At present sugar is universally regarded by dentists as well as laymen as injurious to the teeth."

[1] "Some Chemical Changes Occurring in the Mouth during the Mastication of Bread composed of 'Roller Flour," *Journ. Brit. Dent. Assoc.*, vol. xxii, p. 590.

[2] "The Micro-organisms of the Human Mouth," p. 145.

Again (p. 207), he states "that sugar, being readily soluble, is soon carried away, or so diluted with the saliva as to be rendered harmless," and he held that the chief rôle in the production of decay was performed by bread, potatoes, &c.

Cane and beet sugars are polysaccharides, and before fermentation must undergo the process of inversion; glucose, on the other hand, is a monosaccharide and is, therefore, directly fermentable. Within the last thirty years glucose has been used extensively as a substitute for sugar, and enters largely into the manufacture of syrups, candies, jams, cheap sweets, &c. In the manufacture of glucose a gummy body, namely dextrine, is formed, and this possibly assists the retention of the sugar in the mouth.[1] The idea suggested that glucose is rapidly fermentable, requires experimental proof, and the question of the varying rapidity of fermentation of the carbohydrates used as foods opens up a wide field for research. "There can be no doubt that a mistake has been made in the past in regarding all sugars as similar, and that, in the future, in their relation to caries, they must be looked upon as different substances, transformable, to some extent, into each other; just as peptone, being a proteid, is a changed form of other proteids though possessing many different properties."

In a paper by Dr. L. Ottofy, on "The Teeth of the Igorots,"[2] the relation of sugar to caries is well brought out. In the Igorots of the Philippines, a semi-barbaric race, he found only 2·05 per cent. of carious teeth, while in the Filipinos, the more civilized inhabitants of the islands, the amount of caries was 20·90 per cent. The diet of the Igorots consists of food requiring considerable mastication; bread is unknown and sugar is distasteful to the children. The Filipinos, on the other hand, indulge freely in the practice of chewing sugar, which is sold in small pieces all over the islands, and Dr. Ottofy is convinced that the extensive amount of caries in the Filipinos is due to sugar. There is abundant clinical evidence to show that the use of sugar is closely connected with the amount of caries. In practice it is found that children who eat sweets in large quantities will return from school each term with a plentiful supply of fresh and generally

[1] See paper, "The Problem of Dental Caries," S. Colyer, *Dental Record*, vol. xxiv, p. 301.

[2] *Dental Cosmos*, July, 1908.

rapid caries, but when the eating of sweets is stopped the amount of fresh caries rapidly declines.

Recapitulation.—The process of caries may be concisely described as follows: The form and relative positions of the human teeth favour the lodgment of foodstuffs in solid form or in solution upon or between them. Of the three groups of foodstuffs — nitrogenous food, the carbohydrates, and fats—the second group is particularly concerned in bringing about the process of caries.

Of the three groups of carbohydrates—cellulose, starch and sugar—it is doubtful whether the first (cellulose) undergoes any change in the mouth which gives rise to products injurious to the teeth; whereas starch is first converted into dextrose by the action of the ptyalin of the saliva, and the dextrose, through the agency of micro-organisms (fermentation) into lactic acid, and possibly other organic acids in minute quantities. The sugars, when directly fermentable, are by the same process converted into acids, whereas those not directly fermentable, such as cane-sugar, take up a molecule of water under the action of invertin (a ferment produced by many bacteria), and are then split up into dextrose and levulose, both of which are directly fermentable, and produce lactic acid in the presence of many mouth bacteria.

These acids, from whatever source produced, attack the teeth at the point where they are generated, that is, wherever the foods in solid or fluid form have lodged on or between the teeth, and lead to decalcification, first of the enamel (or cementum), and later of the dentine. The decalcification of the enamel results in its complete destruction, as the organic substance in the enamel is insufficient to hold together after decalcification, whereas decalcification of the dentine does not imply the complete destruction of the organic basis, as this remains in the form of the so-called tooth cartilage. As this organic basis is of a nitrogenous nature it undergoes decomposition in very much the same way as all other nitrogenous substances exposed to the action of bacteria in the presence of moisture and a suitable temperature. The agent which brings about this decomposition is a ferment produced by many of the bacteria of the mouth, and acts in very much the same way as the pepsin of the gastric juice, except that it does not require the presence of acid. Very

little is known as to what changes of a fermentative nature take place in the fats in the mouth. It is possible that a fermentation leading to the formation of fatty acids may occur, but if that is the case the quantity produced is so minute that it has not as yet been detected.

Nitrogenous substances, as already explained above, undergo very active decomposition in the mouth, resulting, however, not in an acid, but in an alkaline reaction; an excess of nitrogenous food—for example, a diet consisting chiefly of meat—might serve to arrest the process of decay, inasmuch as the acids produced in the mouth by the fermentations of carbohydrates would be in part, or completely, neutralized by the alkaline products arising from the fermentation of nitrogenous food.

A consideration of the question of etiology would seem to suggest that the prevalence of caries in modern races is due to the soft character of the food, and the increase in the use of carbohydrates, which undergo rapid fermentation.

(H) SYMPTOMS

Pain in the region of the affected tooth may occur. If the caries is on a surface free to the tongue, the patient will be conscious of a cavity. In many instances, the lodgment of food between the teeth is the first symptom noticed. The pain is due to irritation of the pulp *viâ* the dental fibrils, and will vary according to the situation and extent of the cavity. On occluding surfaces, the fibrils being exposed, changes of temperature or the introduction of irritant substances into the cavity will produce pain, which increases in severity as the cavity becomes larger. In cavities tucked away under the gum or on approximal surfaces pain is often not felt until the pulp is involved. The degree of pain varies with different temperaments, and in the same individual at different periods. Patients of a nervous temperament suffer more than those of a lymphatic temperament. In a few patients, caries gives rise to no pain.

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CHAPTER XIII

The Treatment of Caries

Prophylactic Treatment—Remedial Treatment—The Exclusion of Saliva—The Separation of Teeth—The Preparation of Cavities—The Treatment of Hypersensitive Dentine—The Use of Matrices—Use of Screws for Retaining Fillings—The Materials used for Filling Teeth—The Introduction of the various Filling Materials—The Operation of Excision—The Use of Drugs in the Treatment of Caries—The Operation of Crowning—The Operation of Extraction.

THE treatment of caries may be divided into

(A) Prophylactic.

(B) Remedial.

(A) PROPHYLACTIC

Rational treatment of caries, like the rational treatment of any other disease, must depend upon the knowledge of the etiology of the disease. When once the etiology of a disease is established, the adoption of energetic preventive measures will quickly eradicate the disease. Few better examples of this can be found than in the stamping out of Malta fever. For years this severe and dangerous complaint played havoc with our naval and military forces stationed at Malta and other parts of the Mediterranean, and, indeed, in many other parts of the world. The study of this disease was approached by experimental methods in 1887, and the knowledge thus gained, combined with scientific reasoning, resulted in the infection being traced to its source, namely, the milk of goats. With the banishment of goat's milk from the dietary, the fever has become practically extinct in the Army and the Navy (see figs. 481 and 482).

Although, during recent years, advances have been made in our knowledge of the etiology of dental caries, we are yet far from knowing the true cause of the disease. If the cause were

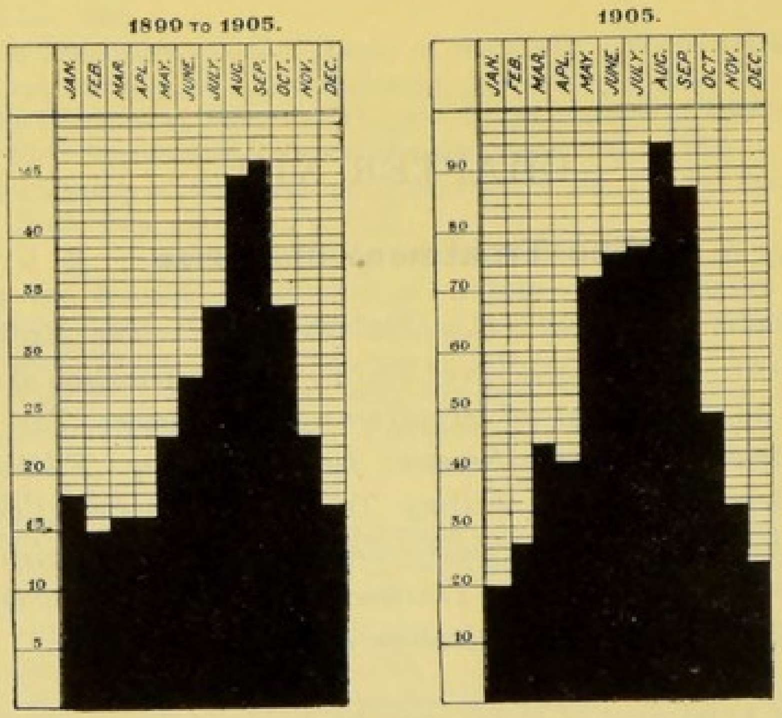


FIG. 481.[1]—Charts of incidence among the soldiers in 1899-1905, and 1905.

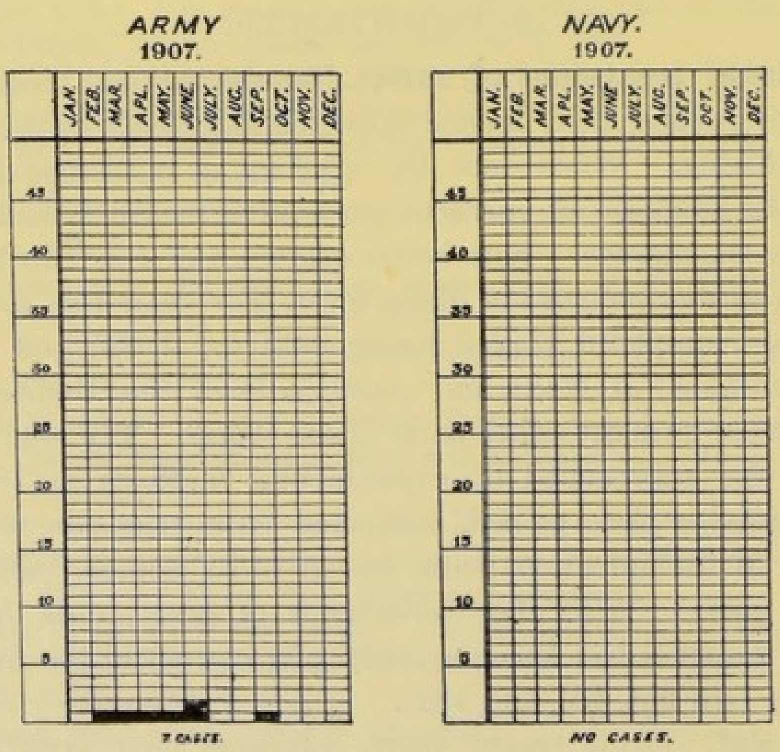


FIG. 482.[1]—Charts of incidence among the soldiers and sailors, 1907.

[1] By kind permission of Colonel Sir David Bruce.

known caries could be eradicated. What is required is a thorough experimental investigation carried out on scientific lines.

In discussing the cause of caries, attention was drawn to certain matters which appear to have a special bearing on the increase of caries, namely, the feeding in infancy, and the character of the foodstuffs, &c. A consideration of these seems to indicate that preventive treatment should be based somewhat on the following lines :—

(*a*) The insistence when possible of breast-feeding.

(*b*) The use in the early years of life of foodstuffs which require efficient mastication.

(*c*) The use of carbohydrates which are not easily fermentable.

With regard to **breast-feeding,** it is true that this natural function cannot always be performed. Too often, however, hand-feeding is substituted, not so much from inability of the mother as from an unnatural desire on the part of the mother to escape the ties which the duty of breast-feeding involves. When, however, breast-feeding is impracticable, every care should be taken to ensure that the hand-feeding is carried out in a proper manner, and it is satisfactory to find that a great advance in this direction has been made in recent years.

The use of such **foodstuffs** as call for some effort in mastication is important, and "pap" food should, as far as possible, be carefully avoided. A very little experience of children will demonstrate the importance of this point. Bread soaked in milk is bolted, while bread given in the shape of a crust or a piece of toast is chewed, simply because the chewing is physiologically necessary. For similar reasons, meat, when given, should be cut in strips and not minced. Mastication promotes a healthy flow of saliva and the saliva assists in cleansing the teeth.

There is little doubt that of the carbohydrate foods, the sugars are the most harmful, especially when taken between meals. **"Sweets" as popularly understood should be forbidden.** As carbohydrates are now known to be the source from which the lactic acid is derived, it is advisable so to arrange a meal that the last foodstuff taken is neither a sugar nor a starch. A meal should, if possible, finish with fruit or cheese. Fruit is especially beneficial, as it is slightly acid and stimulates the saliva. Meals should be given at regular intervals. If the

salivary secretion is constantly being stimulated by incessant "nibbling" at food, it is probably robbed of its physiological properties and the supply required for the regular meals is depleted and probably altered in character.

A functional mouth is a necessity if caries is to be prevented. There are two important factors militating against a functional mouth: one is mouth-breathing and the other the presence of tender teeth. Mouth-breathing, as shown on p. 642, leads to a persistent marginal gingivitis which aids the retention of food around the teeth. It is therefore essential that any condition causing nasal obstruction should be removed in order to admit of correct breathing. Tender teeth prevent mastication, and without proper mastication it is difficult to keep the teeth clean. The mouth, then, must be freed of all tender teeth, either by filling or extraction.

The proper cleansing of the teeth after meals is a most important prophylactic measure, but this must be regarded as secondary in importance to the measures just referred to. If possible, the teeth should be cleaned after every meal, but it is especially needful after the last meal of the day. During sleep, the saliva ceases to flow, and it is then that the main fermentation of the food occurs. The tooth-brush should be small and contain fewer bristles than the brushes usually sold; the bristles should be of different lengths, so as to permit of their passing more easily into the interstices of the teeth. The brush should be used with an upward and downward movement, *i.e.*, in the direction of the long axes of the teeth, or with a circular motion. The following instructions for cleaning the teeth are issued to the patients at the Royal Dental Hospital of London:—

(1) The teeth **must** be kept clean.

(2) Use a small tooth-brush with stiff bristles. Use a little soap and some precipitated chalk.

(3) Brush all the teeth thoroughly, especially the back ones. Brush all surfaces of the teeth.

(4) Clean the teeth immediately **before going to bed.** Take no food of any sort afterwards. Clean the teeth again in the morning.

(5) **Clean teeth do not decay.**

With the eruption of the permanent incisors, the spaces between the teeth should be regularly cleared with silk.

In mouths **where caries is progressing rapidly,** it is a useful measure to swab the mouth with an alkali the last thing before going to rest, for example :—

Mag. carb. levis	ʒiv.
Aq. rosæ	℥vi.
Aquam, ad.	℥xij.

Misce. Shake before using.

After cleansing the teeth, a tablespoonful of the above should be taken into the mouth and sluiced between the teeth.

In cases of acute fevers or any other condition where the patients are helpless, their teeth should be cleaned by the attendants.

Patients wearing dentures should be warned of the danger of neglecting to cleanse both the mouth and the dentures. Dentures cause caries only in so far as they assist in retaining food around the teeth.

In mouths showing a tendency to approximal caries of the anterior teeth, isolation should be obtained by the removal of the first or second premolars or the first molars (see p. 200). Isolation of the incisors and canines is a most valuable method of preventing caries between these teeth.

(B) REMEDIAL

The remedial treatment may be considered under the following headings :—

(1) The operation of filling.
(2) The operation of excision.
(3) The use of drugs.
(4) The adaptation of artificial crowns.
(5) The operation of extraction.

(1) THE OPERATION OF FILLING

(*a*) The Exclusion of Saliva

There are several methods for excluding the saliva during the operation of filling :—

(i.) The Rubber Dam.—In the choice of rubber several points have to be taken into consideration. Elasticity, extensibility, and freedom from smell are essential properties of good rubber. A medium thickness of rubber is best for general purposes.

Various methods are in vogue for *perforating the rubber dam.* The first and simplest is to stretch the dam over the end of an excavator, and then to touch it a short distance from the extremity of the instrument with a penknife, when a small round disc will fly off ; a little practice will soon enable the operator to control the size of the perforation. Another method is to fold a piece of rubber into four, so that the point of folding coincides with the position of the required perforation, and to cut off the corner with a small pair of scissors. By this means, a hole is cut which, although not truly circular, is sufficiently so for the purpose required. Lastly, perforations may be made with punches specially manufactured for the purpose—this is the best method.

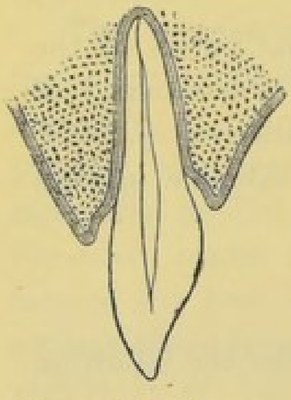


FIG. 483.—Showing attachment of gum to tooth.

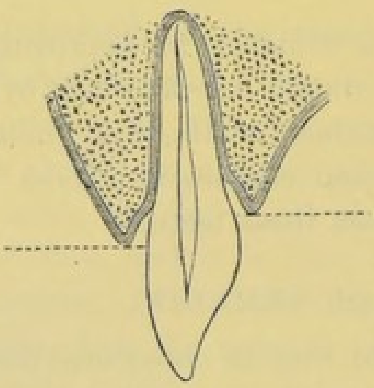


FIG. 484.—Showing position of rubber dam when not tucked under the edge of the gum.

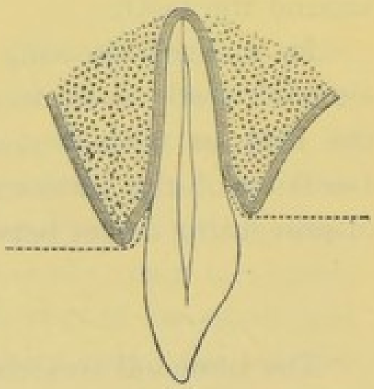


FIG. 485.—Showing position of rubber dam when tucked under the edge of the gum.

In applying the rubber dam to back teeth, a little trouble is at first experienced in gauging the correct position to punch the hole. This difficulty may be readily overcome by placing the rubber in the mouth, and marking roughly where it comes over the tooth or teeth to be encircled. With molars, the holes should be about $\frac{3}{32}$ in. apart from one another. In dealing with simple crown cavities, the rubber may be adapted to the single tooth, but with an approximal cavity, the application must be extended to the tooth adjacent to the cavity. In applying the rubber dam, it is most important that it should be tucked under the edge of the gum, as this prevents the rubber slipping and also checks the

saliva from dribbling down between the rubber and the tooth. The accompanying diagrams illustrate this point.

In fig. 484 is shown the manner in which the rubber is applied when this precaution is not taken; and fig. 485 represents the rubber as correctly applied.

The rubber should be tucked in with a blunt instrument, such as a burnisher, or silk may be passed between the teeth. The former is sometimes quite sufficient, but generally the latter has to be employed. **Clamps** are useful to assist in keeping the rubber in place.

In applying rubber dam to teeth having approximal cavities, it is important that the cervical edge of the cavity should be well defined; if the gum has encroached at this point it will be necessary to remove it. This is best done by cutting the redundant tissue away with a suitable knife, the gum being first rendered anæsthetic with cocaine. Sharp edges are sometimes met with, and as they are a source of great inconvenience, when passing the silk they should be removed, if possible, before the application of the rubber is commenced. Lastly, any deposit on the teeth should be removed before applying the rubber dam.

Application to Front Teeth.—This can be accomplished in the following manner :—

Take a piece of rubber of the necessary size and pierce the number of holes required, taking special precaution to have sufficient space between them. As a general rule it will be found advisable to include at least four teeth under the rubber. For example, in the case of a cavity on the mesial surface of the right central incisor the rubber should include the four incisors. With a cavity on the distal surface of the right lateral incisor, the application should be made to the first premolar, the canine and the right lateral and central incisors. Holding the rubber between the finger and thumb of both hands, stretch it over the required teeth, commencing at one end and passing it over the remainder in order.

Should the teeth lie close together, a little difficulty may be experienced in passing the rubber between them. This is best overcome by drawing a strand of silk between the teeth, which will carry the rubber dam before it If silk will not pass a separation must first be made. This operation completed,

apply the retractors, and should the rubber not lie easily over the lower lip attach weights to either corner. A napkin should be placed under the rubber and brought under the retractors. This, with the use of the saliva ejector, will mitigate some of the inconvenience to the patient. The next step is to **pass the silk** in order to "tuck the dam under the edge of the gum," as already explained. An easy, quick and effective method of doing this is as follows, and a reference to the accompanying diagrams will greatly assist in following the description: It is supposed that

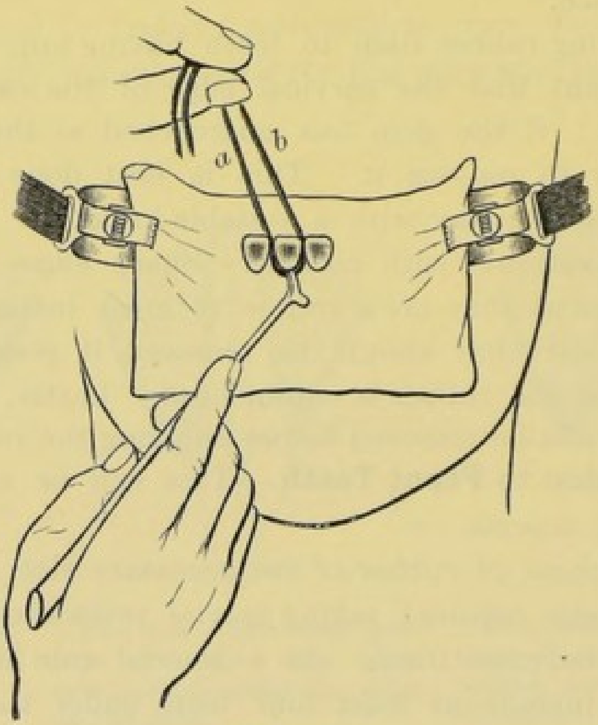


FIG. 486.

there is a cavity on the distal side of the left central. First, take the silk between the thumb and first finger of the right hand and the thumb and first finger of the left, and pass it up between the centrals, leaving it there; repeat the same on the side approximal to the lateral, having the free ends of silk in front and the loop behind. Next take the free ends between the thumb and first finger of the left hand and draw them well forward; at the same time, by means of a burnisher, guide the loop over the cingulum and above the free edge of enamel, still pulling the ends well forward (fig. 486). Hold the end *a* in the left hand in a direction slightly upwards and pass the end *b* over it, and then,

still holding *a* as described, bring *b* between the centrals, using traction in a direction downwards and backwards (fig. 487). Then, either cut the ends off short and leave the silk in position, or remove it altogether. The former is preferable. The silk should be applied to every tooth over which the rubber is stretched.

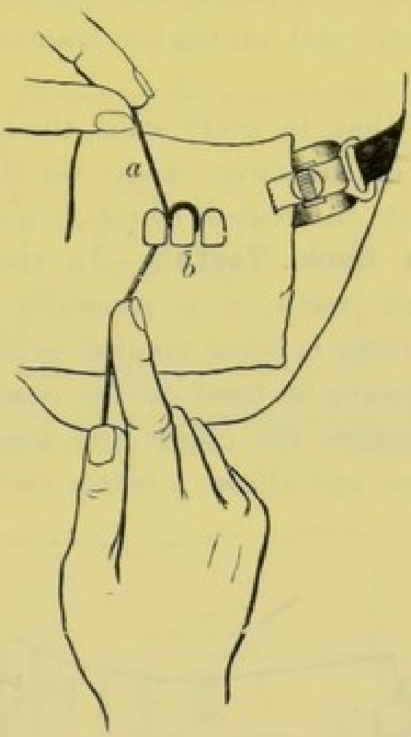


FIG. 487.

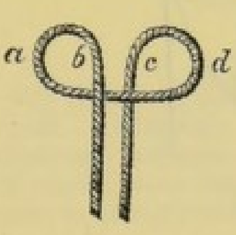


FIG. 488.

FIG. 489.

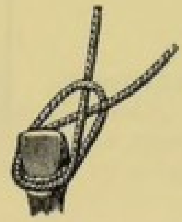


FIG. 490.

In some cases, especially with conical teeth, the above method is not always sufficient to prevent the rubber from slipping. The slipping may sometimes be prevented by passing the end *b* as directed over *a*, then bringing it up again between the central and lateral, and over *a* once more; then applying traction as before

directed. By this means, the tooth is surrounded by a double strand of silk.

Another method of preventing the rubber from slipping is to apply an ordinary clove hitch. This is made as follows: Fold the piece of waxed silk as shown in fig. 488, next simply pass, not fold, the loop *c d* in front of loop *a b* as shown in fig. 489, then apply to the tooth by taking the double loop well up behind the neck of the tooth, and exercising traction alternately on the ends (fig. 490).

It is important that, in every case, the silk should be passed and the knot tied, or the twist made, on the side of the tooth away from the cavity, the reason being obvious.

Application to Back Teeth. — In the application of the rubber dam to back teeth, it is generally necessary to use a clamp, and if the rubber is being applied to more than one tooth, the clamp should always be fixed on the most distal tooth. The use of a clamp prevents the cheek and tongue drawing off the rubber when in place, and allows a better view of the cavity.

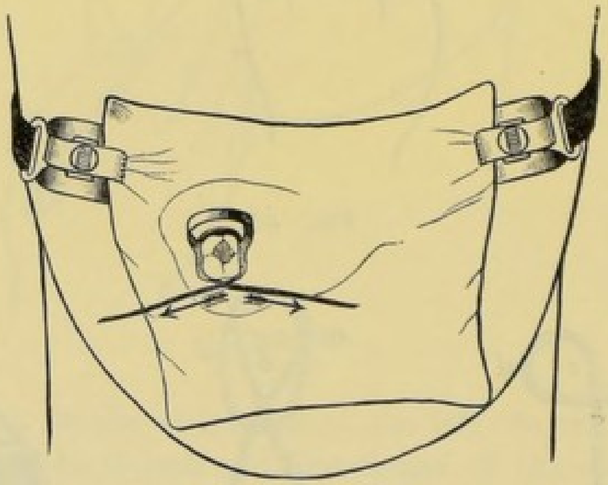


Fig. 491.

When using a clamp, two methods are open to the operator:—

(*a*) The clamp may be applied, and the dam stretched over it —this method is handy where small clamps are used; or,

(*b*) The clamp may be passed through the perforation in the rubber, and, being placed in position on the tooth, the rubber may be gradually insinuated over its edges with the first fingers.

Having adjusted the clamp, stretch the rubber over as many

teeth as is needful, using silk, if necessary, to pass it down the interstices. Apply the retractors, and carry silk round all the teeth, including the one on which the clamp is placed. This latter precaution is necessary, as the clamp does not cause the rubber to tuck under the gum, and without the silk a possible cause of leakage would be left. Passing the silk is best effected

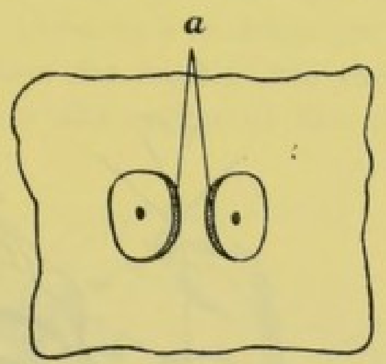


FIG. 492 (Ottolengui).—Diagram showing leakage due to leaving insufficient space between the holes in the rubber. (*a*) indicates margin of rubber.

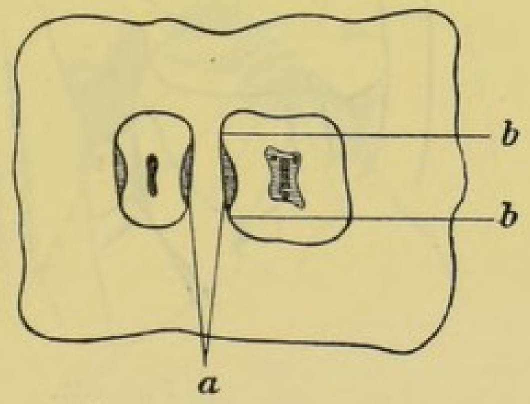


FIG. 493 (Ottolengui).—(*a*) indicates margin of rubber; (*b*) prominences of the tooth. Diagram illustrating leakage due to shape of tooth. The rubber stretches between the prominences of the tooth, leaving a space. A pledget of cotton-wool dipped in gum sandarac varnish and held by a ligature in the space, is usually sufficient to stop the leakage.

in the following manner: Place the silk behind the clamp, and bring the end which is towards the inside of the mouth under the palatal or lingual flange, as the case may be, and then pass it between the approximal surfaces of the teeth in front. Repeat this operation with the other end by passing it under the buccal flange and also between the approximal surfaces. Now apply traction to the end under the palatal flange in an outward

direction, and to that under the buccal in an inward direction (see fig. 491). Then cut off the ends of the silk, or remove it altogether. In applying the silk to the remaining teeth, practically the same methods are employed as are adopted for the front teeth.

In removing the rubber, the operator must be very careful that the silk ligatures are not left behind, otherwise inflammation, sometimes of a very troublesome character, results. It is well,

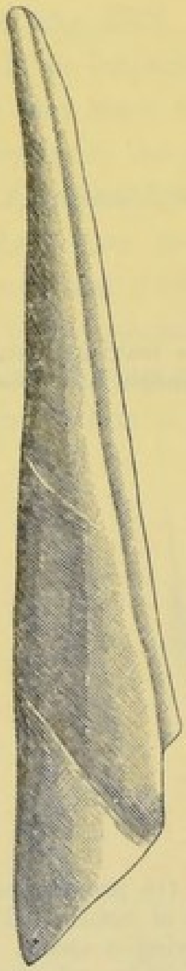


FIG. 494.

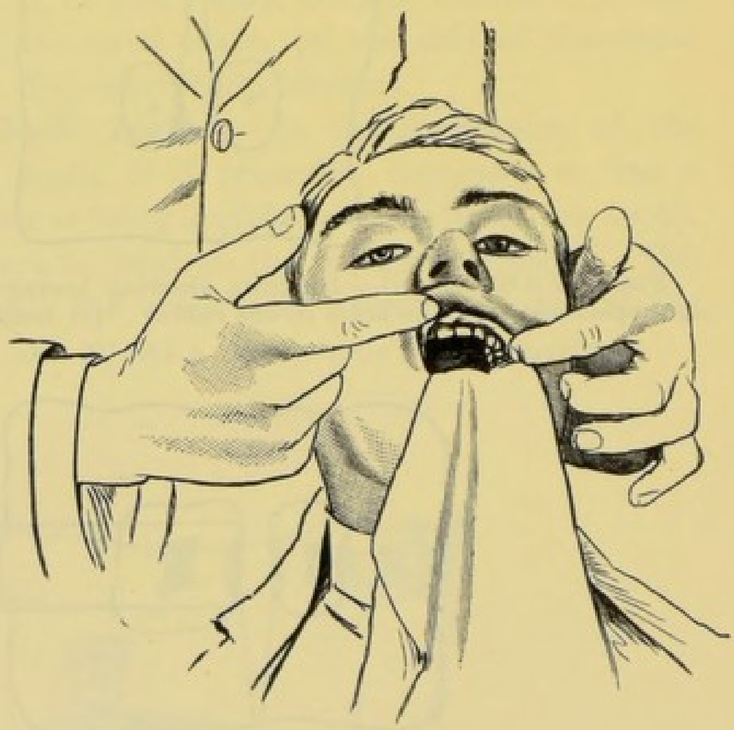


FIG. 495.

therefore, to make a rule to take off the ligatures first, then the rubber, and always, after removing the latter, to look at the holes and see that they are perfect, as a ring of rubber may be torn off and remain on the tooth and set up trouble similar to that caused by an elastic band used for regulating purposes.

Leakage after the rubber dam is in place may be due to the holes being too large or to the space between them being

insufficient, or to some peculiarity in shape of the tooth (see figs. 492 and 493).

(ii.) The Use of Napkins.—Under certain conditions napkins are useful, and, if properly applied, will often be found very effective. There are many ways of applying them, but the one described as follows will be found especially useful: Fold the napkin into the shape shown in fig. 494, and take hold of it with a pair of conveying forceps about $1\frac{1}{2}$ in. to 2 in. from the pointed ends. For the maxillary teeth, pass the napkin into the sulcus between the gum and the cheek in the region of the molars, continue the

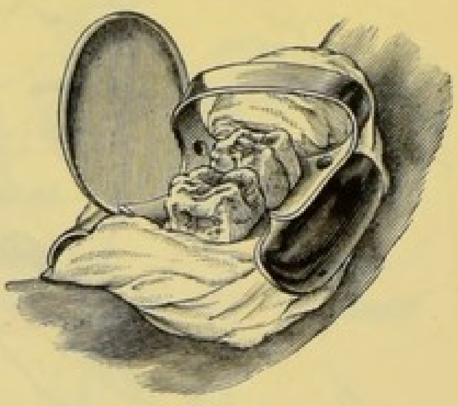
Fig. 496.

packing, bringing the napkin forward towards the incisor teeth. The remaining portion should be passed behind the molars and spread out as shown in fig. 495. While working, the operator should keep his finger well pressed on the part of the napkin which lies over the opening of Steno's duct. The application of a clamp to one of the posterior teeth will greatly assist in preventing the napkin from "pulling out." For teeth in the mandible, exactly the same proceeding should be adopted (fig. 496), the bulky portion being well pressed down into the floor of the mouth, and it is as well to let the tongue lie over the napkin, rather than

the napkin over the tongue, as the tongue will tend to keep the napkin in place.

(iii.) **Bibulous paper or amadou** is used by many operators in place of napkins, and is applied by simply packing pledgets of the material on either side of the gum, holding them in position with the finger and thumb or by some mechanical contrivance. A piece of bibulous paper placed over Steno's duct will keep the outer side of the maxilla or mandible quite dry, and, with the aid of the saliva ejector, is often quite sufficient to keep cavities dry during short operations. In the mandible, a pad should be placed beneath the side of the tongue. Rolls of cotton-wool about $1\frac{1}{2}$ in. may be obtained ready for use and they are certainly an easy

Right side.



Left side.

FIG. 497.

and neat method of applying this class of material. In connection with the napkin and bibulous paper, clamps are extremely useful, that shown in fig. 497 being a useful design. The clamp should be placed in position, and a roll of bibulous paper passed through the hole in the lip of the clamp, taken round the back of the tooth, and returned under the plain lip of the clamp. When the rolls become moistened, additional paper should be packed under the lips and over that already in position. Slight tilting of the head to the opposite side will allow the saliva to accumulate and so assist in keeping dry the side which is being operated upon.

When only a napkin is used and not the rubber dam, the moisture appears between the necks of the teeth, coming from the glands near the margin of the gum, and is extremely troublesome. A very excellent plan for obviating this difficulty is

recommended by Mr. Matheson. He ties to little square pledgets of amadou a small piece of waxed silk; the silk is passed between the teeth, and the amadou drawn into position between them.

(iv.) **The saliva ejector** is a useful adjunct to the various methods of excluding saliva, and is especially useful in conjunction with other methods. The comfort to the patient and the operator by the use of this instrument cannot be over-estimated. The mouth tubes must be sterilized before being used. Saliva ejectors with specially made clamps form a very efficient means of excluding moisture during short operations.

(*b*) Methods of Separating Teeth

The main objects in separating teeth are to give space for the free use of instruments, either for filling or examination purposes, and to enable the contour of the teeth to be restored. In young subjects the separation of teeth can be accomplished with comparative safety, but, in the old, wedging sometimes produces chronic periodontitis, and should therefore be used with judgment. Separation should not be adopted in any case where there are conditions militating against repair of the tissues.

Of **immediate methods**, separation by means of **wooden wedges** is very simple. Two narrow wedges of fine-grained wood, such as orange- or box-wood, are inserted between the teeth, one at the neck and the other at the cutting edge. The wedges are alternately tapped with a mallet until sufficient space is obtained. The wedge between the teeth at the cutting edge is then removed, and the other left in place. Another method of inserting wooden wedges is with forceps made for the purpose, one blade conveying the wedge, the other a pad of rubber to protect the enamel from injury whilst the wedge is being introduced.

Separation of teeth is best carried out by means of an instrument especially designed for the purpose. The separation must be gradually obtained, and care taken to avoid injury to the tooth tissue with the blades of the instrument.

A disadvantage one often meets with in separation is a tendency for the instrument to slip towards the gum. This can be counteracted by placing small pieces of gutta-percha, rubber, or

lead under the bows of the separator when commencing to turn the screws.

A useful method of separation, especially with posterior teeth, is to prepare the cavity roughly at the first sitting, and fill up the space with **gutta-percha,** bringing it against the side of the adjacent tooth. The gutta-percha should be inserted in a semi-plastic condition, and forcibly wedged up with a cold burnisher. The saliva causes the gutta-percha to swell, and so separate the teeth. The cheaper forms of gutta-percha are best for this purpose, as they swell more readily.

(*c*) The Preparation of Cavities

It is not intended to describe fully all the various types of cavities and methods of inserting fillings which occur in practice; attention can be directed only to the more salient and elementary points. The manipulative skill required for correctly filling teeth can only be acquired by practice.

(i.) General Points.—Success in filling depends largely upon a careful preparation of the cavities. In the **retentive shaping,** care must be taken to avoid injury to the pulp and needless sacrifice of tooth substance which might endanger the stability of the cavity walls. **The simplest mode of shaping is to cut the cavity so that some part of the interior is a little larger in diameter than the diameter of the orifice.** In cavities with all the walls standing, this may be effected by making the walls slightly divergent from the orifice inwards. With cavities not possessing four walls, retention is usually obtained by means of **grooves.** The grooves must not be too deep; a deep groove is difficult to fill, and is a source of weakness. The grooves must be cut in the dentine, and in a direction parallel with the pulp. A frail margin of enamel should not be allowed to remain at the cervical portion of the cavity. For example, in fig. 498 the margin of enamel is frail, and liable to fracture during filling. The cavity should be extended so as to remove all the enamel.

The **extension of cavities** beyond the actual limit of the caries is often advisable in order to remove possible sources of failure and obtain **"self-cleansing" edges.** If more than one

cavity exists in a tooth, and there is little intervening tissue between them, the intervening tissue should be removed. Examples: On the occluding surface of a maxillary molar, cavities frequently exist in the anterior and posterior sulci, and if, when the cavities are prepared, only a thin stretch of tissue remains, as seen in fig. 499, it is better to unite them. In teeth with cavities in the approximal surfaces, as seen in fig. 500, the intervening tooth structure should be removed, as fracture is

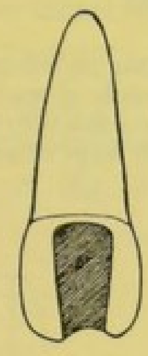


Fig. 498.

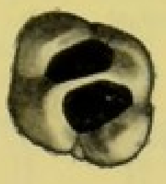


Fig. 499.

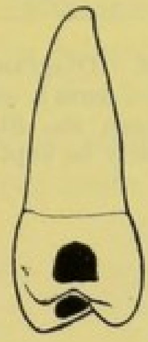


Fig. 500.

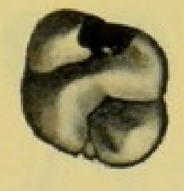


Fig. 501.

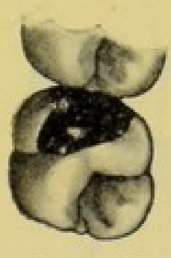


Fig. 502.

certain to occur from the force of mastication. In cavities on the occluding surface of the premolars and molars the fissures should be freely cut out.

When the wall of a cavity is in close proximity to a fissure, as seen in fig. 501, the cavity should be extended so as to include the fissure as shown in fig. 502. The extension of cavities so as to ensure "self-cleansing" edges is most desirable. All joints between fillings and tooth substance should be made as accessible as possible to the tongue and tooth-brush, so that food may be prevented, as far as possible, from lodging near them. It is also most desirable that **fillings should be in contact with the**

approximal teeth to prevent injury to the muco-periosteum during mastication (see figs. 503 and 504).

The Treatment of the Enamel Margins.—The best results are obtained by keeping the margin at right angles to the teeth in all except occluding surfaces (fig. 505). If the edges on occluding surfaces are left much undercut, a few enamel fibres will be

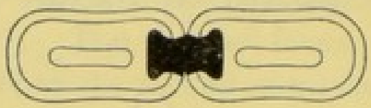


Fig. 503.—Diagram showing cavities prepared in such a way that the junction between the filling and enamel cannot easily be kept clean.

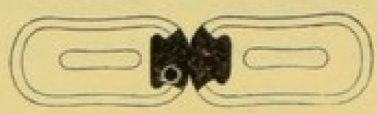
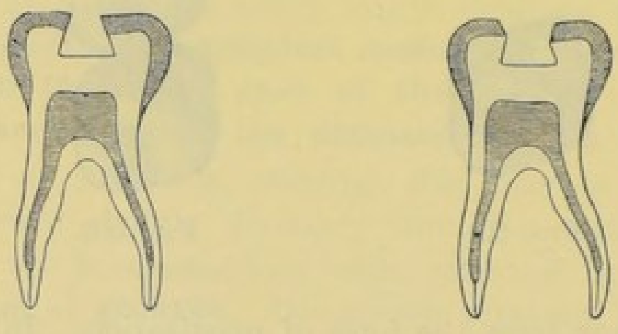


Fig. 504.—Diagram showing cavities prepared in such a way that the junction between the filling and enamel can be easily kept clean.

(*a*) Enamel margins incorrectly prepared. (*b*) Enamel margins correctly prepared.

Fig. 505.



(*a*) Showing how not to leave the margins of enamel. (*b*) Showing how the enamel margin should be prepared.

Fig. 506.

unsupported by dentine—the fibres always run at right angles to the external surface of the enamel at that point—and the result will be that, with pressure, they will give way, forming a vulnerable point in the filling (fig. 506, *a*). If, however, the margin is left but slightly bevelled, all the enamel fibres will be supported by dentine, and a source of failure will have been removed (fig. 506, *b*).

The best instruments for carrying out this part of the work are fine-cut cavity burrs and stones.

(ii.) Relation of the Pulp Canals to the Surfaces of the Teeth.—Maxillary Teeth.

(*a*) **Incisors.**—The pulp of the **central incisor** follows to a great extent the contour of the tooth. It is prolonged towards the mesial and distal angles (fig. 507); care must therefore be taken to avoid cutting deeply in this part of the tooth. A section of the tooth near the neck shows that the pulp lies a little nearer to the labial than the palatal aspect of the tooth; pits and grooves can therefore be made with greater safety in the palatal part of the tooth. Access to the pulp canal should be gained through the palatal aspect of the tooth, the opening being made above the pit (fig. 508) and not through it. An opening made through

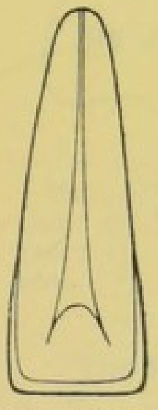


FIG. 507.

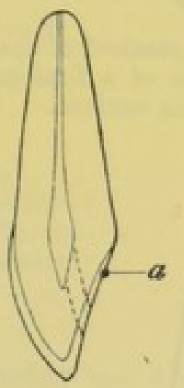


FIG. 508.

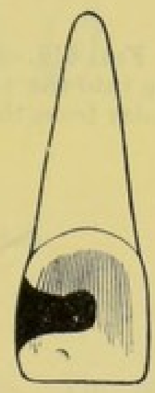


FIG. 508.

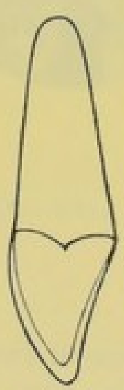


FIG. 510.

the pit will meet the canal at an angle. The nearer the opening is made towards the cutting edge the more direct will be the access to the canal. The direction in which an approximal cavity should be extended to open the pulp canal is shown in fig. 509.

The enamel on the approximal surfaces ends as shown in fig. 510. This fact must be taken into consideration when preparing the cervical portion of the cavity.

The pulp of the **lateral incisor** is practically similar in shape to that of the central, but it is larger in proportion to the size of the tooth and is therefore more often exposed.

(*b*) **Canine.**—The pulp is not prolonged towards the mesial and distal angles as in the incisors. In comparison with the

incisors, the pulp is relatively small. Access to the pulp canal should be gained through the palatal aspect of the tooth. The nearer the opening is made towards the cutting edge the more direct will be the access to the canal.

(*c*) **Premolars.**—In the **first premolars** there are usually two canals. The pulp is constricted at the neck, as shown in fig. 511.

FIG. 511.

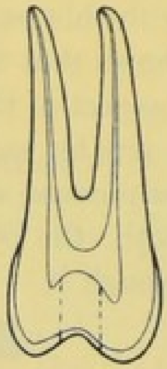


FIG. 512.—Showing method of opening into the pulp canals of a first premolar from the occluding surface.

FIG. 513.

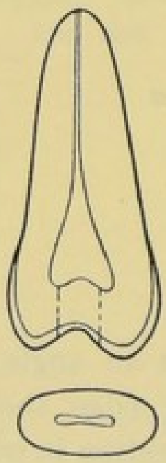


FIG. 514.

In extending cavities to the pulp canal, it is almost always necessary to cut towards the cusps, as shown in fig. 513.

The **second premolar** usually has one root canal. The pulp is not so constricted at the neck as is the case in the first premolar. Access to the pulp canal is gained in the same manner as with the first premolar (see fig. 514).

(*d*) **Molars.**—The **first molar** has three roots. The pulp

approaches the anterior aspect of the tooth more than the posterior, and is therefore more liable to be exposed in anterior than in posterior cavities. The relative position of the orifices of the canals is shown in fig. 515. The direction of the axis of the pulp canals towards the occluding surface is seen in fig. 516. Access to the canals is gained by extending the cavities towards the buccal surface as shown in fig. 517. By this means, direct access to the buccal and palatine roots can be obtained.

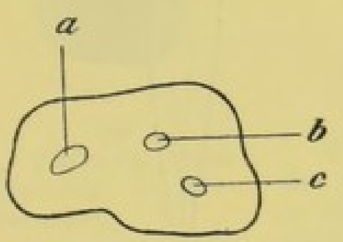


Fig. 515.—(*a*) Palatine root; (*b*) posterior buccal root; (*c*) anterior buccal root.

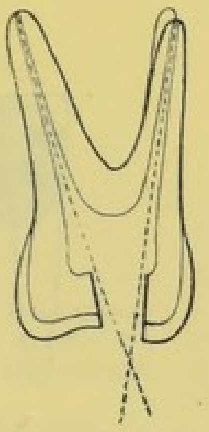


Fig. 516.

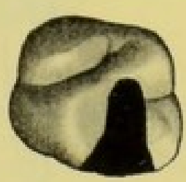


Fig. 517.

The **second molar** has three roots. The palatine root is more in line with the longitudinal axis of the tooth than is the case with the first molar, and for this reason access to the canals should be gained by extending the cavities towards the centre of the occluding surface rather than towards the buccal aspect The pulp, as in the first molar, is situated nearer to the anterior. than to the posterior aspect of the tooth.

Mandibular Teeth.

(*a*) **Incisors and Canines.**—Access to the pulp chambers of these teeth should be gained by an opening on the lingual surface, the opening being made well towards the incisive margin (figs. 518 to 520).

(*b*) **Premolars.**—The crown of the **first premolar** is slightly bent on the root, the inclination being towards the tongue. A section of this tooth shows that direct access to the pulp canal is best gained by drilling through the lingual aspect of the buccal

cusp, as shown in fig. 521. In extending approximal cavities to the pulp canals the operation should be carried out as shown in fig. 522. The usual method of extending the cavity through the coronal fissure will strike the pulp canal at an angle, while extension as advised will give direct access to the canal.

With the **second premolar,** the inclination of the crown to the tongue is not so marked, extension to the pulp canal should therefore be made by cutting a little more towards the coronal fissure (see figs. 523 and 524).

FIG. 518.—Showing method of approaching the pulp canal in a mandibular incisor.

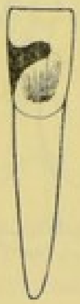


FIG. 519.

FIG. 520.—Showing method of approaching the pulp canal in a mandibular canine.

FIG. 521.

FIG. 522.

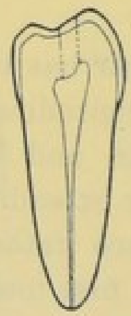


FIG. 523.

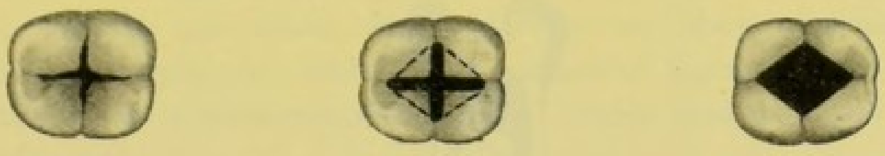
FIG. 524.

(*c*) **Molars.**—The **first molar** has two roots. The canal in the anterior root is much constricted in the centre, while the pulp canal in the posterior root is well marked. Access to the pulp canals should be gained by extending the cavity towards the central portion of the occluding surface.

The **second molar** has two roots. The pulp canal in the anterior tooth is not, as a rule, constructed as in the first molar.

Access to the canal is gained in a way similar to that pursued with the first molar.

(iii.) **Simple Cavities.**—The simplest form of cavity is that in which all the walls are complete, and good examples of this are the cavities occurring upon the crowns of molars and premolars. To shape these, the walls should be made slightly out of the perpendicular, the floor being left flat, and the edges trimmed as directed. All fissures on the occluding surface must be freely cut out.



(*a*) Showing tooth previous to preparation.

(*b*) The dotted lines show the portion of enamel to be removed by the enamel chisel.

(*c*) Cavity prepared. Note: the margins should be left a little more rounded than shown in diagram.

Fig. 525.

(*a*) First mandibular molar. Showing the portion of tissue to be removed with the enamel chisel after cutting through the fissures.

(*b*) Showing the cavity prepared.

Fig. 526.

In preparing simple cavities *the modus operandi* is as follows: Example: carious second mandibular molar (fig. 525). With a fissure burr a cut is made through all the fissures, as shown in fig. 525,*b*. An enamel chisel is then used to break down triangular pieces of enamel thus left. The carious dentine is then removed with suitable instruments and the walls suitably shaped. When using cohesive gold in mandibular molars, it is often found that if the anterior wall is undercut, or even quite perpendicular, the cavity is extremely troublesome to fill. To

overcome this difficulty the anterior wall should be left quite sloping (fig. 527), and then it can be easily seen, and the cavity properly filled, the filling being held in by making the buccal and lingual walls of the cavity diverge slightly towards their posterior aspects.

For simple cavities on the labial, buccal and lingual surfaces, the same rules apply as to simple crown cavities. For cavities on the incisive margin of the anterior teeth, a slight undercut should be made throughout the breadth of the cavity. The edges

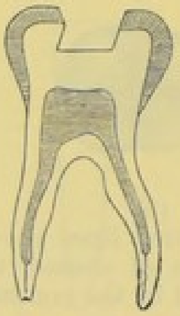


Fig. 527.

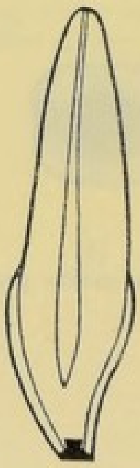


Fig. 528.—Cavity involving cutting edge of central incisor. Transverse section showing method of preparing cavity.

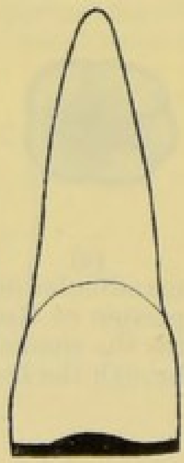


Fig. 529.—Showing cavity filled.

must be prepared in such a way that the filling, when inserted, completely covers them, otherwise failure through fracture of the enamel margins is liable to occur (see figs. 528 and 529).

(iv.) **Approximal Cavities.**—When present on the approximal surface (fig. 530) of the **molars and premolars** access must be

gained through the occluding surface. This is carried out with a small fissure burr, the cut being taken well back on the coronal aspect. The weak edges of enamel (see dotted line, fig. 531) are then broken down. The carious dentine is next cleared away. A cavity somewhat cup-shaped will then be left to deal with (fig. 532). In the shaping it must be remembered that there are two directions in which the filling has to be prevented from coming out, the one from above downwards, the other laterally. The labial and lingual walls (*a* and *b*) should therefore be cut so as to diverge not only towards the cervical margin, but also towards the axial portion of the tooth. To carry out this step two grooves are made which diverge as they approach the cervical margin (fig. 533). The portion of tissue shown by the dotted lines is then removed, and a double wedge-shaped cavity is obtained.

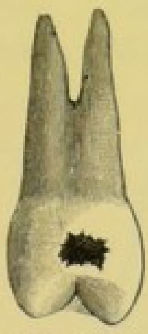


Fig. 530.

Fig. 531.

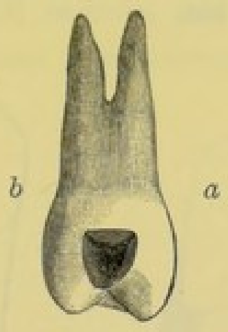


Fig. 532.

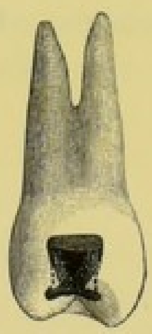


Fig. 533.

Should the fissure in the coronal surface be carious, it must be cut out, but in doing this as little tissue as possible should be removed in the case of premolars. In these teeth, if large cavities are present on both anterior and posterior surfaces, the inner cusp is liable to fracture; the retention, therefore, of an isthmus of dentine between the outer and inner cusps considerably increases the stability of the tooth. It is also a good plan to cut away the inner cusp and extend the filling over it. In approximal cavities to be filled with cohesive gold, the filling is started by wedging a piece of gold into a pit or groove. The latter is generally preferred, and consists of a small groove, slightly undercut, in the cervical wall of the cavity. In a few cavities the older method of "**starting pits**" will be found

useful. These pits are made as follows: The drill is buried to such a depth that the head is just below the level of that part of the cavity where the pit is to be made, and the head is then moved with a slight rotary motion; the result is a small cavity (fig. 534). If the drill head is rotated when only half buried, a

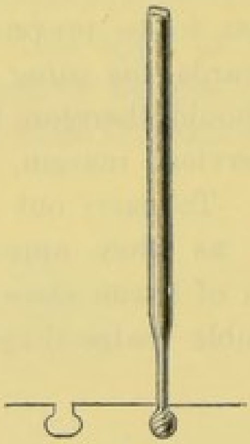


Fig. 534.

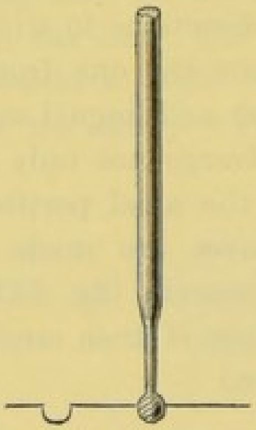


Fig. 535.

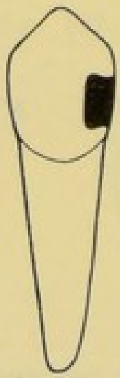


Fig. 536.—Showing approximal cavity in a mandibular premolar opened up from the labial wall.

cup-shaped cavity will be produced, and this is useless (fig. 535). Starting pits should always be drilled in the dentine itself. If drilled at the junction of the enamel and dentine, one wall will be formed of enamel, which leads to fracture during filling. The direction of starting pits should be as far as possible away from the pulp.

The advantage of shaping approximal cavities like a double wedge for cohesive gold is that all parts are easily accessible, and filling is thus more satisfactorily carried out.

Small approximal cavities in molars and premolars situated near the gum may be approached from the labial or buccal walls instead of opening up from the crown, which entails the loss of much sound tissue (fig. 536). The retentive shaping of the cavity is carried out as described above. In these cavities the lingual wall forms the base. This method of treating approximal cavities is adopted when the caries is situated in the root of the tooth, as seen in patients with "recession of the gums." One disadvantage of this method is the difficulty of producing self-cleansing edges.

Of approximal cavities in the anterior teeth the smallest are often the most difficult to fill. A good separation of the teeth is needful, as the more space available for preparing cavities the less tissue is sacrificed in retentive shaping. In small cavities for which non-cohesive gold is intended, the preparation is similar to that for simple cavities—namely, walls slightly divergent. For cohesive gold, small cavities are to be prepared as follows: With a fine finishing burr the anterior wall is cut so

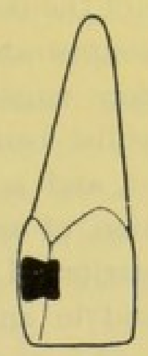


FIG. 537.

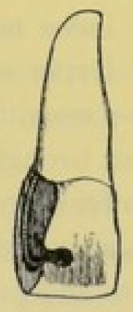


FIG. 538.[1]

that it slopes outwards and can be easily seen, a starting pit being made at the cervical margin, and an opposing point below for retention of the filling. With larger cavities an approach should be made from the lingual aspect, the labial wall being saved as much as possible. The shaping of the cavity will then be somewhat like that of approximal cavities in premolars and molars, retention being retained by a slight groove in the cervical wall, opposed by a small groove or pit, according to the amount of tissue available (fig. 537).

[1] From Kirk's "Operative Dentistry."

When the cavity involves the side of the tooth to a large extent, the labial and lingual walls must both be freed from all frail enamel and a different mode of procedure adopted in shaping it. **The labial and lingual walls should not be grooved.** In the cervical wall, a groove should be made, and opposed by a good-sized pit drilled towards the apex of the cavity. In many cases, the incisive portion of the cavity cannot with safety support an anchorage, but if the cavity is extended as shown in fig. 538, an excellent hold will be obtained.

Cavities for plastic fillings should be prepared in a manner slightly different from those prepared for gold. The enamel margins on the occluding surface should be straight and not bevelled, as the thin layer of enamel thus left is less likely to fracture than the feather edge of plastic material.

(*d*) Hyper-sensitive dentine

The preparation of cavities for filling is at times hampered by hyper-sensitive dentine. The true relations of the dentinal fibril to the pulp have not been satisfactorily demonstrated, and the treatment of hyper-sensitive dentine is therefore empirical. One theory of the sensitiveness of the dentine whilst being operated upon has been brought forward by Dr. Argent, and is interesting because it offers an explanation of the action of certain drugs which are used in treatment. The pain is attributed to pressure transmitted to the pulp. The fibril is enclosed in an unyielding case; pressure therefore on the approximal end is transmitted to the distal end, and so to the pulp. A condition, therefore, which prevents this pressure, such as the formation of a coagulum in the dentinal tube, will ameliorate the hyper-sensitiveness. It is interesting to note that the most efficacious remedies are those which coagulate albumen. The area of hyper-sensitive dentine frequently varies, one portion of the tooth being distinctly more painful than another. The portions of dentine immediately beneath the enamel, and at the neck of the tooth, are usually the most sensitive.

With an acid condition of the saliva, the teeth are liable to be very sensitive. The degree of pain is also, in a measure, dependent upon the health of the patient. In lowered conditions, the

nerve endings are often rendered more sensitive, and the sensitiveness is magnified by a diminution of the resistance to pain. The pain can, however, be greatly alleviated by keeping the cavity dry during excavation, and by using sharp instruments with a decided cutting and not scraping action.

Treatment :—

Dehydration.—The use of hot air in the form of blasts from a suitable syringe often gives good results. The application may cause a little pain, but this depends upon the tact and care with which it is applied. The hot air dehydrates the dentine. The previous application of absolute alcohol will increase the dehydration, but renders the treatment more painful. The results obtained are generally satisfactory.

Carbolic Acid.—Strong carbolic acid allowed to remain in the cavity for a few minutes and the dentine dried with hot air. This remedy is not very efficient if a result is desired at once, but if the carbolic acid is sealed in a cavity for two or three days a decided obtunding of the dentine is obtained.

Zinc Chloride.—Chloride of zinc is a powerful coagulant, and must be used with caution when the pulp is near. The cavity must be isolated and a small piece of chloride of zinc in the solid state allowed to dissolve. The application causes pain, which rapidly passes away.

Nitrate of Silver.—This drug can only be used to the posterior teeth, owing to the unsightly discoloration it causes. It is slow in its action. In superficial cavities, the nitrate of silver is applied either in the form of a fine powder on a piece of cotton-wool slightly moistened, or the drug in a solid state may be rubbed over the sensitive surface. The tooth is then left for one or two days, when the dentine will be found to be less sensitive. In deeper cavities, a little of the fine powder may be sealed in with gutta-percha.

In cases where it is intended to use metal fillings and the dentine is sensitive, it is better to insert an oxy-phosphate filling and allow it to remain for about six months. In some instances, the tooth substance is so sensitive that it is found almost impossible to remove any of the carious tissue. A filling of oxy-sulphate of zinc, if left in place for one or two weeks, will considerably allay the sensitiveness and so permit preparation of

the cavity. In posterior teeth which are very sensitive, the application of nitrate of silver may be substituted for the oxy-sulphate.

Preparations containing formalin give good results, but they must be used with care, as formalin possesses great power of penetration, and may endanger the vitality of the pulp.

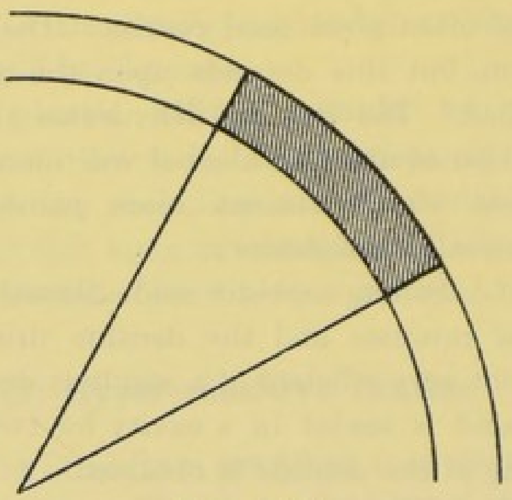


FIG. 539.[1]

(*e*) The Use of Matrices

The matrix is an indispensable instrument for making contour fillings. By the use of properly constructed matrices the entire crown of the tooth can be restored, thus obviating the use of crowns. A **simple matrix** may be made out of a piece of metal bent to the shape of the tooth and fixed in position by a wedge at the cervical margin. To Mr. Lennox belongs the credit of first describing a rational method of constructing matrices which will conform well and closely to the tooth at both cervical and occlusal edges. A tooth tapers from the crown downwards and approximately resembles a cone; a matrix to fit correctly must taper in a similar way, and should therefore be the segment of a flattened ring of metal. It is found by calculation that the inner curve of the segment corresponds to a circle with a radius of $1\frac{13}{16}$ in. The ends of the matrices must correspond in direction to the radii of the ring (see fig. 539). It is found that matrices for molars

[1] The blocks for figs. 539 to 543 have been kindly lent by Messrs. Claudius Ash, Sons and Co.

and premolars can be cut from a similar curved segment, the difference being a variation in the length of the segment. In fitting matrices to roots which are grooved, for instance the anterior aspect of the first upper premolar, Mr. Lennox has sug-

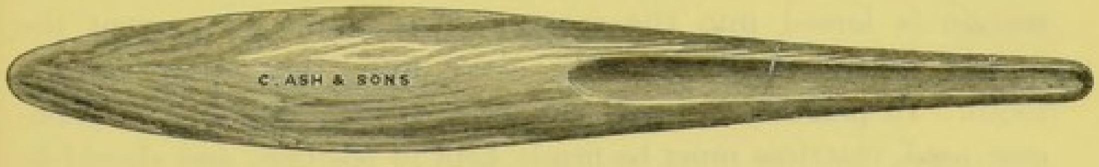


Fig. 540.

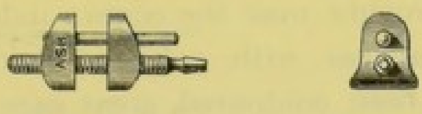


Fig. 541.

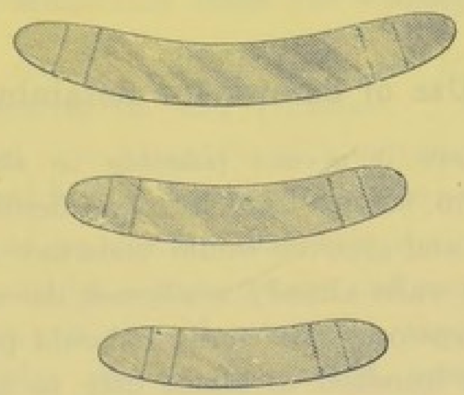


Fig. 542.—Matrices for various-sized teeth.

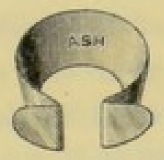


Fig. 543.—Matrix ready for use.

gested a neat contrivance in the form of a mandril, the ends of which correspond to the cones formed by the matrices suitable for an average premolar and molar, respectively. Down the

mandril grooves are cut to correspond to the grooves in the teeth. The mandril is used as follows: The lip of the matrix having been inserted into the slot in a clamp, the matrix is slipped on to the mandril and with a hammer tapped into symmetrical shape.

Before withdrawing the matrix from the mandril the lower margin is forced into the groove. This seems to prevent the matrix, when applied, drawing away from the groove on the tooth. In practice, Lennox matrices answer admirably. Whenever used, matrices must be firmly kept in position, and should fit accurately and tightly against the cervical margin. Plastics can easily be used, but, with gold, much care must be taken to see that the metal is brought over the edges; indeed, it is extremely difficult to use matrices with cohesive gold. With amalgam fillings which have been contoured, great care must be exercised in removing the matrix, and generally it is better to allow the matrix to remain until the filling has hardened. Matrices should be made of thin but strong metal.

(*f*) The Use of Screws for Retaining Fillings

In places where it is not possible to shape the cavity to a "retentive" form, screws fixed into the dentine are useful. In cases where cuts and grooves would endanger the pulp or throw an extra strain on walls already weakened, the screw is also useful as a means of retention. The screws should possess fine threads varying from one hundred to about fifty to the inch according to the size of screw used.

The location of screw is of importance. If the pulp has been removed the screw should be inserted into the canal. With living pulps the screw must be inserted as far as possible from the pulp, but yet not too near the enamel margin. In incisors and canines the linguo-cervical angle is better than the labial. In the molars and premolars it is a good practice to fix the screw in the centre of the body of the tooth near the coronal surface.

It is important that the screw when fixed in the pulp canals should be of sufficient size to obtain a firm grip—a point often overlooked. The form shown in fig. 544 is useful. The end is tapered and the screw steadily inserted.

If too much force is used, the root may be split. When

a firm grip has been obtained, the excess portion is cut off with a pair of sharp pliers. Screws should project well into the cavity. In teeth with living pulps, the form shown in fig. 545 or fig. 546 may be used. A small hole is first drilled in the dentine with a suitable instrument, and the screw gradually inserted.

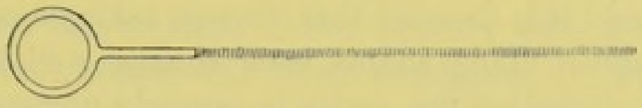


FIG. 544.

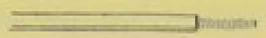


FIG. 545.

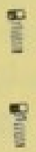


FIG. 546.

(*g*) The Materials Used for Filling Teeth

The materials used for filling teeth are gold, tin, amalgam, osteo-plastics, gutta-percha and porcelain. Solutions of gum resins are employed in conjunction with cotton-wool as temporary measures. **An ideal filling** should not only be hard enough to resist attrition, but should be able to withstand any chemical action in the mouth; it should be a non-irritant and a non-conductor, and easy of adaptation; it should retain its shape and form after insertion, and lastly, the colour should resemble that of the natural tooth. At present, none of the fillings in general use fulfil all these conditions. A careful selection of the material has therefore to be made in any given case.

(i.) Gold.—Two forms are used, viz., *the cohesive and the non-cohesive preparations*. Gold used for the production of "foil" must be pure. If silver, copper, palladium, or zinc are present in small quantities as impurities, the softness of the gold foil is impaired, but not its cohesiveness. The cohesive properties of foil are destroyed by the fumes of certain gases. Cohesive gold is usually prepared in the forms of sheets and cylinders.

In the cohesive method, each piece of gold is made to cohere to that already in place, and should not move in the slightest degree after it has once touched the filling. **In the non-cohesive**

method, the portions of the filling are held together by being intimately interlaced and wedged against each other and over one another.

Each method has its special advocates, those for the non-cohesive claiming that it adapts itself better to the walls of the cavity than the cohesive, and can be more quickly worked ; while for cohesive gold it is asserted that, though taking longer to work, it makes a harder filling, adapts itself equally well to the walls of the cavity (provided the cavity is properly prepared) and has the additional advantage, in approximal cavities, of being able to withstand the force of mastication.

The use of gold as a filling material has during recent years been, to a great extent, superseded by amalgam for the posterior teeth and porcelain fillings for cavities in the anterior teeth. The substitution of amalgam for gold in the posterior teeth is largely due to the great advance which has been made in the latter material, and it is possible to construct an amalgam filling which will be as efficient as a gold filling. Amalgam, too, possesses the great advantage of being more easily contoured, and, in finishing, the soft tissues at the neck of the tooth are not nearly so likely to be injured—a point of considerable importance in relation to periodontal disease. In the anterior teeth, porcelain fillings have supplanted gold fillings on account of their superiority from the æsthetic point of view. They are, however, not so reliable as gold fillings and the latter material should be used whenever possible.

Of the two forms of gold it may be said that non-cohesive is best for crown cavities, and the cervical one-third of approximal cavities in molars, premolars and anterior teeth ; cohesive being more serviceable when any contour is required or any strain is likely to be thrown upon the filling.

The advantages of gold as a filling are (*a*) that it does not alter its shape, and therefore forms a practically water-tight plug ; (*b*) that it withstands attrition. In using gold, however, it should be remembered that it has no preservative action whatever upon the tooth substance.

(ii.) Tin.—Tin is very little employed as a filling by itself, being generally used in combination with gold. The advantages claimed for it are that (*a*) it is easy to work ; (*b*) it has a pre-

servative action upon the tooth substance. For the latter reason it may be used as a lining to cavities and at cervical margins. It has one distinct disadvantage in the fact that it becomes black.

(iii.) Plastic Fillings.

(*a*) **Amalgam.**—An amalgam is an alloy of which one constituent is mercury. The amalgams used in dental practice consist of the combination of the mercury with a single metal, as in palladium, copper and silver amalgams, or with alloys of two or more metals. Amalgam has a much greater range of usefulness than any other filling. It needs, however, but a short clinical experience to discover that amalgam is eccentric in its behaviour. One filling inserted with due care will make a permanent and reliable plug, while another made with equal care is a failure. This uncertainty in behaviour is no doubt due to some fault in our methods, which, owing to our imperfect knowledge of the nature of amalgams, we are at present unable to recognize and rectify.

(1) **The Experimental Investigation of Amalgam.**—An extended investigation of amalgams has been made by Dr. Black,[1] and he has discovered several interesting features in their behaviour. If a block of amalgam be submitted to stress, and the force turned on rapidly by means of a screw, it will be found that when the stress reaches a certain point the block of amalgam goes to pieces with a crash. This point is termed the "*crushing stress.*" It is found to vary greatly with the composition of the fillings, the amount of mercury employed, and the method of mixing and working. If the block of amalgam be submitted to constant stress—less than the crushing stress—it will be found that the mass gradually yields. This is termed the *flow* of the amalgam, and is common to metals under pressure. The amount of flow depends upon the pressure, the flow being the same ratio as the force employed.

The flow varies according to the composition of the fillings, amount of mercury employed, &c. All amalgams flow, with the exception of copper. Palladium was not examined. The force of mastication will produce "flow" in amalgam fillings, and is probably a frequent cause of failure. An interesting observation

[1] *Dental Cosmos*, 1895.

on this point is recorded by Dr. Black. For a family of three grown-up children he inserted many amalgams, all of which retained their edges perfectly during six years of observation. For another family of four a fair number of fillings were made with the same amalgam, and with equal care, but in this family not a single filling retained its margin for two years. The disposition to caries in both families was about equal. A study of the cases with the gnatho-dynamometer showed that in the second family the force of mastication was nearly three times as great as in the first.

Ageing is the term used to denote the change or changes which take place in the working properties of an amalgam after being cut. The question has been very fully dealt with by Dr. Black.[1] His investigations were confined mainly to silver-tin amalgams.

Certain effects are produced on amalgams by ageing namely :—

(*a*) They work more smoothly and set more slowly.

(*b*) The liability to shrinkage is increased.

(*c*) The point of "crushing stress" is raised.

(*d*) They require less mercury for amalgamation.

Dr. Black's experiments show that ageing is due to the effect of temperature on the cut alloys. As long as the alloy remains in the ingot no change takes place. Age also is not produced by light, dampness, oxidation, or motion. Cut alloys kept at a temperature below freezing do not undergo ageing. At the ordinary temperature of rooms ageing takes places slowly ; for instance, in an experiment recorded, the maximum amount of shrinkage was attained in about three weeks. At higher temperatures, such as 120° F., 130° F., 140° F., the change takes place more quickly. At 120° F. the full effect is produced in three and a half days, while the action of boiling water produces the change in ten to fifteen minutes. Dr. Black explains the changes that heat produces in an alloy as follows : Cutting or filing produces some modification, which is probably similar to the effect produced on most metals when subjected to constant hammering. Annealing the filings probably restores them to their original condition. When the

[1] *Dental Cosmos*, vol. xxxviii, p. 965.

annealing is properly carried out, the alloy will remain in the same physical state for an indefinite period. Filings properly annealed and stored in bottles were found not to have changed in any respect.

Mr. Tomes finds that old, fully set amalgams, strongly heated and at once packed in with hot instruments, make ink-tight plugs. Freshly mixed amalgams treated in the same way give practically the same results. Amalgam used in this way sets very rapidly, in fact, too quickly to admit of its employment in practice. The rapidity of setting can be lessened by adding fresh amalgam to the reheated mixture, but the addition of this fresh amalgam renders the filling more liable to contract. Mr. Tomes has also shown that the surface of a fully set amalgam presents a crystallized surface. The size of the crystals differs greatly in different amalgams, but is little influenced by the amount of mercury. "Heat causes their immediate formation in an amalgam in which it would otherwise take some hours; heating a slab already crystallized causes the disappearance of the crystals, but they immediately reform."

(2) The Properties of Different Amalgams.—(*a*) *Copper Amalgam.*—In this amalgam the copper is obtained by precipitation from a weak solution of sulphate of copper, and the precipitate washed in strong sulphuric acid and dried. Mercury is then added to the copper, and the mass made up into pellets. The maximum amount of copper should not exceed 25 per cent.; if a higher quantity is used discoloration rapidly occurs. When required for use the pellets are heated and ground up in a mortar, and any excess mercury squeezed out, the mass being inserted fairly dry. Copper amalgam does not "flow" under stress. It does not shrink or expand. It apparently acts upon the tooth substance, and is especially useful in teeth attacked with rapid caries. The disadvantages of copper amalgam are: (i.) That it discolours, and at times stains the tooth substance; (ii.) that it undergoes disintegration.

The *black discoloration* is due to the formation of sulphide of copper. This chemical action also occurs on the surfaces in contact with the cavity walls, hence the stained condition of the dentine so frequently seen. The cause of the green stain is not clear. *The disintegration* is probably brought about as follows:

Sulphuretted hydrogen, which is always present in the mouth, acts on the copper in the presence of a weak acid, forms a sulphide, and thus sets free the mercury. The rapidity of wasting varies in different mouths, and would seem to depend upon (i.) density of the filling, (ii.) quantity of the solvent—this is probably in direct ratio to the collection of food *débris* about the teeth—and (iii.) friction. The wasting which so often occurs at the gingival margin is most troublesome. A nidus for food is formed and caries commences above the gingival margin; in fact, copper amalgam in approximal cavities has all the disadvantages of an osteoplastic in a similar situation.

The pellets should be protected from the flame by being heated in a suitable instrument.

(*b*) *Palladium Amalgam.*—Precipitated palladium is used. A large amount of mercury is required to produce amalgamation (about four of mercury to one of palladium by weight). The amount required varies with different samples of the metal. For mixing, an agate mortar and pestle are best. The combination of the palladium with the mercury is attended by the evolution of heat, often ending in explosion. The explosions fortunately never take place in the tooth, which is probably owing to the abstraction of the heat by the tooth substance. Palladium sets very rapidly; it turns black but does not stain the tooth. The setting may be retarded by making the amalgam in an iron mortar and pestle which absorbs the heat. Palladium expands, and must therefore be used with care in teeth with frail enamel walls. The addition to the palladium of about an equal part by weight of copper amalgam seems to counteract the expansion and slow the setting, but has the disadvantage of sometimes staining the tooth. Palladium is a most useful filling in small cavities on the occluding surfaces. The uncertain action of palladium has been attributed to the setting free of occluded hydrogen. Palladium, when brought in contact with nascent hydrogen, absorbs it freely, probably forming an alloy. The palladium has a greater affinity for mercury than hydrogen, hence in amalgamation the latter is displaced and immediately resumes a gaseous state, causing the violent explosive action occasionally seen.

(*c*) *Silver-tin Amalgams.*—The majority of amalgams used in practice contain, as a base, silver and tin with a small varying

proportion of other metals. If mercury is combined with silver, an amalgam is formed which expands in setting, but discolours badly owing to the presence of sulphuretted hydrogen in the mouth, resulting in the formation of silver sulphide. Silver amalgams, in addition, stain the tooth substance. *If tin is added*, the amalgamation is assisted and the discoloration lessened, but the tin tends to produce shrinkage, slow the setting, and diminish the edge strength. Dr. Black, who has carried out an exhaustive investigation into silver-tin amalgams, finds that alloys containing from 65 to 75 per cent. of silver expand when fresh cut but shrink when fully aged, the expansion increasing and the shrinking diminishing as the proportion of silver is increased. Alloys containing from 50 per cent. to about 62 per cent. of silver shrink, the shrinkage being much more marked when the alloy is fully annealed. Alloys containing less than 50 per cent. of silver first shrink and then expand. When used freshly cut, the expansion is the greater; when aged, the shrinkage is the greater. The percentage of silver has a marked effect on the working of the amalgam. Alloys containing from 65 to 75 per cent. of silver make hard, quick-setting and strong amalgams. Alloys with less than 60 per cent. or more than 75 per cent. of silver make soft, slow-setting amalgams. An alloy of 72·5 silver 27·5 tin, after annealing, does not contract or expand.

The Effect of various Metals on Silver-tin Amalgams.—Silver-tin amalgams are considerably modified in their behaviour by the addition of various metals. This question has also been investigated by Dr. Black, and the statements here made are mainly based upon his published notes.

Gold.—The addition of gold increases the edge strength or crushing stress and makes the amalgam clean and easy to work. It assists to keep the filling a good colour. The setting is, however, reduced, the shrinkage and flow increased.

Copper reduces shrinkage, assists setting, and considerably increases the crushing stress. The flow is diminished. The copper has probably a distinctly beneficial action on the tooth substance, but has the disadvantage of increasing the discoloration.

Platinum.—This metal, according to Dr. Black, considerably slows setting. It reduces shrinkage. Fletcher, however, main-

tains that platinum gives to amalgams the property of rapid hardening.

Zinc causes expansion, which takes place very slowly, increases the setting, and adds to the crushing stress. The flow is much decreased. Amalgams containing zinc require a large amount of mercury.

Lead.—This metal is likely to occur as an impurity. It assists amalgamation and makes the mass work softly and set slowly. It increases the flow and adds to the discoloration.

Aluminium.—This metal assists amalgamation and causes great expansion, but the chemical action set up during amalgamation is so violent as to render the mass too hot to handle.

(3) The Disadvantages of Amalgam.—Amalgam is the most useful of the various fillings, but it possesses two important disadvantages :—

(*a*) Liability to become discoloured, principally through the formation of sulphides from the action of sulphuretted hydrogen in the mouth.

(*b*) Tendency to alter shape and fracture at the edges.

Both these drawbacks may, to a certain extent, be overcome by :—

(i.) Careful attention to the composition and manufacture of the alloy.

(ii.) Attention to the preparation of the cavity.

(iii.) The method of inserting the filling.

(i.) The effect of the various metals has now been considered. Viewed by the light of present knowledge, it appears that the basis of the alloy should be composed of silver and tin, with the addition of gold and zinc or copper when the amalgam is not to be used in a position likely to be seen. In addition, it is important that the utmost care be taken in casting and cutting the alloy, and also in annealing the fillings.

The following is the formula of a good working amalgam :—[1]

Silver	69·5 parts.
Tin	25·5 ,,
Gold	4·0 ,,
Zinc	1·0 ,,

[1] For the various formulæ of fillings I am indebted to Mr. Andrew Kelly.

In alloying in the usual way in the open fire, more or less of the metals are oxidized and the composition of the ingot is thus altered. Recently, Dr. Black has introduced an electric crucible which is closed. During melting, a stream of illuminating gas, which is a deoxidizing agent, is passed through the crucible. It is important that annealing of the alloys should be carefully carried out, and each sample properly tested before being used.

(ii.) **The preparation of the cavities** for amalgam fillings differs only slightly from that required for gold fillings. Amalgam being a plastic material, it is not so important that there should be direct access to all parts of the cavity. The edges should be left straight, and not bevelled, as the thin layer of enamel is less liable to fracture than the thin ledge of amalgam which would be present if the edges were left bevelled. The student must remember that the preparation of cavities for the insertion of the amalgam fillings requires as much care and attention as gold work. Too frequently, amalgam fillings are made in a careless and slovenly manner.

(iii.) **The method of inserting the filling** (see pp. 478 to 480).

(4) **Galvanic Action from Amalgam Fillings.**—The occlusion of teeth containing amalgam and gold fillings will start galvanic action under certain conditions. The following are examples from practice.

A left second molar was filled with amalgam. Occluding with this tooth there was a gold crown. Two days afterwards the patient returned complaining of distinct pain every time the amalgam and crown were brought into contact, and stated that the pain was, in her opinion, due to electrical action. The whole of the surface of the amalgam filling, where the gold occluded with it, was cut out and filled with a non-conducting filling (oxy-phosphate), and the pain vanished. In another patient, there was a biting-block of gold which occluded with an amalgam filling. The tooth was not painful to heat or cold, but every time it was brought in contact with the gold biting-block pain was felt.

(β) **Osteoplastics.**—Three varieties are used—oxy-chloride, oxy-phosphate and oxy-sulphate.

(i.) *Oxy-chlorides.*—The powder consists of zinc oxide which has been heated almost to whiteness for about two hours, during which time it loses half its bulk. Borax and silica are often

mixed with it with a view to increase its hardness. Oxide of zinc often contains arsenic as an impurity, but it is not probable that arsenic is ever present in sufficient quantity to exert any deleterious effect. The fluid is a solution of zinc chloride in water in the proportion of four to three. Oxy-chloride of zinc does not form a permanent filling, being acted upon by fluids of the mouth, especially at the cervical margin. It is also of little use in places where there is much attrition. It is hygroscopic, sets slowly, is an irritant and an antiseptic. Oxy-chloride is principally employed as a root filling and as an obtundent for sensitive dentine.

(ii.) *Oxy-phosphates.*—The powder is made of oxide of zinc. The oxides of magnesium and aluminium are sometimes added with a view of accelerating the setting. The various shades are produced by colouring matters, and these probably lessen the resistance of the filling to solvents. The fluid is principally composed of phosphoric acid, zinc oxide and water.

The following is a type formula :—

Powder :	Alumina	1·5 parts.	*Fluid :*	Phosphoric acid	65 parts.
	Magnesia	7·5 ,,		Zinc oxide ..	16 ,,
	Aluminium silicate	8·5 ,,		Alumina ..	6 ,,
	Zinc oxide.. ..	82·5 ,,		Water	13 ,,

As a filling it is more permanent than the oxy-chloride. It is soluble in the alkaline secretions of the mouth. It is antiseptic, though not so marked as the chloride, and, like the latter, it may lead to death of the pulp if used in too close proximity to that organ. Oxy-phosphate fillings last, on the average, about two years, though they may continue serviceable for seven years, and in rare instances longer.

The use of oxy-phosphate is indicated—

(1) As a flooring in crown cavities (when not too near the pulp).

(2) As a root filling (to be subsequently described).

(3) As a lining to cavities with frail walls.

(4) In cavities which are sensitive, and in which it is desired to put a metal filling—an oxy-phosphate inserted in such, and allowed to remain for a period of three to six months, will act as an obtundent.

(5) In front teeth of weak structure in which gold is contra-indicated.

(6) In combination with amalgam.

(7) For the fixation of crowns and porcelain inlays.

It should not be used in cavities which cannot be kept quite free from moisture during filling.

(iii.) *Oxy-sulphate.*—In oxy-sulphate, the powder is composed of a mixture of calcined sulphate of zinc and oxide of zinc. The fluid is a solution of gum arabic.

The following is a useful formula :—

Powder:	Zinc oxide ..	82 parts.	*Fluid:*	20 per cent. solution of gum acacia, to which a suitable preservative may be added.
	Zinc sulphate ..	11 ,,		
	Mastic	7 ,,		

Oxy-sulphate is extremely useful :—

(1) As a flooring to sensitive cavities near the pulp.

(2) For covering exposed pulps (in combination with a sedative).

(3) For very sensitive cavities. A filling of oxy-sulphate used for one or two weeks will considerably allay the sensitiveness.

(iv.) *Oxy-phosphate of copper* has been introduced by Dr. Ames, but it is of doubtful utility. It is soluble in the mouth and becomes intensely black. It possesses the property of tenacity.

(γ) **Translucent Cements.**—During the last few years translucent cements have been extensively used as fillings. The following is a type formula :—

Powder:	Alumina ..	31·5 parts.	*Fluid:*	Alumina ..	7 parts.
	Lime	12·2 ,,		Phosphoric acid	76 ,,
	Silica	44·8 ,,		Water	17 ,,
	Fluorine ..	10·5 ,,			
	Water	·7 ,,			

It is too early to express a definite opinion on the value of translucent cements, but there seems little doubt that with improvements in their composition and a better knowledge of their behaviour they will be found a most valuable filling. Their use is indicated for æsthetic purposes in cavities in the anterior teeth. They should not be used on occluding surfaces, or for the approximal cavities in premolars and molars, as in these places amalgams or gold are more serviceable and reliable.

(δ) **Gutta-percha.**—Gutta-percha is the inspissated juice of *Isonandra gutta* and other trees of the natural order *Sapotaceæ*. According to Baumhauer, the chief constituent of gutta-percha is a hydrocarbon having the composition $C_{10}H_{16}$, identical with

the *gutta* of Payen; the other constituents, alban $C_{20}H_{32}O_2$, and fluavil $C_{27}H_{32}O$, being probably products of oxidation. Gutta-percha is insoluble in alcohol, slightly soluble in ether, benzol, and oil of turpentine, freely soluble in chloroform and carbon disulphide. For dental purposes it is generally combined with zinc oxide and silica, with or without some colouring matter. The resins appear to lower the softening point, increase the time of setting, and considerably diminish the tensile strength.

Gutta-percha deteriorates from exposure to air and light, more especially the latter. The deterioration depends greatly upon the quality of the gutta-percha used in preparing the filling. A good gutta-percha filling should be tough, should soften at a temperature not more than 175° F., and should set in from thirty to forty-five minutes. It should be "sticky" in working. The filling material is best preserved in the form of sticks wrapped in tin-foil and kept in a box, pieces being cut off as required. The following formula is recommended by Mr. Rushton[1] :—

Pure gutta	50 parts.
Finely levigated silica	30 ,,
Oxide of zinc	20 ,,

The gutta should be gradually heated and the powders added in small quantities at a time.

The following is a useful type of temporary gutta-percha :—

Gutta-percha	18 parts.
Hard paraffin	9 ,,
Calcium sulphate	26 ,,
Oxide of zinc	47 ,,

Properties.—As a filling, gutta-percha is a perfect non-conductor, and, though it does not make a water-tight filling, fresh caries seldom seems to occur from this defect. In dirty mouths, it discolours, becoming yellowish in appearance. If inserted too near the pulp, it frequently leads to the destruction of that organ. Cavities in which gutta-percha is temporarily placed often appear to be more sensitive on the removal of that material than before its insertion, which seems to show that gutta-percha increases the sensitiveness of dentine.

Indications for Use.—Gutta-percha should not be used upon a

[1] *Trans. Odonto. Soc.*, 1898, p. 120.

masticating surface, as it bears attrition badly. Gutta-percha, though principally used as a temporary filling, is occasionally of great use permanently, the principal cases in which its use is indicated being :—

(1) The anterior teeth of young children, as the saliva in children seems to dissolve osteoplastics very quickly.

(2) In some approximal cavities in children.

(3) In certain cavities on the buccal and labial surfaces of teeth.

(4) At the cervical margin of a cavity, the remainder of which is filled with osteoplastics.

(5) For filling root canals.

(6) As a temporary filling in cases where it is necessary to wedge the teeth (see Separation of Teeth).

(ε) **The Solution of various Resins.**—Gum mastic and gum sandarac are used as temporary fillings. They harden through the resin being precipitated by the saliva and the evaporation of the solvent ether, chloroform, &c.

(ζ) **Porcelain Inlays.**—During the last few years, porcelain inlays as fillings have claimed a large amount of attention. They possess the advantage of more nearly resembling the appearance of the tooth than any other filling, and are therefore extremely useful for cavities on exposed surfaces. They are fixed in position with oxy-phosphate cement. In estimating the usefulness of this filling, it must be remembered that oxy-phosphate cement is acted upon by the saliva, and that the layer of cement present between the inlay and the tooth substance must be regarded as a vulnerable point. Practical experience, however, seems to show that a thin layer of cement is acted upon much more slowly than is the case with oxy-phosphate fillings. In durability, porcelain inlays are inferior to gold and amalgam, but they are superior to gutta-percha and osteoplastics.

Methods of Preparation.

(i.) *The Rotation Method.*—To Dr. Storer How, of Philadelphia, belongs, it is believed, the credit of introducing this system of inlaying.

The cavity in the tooth is gradually enlarged to be circular in outline, but slightly tapering towards the base. Fine cut burs are needful, and the drilling must be done with delicacy but

firmness of touch, in order that the cavity be truly circular. A rod of porcelain of the right colour and approximate size is selected, a disc is cut off and fastened by means of shellac to a mandril rotated by the engine. With carborundum wheels the porcelain is accurately fitted to the cavity; the disc, when lying in the cavity, should project slightly beyond the surface of the tooth. The inlay is fixed with some form of oxy-phosphate mixed thin. When the cement is hard, the inlay is ground flush with the surface of the tooth, and finally polished with an Arkansas stone and a little putty powder. The finishing is better carried out at a subsequent visit. The final fitting may be done by wetting the inlay with fine polishing paste and rotating it in the cavity. Care must, however, be exercised, as the disc is liable to stick fast and injure the enamel margins. Some operators prefer to cut the inlay from an artificial tooth, and, so far as colour is concerned, a more satisfactory result can in this way be obtained. The disadvantage of the rotation method is the needless sacrifice of the sound tissue in many cases. Messrs. Claudius Ash, Sons and Co. have prepared a series of circular inlays of various colours corresponding in size to fine-cut burs, and by this system the process of inlaying is considerably accelerated.

Irregularly Shaped Inlays.—*The cavity* must be formed without undercuts, and in such a way as to counteract the lines of greatest pressure. For example, in the large inlays in the upper incisor teeth the main strains on the inlay are upwards from the occlusal surface and outwards from the palatine. The upper strain may, to a certain extent, be neutralized by preparing the cervical portion of the cavity, and the outward strain by cutting away the palatine wall so that the labial wall extends beyond it and takes the outward strain (see diagram, fig. 547 A and B).

The Matrix.—The matrix may be made from gold foil No. 40 or platinum ($\frac{1}{2000}$ in.). A piece of suitable size and shape is selected, and two or three small nicks made in it. The foil is then placed over the cavity and gently pressed home with a piece of amadou, and an impression of the cavity obtained. The foil is then bent over the edges, and burnished so as to secure a sharp and exact mark of the edges. It is an advantage to melt a little wax into the matrix before removing it from the tooth. By this means, the liability to crumple the matrix is

overcome. With a suitable instrument, the matrix is enticed out of the cavity and immediately invested in a mixture of silex and plaster.

Many operators prefer to take an *impression of the cavity*, and for this purpose generally use either gutta-percha or dental lac. From this impression a mould in oxy-phosphate of copper cement is made, and a matrix of thick platinum ($\frac{1}{1000}$ in.) fitted either by hand or by means of a small swager.

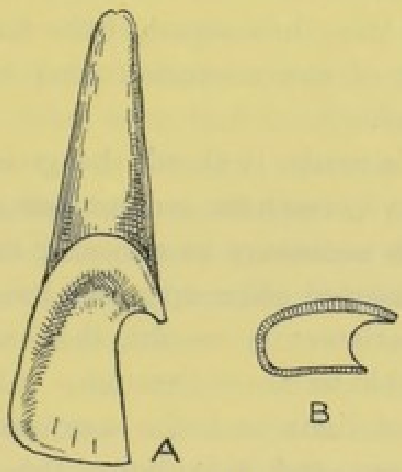


FIG. 547.

The inlay may be made of a low- or high-fusing body. The former is suitable for small cavities requiring but little contour, the latter for larger inlays. High-fusing bodies make stronger inlays and present a more natural appearance. Inlays made in this way are composed of three bodies :—

(1) The foundation, melting at 2,300° F., corresponding to the dentine.

(2) The high-fusing, melting at 2,150° F., corresponding to the enamel.

(3) The medium-fusing, melting at 2,000° F., corresponding to the surface.

The temperature is gauged either by a pyrometer or pellets of gold alloy, which fuse at different degress. The body should be mixed into a stiff paste with distilled water, the various stages being as follows :—

(1) The foundation body is packed into the matrix, and with a suitable instrument a cross + is made. The object of this is to cause the body when fused to tend to separate into four small

masses rather than one large one in the centre. After fusing, the matrix with the body is replaced in the mould and the edges of the matrix again burnished over the edges of the cavity. When the matrix has been made direct from the cavity, although this step is not necessary, there is more certainty of a good result if the matrix is again introduced into the cavity, and burnished into place, and then invested again.

(2) The high-fusing body is now added and built up to the necessary contour, and the inlay fused again. This operation is repeated until the inlay has assumed the form desired.

(3) A thin layer of the medium-fusing body is then added, and the inlay finished.

When the inlay is made, it should be grooved and the cavity slightly undercut, oxy-phosphate cement being used for fixing.

Some experience is necessary in choosing the shades for inlays, as the inlay when inserted often appears altered in colour. Deep inlays yield more satisfactory results than shallow ones, as the cement is not so liable to show through. Alteration in colour is due to the amount of light and the amount of reflection. The more perfect the front and side light, the less the variation. Labial inlays give good results, while in approximal ones the adjacent tooth shuts off some of the light and so affects the colour, making it appear darker.

(η) **Gold Inlays.**—Inlays made of cast gold are advocated by certain operators for use in approximal and crown cavities in the posterior teeth, the inlays being fixed into position by means of oxy-phosphate cement. It is difficult to see that these inlays have any advantage over properly constructed amalgam fillings. With the latter, retention is obtained by means of proper under-cuts—a much more reliable and rational method than by the adhesiveness of osteoplastics. With amalgam, good edges can be obtained and the filling more easily brought to the proper contour. The student must never allow the prospect of a larger fee to influence his choice of a filling material.

(*h*) Introduction of Filling Materials.

(i.) **Gold.**—This subject will be considered under four headings, viz. :—

(*a*) The method of using cohesive gold.

(β) The method of using non-cohesive gold.

(γ) Combination of the cohesive and non-cohesive methods.

(δ) Gold in combination with other metals.

(a) **The Cohesive Method.**—This method is more usually adopted than any other. To consolidate gold, either hand pressure or mallet force is used; in the former, the force is given to the plugger direct from the hand of the operator; in the latter, by means of a blow struck by a mallet which may be used by hand, or by some mechanical contrivance, automatic, engine or electric.

The *hand mallet*, the simplest of all mallets, is made of various materials and in various shapes; the usual form consists of hard wood filled with lead to obtain a dead, steady blow. This mallet is used either by the operator himself, or by an assistant; the blow delivered on the end of a plugger should have a sharp springing stroke. Many operators claim that the results obtained by the use of a hand mallet are better even than those obtained by the electric mallet.

Automatic mallets work by the action of a special spring, and some of the modern forms have a back action. The automatic mallet should be used like a pen, with the end, if possible, resting on a finger of the left hand, thus giving the mallet a point of purchase.

The plugger should also be raised a little distance from the surface of the filling, so that each time a blow is delivered the plugger is practically thrust into the gold. Some place the plugger point on the filling, and then push the mallet, but a great amount of the force is thus lost. The automatic is a fairly serviceable form of mallet, but care should be taken to use pluggers the action of which will be as far as possible in a direct line with the force of the blow.

Of *engine mallets*, Bonwill's is the best. The blow is struck by the action of a cam on a pulley driven by the engine, which, as it revolves, strikes upon the edge of the plugger. The number of blows struck depends upon the speed at which the engine is worked. The disadvantage of the engine mallet is that the blow is frequently jerky, but if used with care it is undoubtedly a great help in filling. Various mechanisms are used to regulate the blow, which is consequently almost completely under the control of the operator.

The method of using the engine mallet is somewhat similar to that of the electric mallet, and will be described subsequently.

The *electric mallet* is a good instrument for condensing gold. The advantages claimed for it are :—

(i.) The blow is delivered upon the packing instrument at the point where its force is greatest.

(ii.) The force of the blow can at all times be controlled by the operator.

(iii.) It condenses the gold thoroughly and evenly throughout the filling.

(iv.) The gold can be impacted against thin frail walls with ease, and without fear of fracturing the enamel.

It is needless to say that everyone who uses the electric mallet should thoroughly understand its mechanism. Only cohesive gold should be used with it.

The following description of the method of using the electric mallet is condensed from Marshall Webb's "Operative Dentistry" :—

"In commencing the filling one or two pieces of foil should be placed in the retaining point of the cavity with the instrument by hand; as each piece of gold is passed over the spirit lamp, and introduced into the cavity (either by an assistant with light pointed foil carriers, or by the operator himself with the packing instrument), and simply attached to the starting-point or to gold already in the cavity, the electro-magnetic mallet should be set in operation, and the finely serrated point of the packing instrument touched upon or placed (not pressed) against the gold, in a manner similar to that of making dots on paper with a pencil. Light, medium, or hard blows can be made without changing the adjustment of the instrument, as full or heavy lines are made on paper with a pen. When the electro-magnetic mallet is brought into operation and guided as indicated above, gold can be carried against and over the margins (even frail edges) of enamel without fracturing them, and without the packing instrument passing off and puncturing the rubber dam and wounding tissue. Almost the same blow is required throughout each and every operation, because the gold should be solid and uniform in density, hence the action of the battery must always be about the same in intensity and constancy, and the pieces of gold for a given opera-

tion ought to be nearly the same size; all foil should be rendered cohesive by passing through the flame."

Two forms of gold are usually employed, viz., tape and pellets. *The tape* is usually obtained by folding up sheet gold to the required thickness, though some firms sell the gold folded up, so that it only requires cutting to be ready for use. A sheet of gold measures 4 in. square, and the foils are generally numbered according to the weight of the sheet; thus a sheet weighing 4 gr. is termed No. 4 thickness, a sheet weighing 8 gr. is termed No. 8 thickness. Gold tape is also numbered according to the weight of the sheet, thus, "48 tape" is tape which weighs 48 gr. per sheet of 4 in. square. The tape generally used is from 32 onwards. To obtain these thicknesses it is usual to fold thinner foil. Thus, No. 4 foil folded once makes No. 8, folded twice makes No. 16, and three folds make No. 32. Two or three sheets can be folded at once when greater thicknesses are required.

Instead of thin foils thus folded, some use heavy or rolled gold of thickness averaging from 20 to 60. This form is extremely cohesive and useful for contouring, but it is not so easily worked, and does not adapt itself to the cavity so well as tape prepared by folding. For folding gold, a pad and a foil knife will be required, care being taken that the edge of the foil knife is perfectly straight.

Having folded the gold the next step is to cut it into strips, and an easy method of cutting it quickly and evenly is as follows: Take the folded gold in a pair of tweezers held between the thumb and first and second fingers of the left hand, then take the foil scissors in the right hand, resting the lower blade on the third and fourth fingers of the left hand; by this means the scissors are steadied and the gold may be cut to any width desired.

The thickness of gold used varies; for retaining pits and difficult cavities No. 32, for more accessible places Nos. 48, 64, 96. In using the heavier foils considerable practice is required. The width of strips also varies; for retaining pits they may be practically as fine as can be cut ———; for difficult cavities ▬▬▬, and for more accessible places according to the breadth of the cavity.

The foil may be used in the form of *rope*. The other form of cohesive gold, viz., *pellets*, requires but short notice. There are numerous makes in various shapes; the cylinders are the most

useful form. As to choice between the use of foil and pellets considerable difference of opinion prevails. Tape is probably the better, especially for building over edges and contouring. Those, however, who use pellets claim that they are more easily and more quickly worked. In some cases they may be more easy to work in the early stages of the filling, but that they can be more rapidly worked is open to doubt, for when one is able to manipulate foil of 64 thickness onwards with the electric mallet the advantage of tape over cylinders in saving time is considerable. Moisture, grease and exposure to air destroy the cohesiveness of gold, and care should be taken to avoid contact with the hands. Though foils are sold as cohesive, it is always best to anneal them before using. This is usually accomplished by passing the gold through an alcohol flame. The alcohol must be quite pure. The safest method to avoid possible impurities from the flame is to place the gold in a tray of mica or platinum and heat it over the flame, or an electric heater may be used.

In annealing, avoid overheating the gold, as many kinds become harsh when exposed to a high temperature. Good cohesive gold can be annealed to a dull red heat without becoming harsh.

For **starting cohesive cavities,** two principal methods are in vogue, viz., starting pits and grooves.

Starting pits are seldom used now except in shallow cavities.

For facility of description, the *filling of cavities will be considered under three main heads,* viz., (i.) crown cavities, (ii.) approximal cavities in molars and premolars, (iii.) approximal contour cavities in front teeth.

(i.) Crown Cavities.—These cavities are typical in molars. They are best started with cylinders or rope, as follows: Take two or three large cylinders, according to the size of the cavity, and, with a suitable plugger, tuck them round the margins of the cavity, leaving the centre. This operation only slightly condenses the cylinders, but the gold is in a convenient position for working. Steady the cylinders with a plugger held in the left hand, and, by firm pressure, first round the edges towards the walls, and then in the centre, condense the gold closely. It is very useful to condense a strip of cohesive tape with the cylinders, as it will enable the operator to start his cohesive foil more easily.

The cylinders being steady, anneal a piece of tape by passing it through the spirit flame, keeping the part between the tweezers in the flame a little longer than the rest, place the gold in the cavity and condense with suitable pluggers, using either hand pressure or mallet force. In condensing, fold the gold over so that each fold lies parallel with the floor, and exert the force in a direction as far as possible towards the walls of the cavity.

The piece being in position, fresh portions are added and thoroughly condensed until the cavity is full.

In malleting, the force of the blow should be directed towards the walls of the cavity, the most inaccessible parts being filled first, and the filling kept a little higher towards the walls than the centre. It is impossible to build the gold so accurately as to bring it exactly flush with the edges of the cavity, hence it

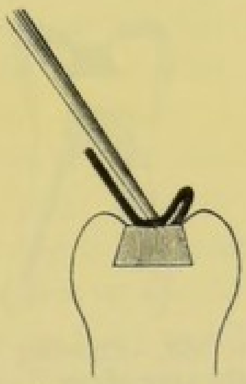


Fig. 548.—Showing loop hanging down.

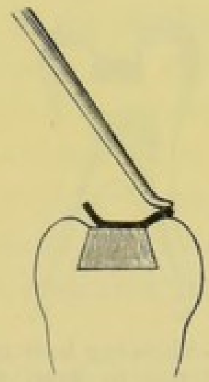


Fig. 549.—Showing loop malleted down.

becomes necessary to mallet the gold over the edge, and when the plug is completed to cut down the surplus by means of burrs and carborundum points.

The most important, and at the same time the most difficult, part of a filling to execute with accuracy and nicety, is the operation of **building over the edges.** It can be accomplished as follows : Tuck down a strip of gold near the margin of the filling, and having carried the tape over the edge, refix it again over the same spot (fig. 548). A loop of gold is thus left simply hanging over the edge ; first tap this loop down gently, and then mallet, taking care not to use too much force (fig. 549). Having built over all the edges, and filled up the centre of the cavity to the right level, the next step will be to trim the filling by cutting down the

surplus over the edges, smoothing the surface and polishing. For this purpose finishing burrs and stones are used, the former for cutting away the surplus over the edges, the latter for smoothing the surface. In using these care should be taken to cut in a

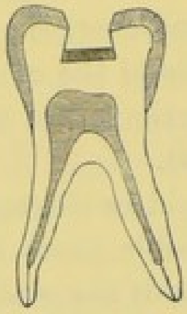


FIG. 550.—Showing the filling started by wedging cylinders into the base of the cavity.

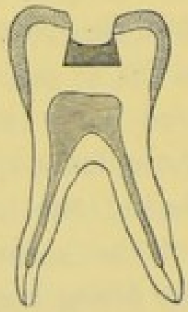


FIG. 551.—Showing how to fill the cavity, keeping the gold a little higher against the walls than in the centre.

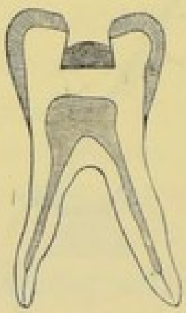


FIG. 552.—Showing how not to fill the cavity, "not to keep the gold higher in centre than at sides."

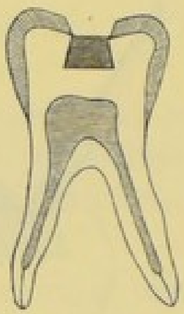


FIG. 553.—Showing the time to build over edges.

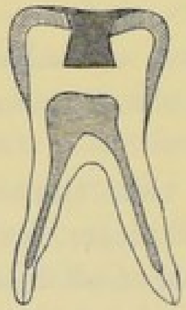


FIG. 554.—Showing the cavity filled ready for trimming.

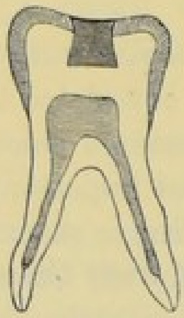


FIG. 555.—Showing the filling completed.

direction from the filling to the tooth, rather than from the tooth to the filling, because in the former case one is likely to burnish the gold over the edges, in the latter to tear the gold away from the edges. When the edges have been trimmed attention should

be turned to the bite, care being taken that the filling is not high (a most important point). When it has been ascertained that the bite is not obstructed, the surface should be smoothed first with a carborundum, and then with an Arkansas or Hindostan stone, the object of the latter being to remove scratches, and so produce a higher finish; finally, complete the operation with some pumice on either a wooden or rubber point. The various steps in filling a molar are diagrammatically illustrated in figs. 550 to 555.

In trimming the edges, the joint between the enamel and the gold should not be considered perfect until the finest probe passed from the filling to the tooth, or *vice versa*, does not catch, the edges being considered trimmed when the probe passes over all the parts without catching.

(ii.) Approximal Cavities in Premolars and Molars.—These cavities are best started from a groove in the cervical wall. A piece of gold is annealed, placed in the groove and gently pressed into position. One end of the gold is thoroughly condensed, while the other end is held firmly with an instrument. The condensed portion is then kept firmly pressed into place, while the remainder of the gold is condensed. It is most important that the gold in the groove should be steady. If retaining pits are used, they should be filled as follows:—

In annealing the strip of gold, it sometimes happens that the end held by the tweezers does not get thoroughly annealed. To avoid this possible contingency the strip of gold should be held by one end, and, when sufficiently heated, should be taken up by the other end and again passed through the flame.

Having annealed the strip, gently lay it over the orifice of the pit by means of the tweezers, and with a fine-pointed plugger, invaginate the gold into the pit. In removing the instrument, give it the slightest amount of rotation, this will prevent its bringing out the gold. The gold is now firmly tucked in, in successive folds, until the cavity is full.

It is essential that a firm pressure should be maintained throughout the operation of filling. The plugger used should be less in circumference than the pit, otherwise the gold will be cut in the act of filling.

The pits being filled, a bridge of gold is made from one to the

other, and the foil condensed in layers parallel to the floor. The next step is to build from this bridge in a direction towards the cervical edge, using exactly the same methods as described under

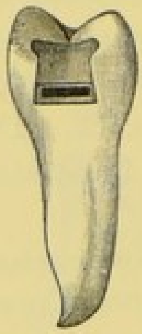


FIG. 556.—Showing gold bridged between retaining points, or groove filled.

FIG. 557.—Showing gold built over cervical edge.

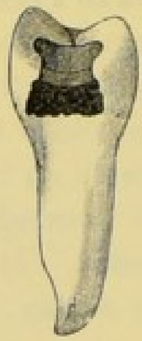


FIG. 558.—Showing how to build, keeping the gold a little higher against the sides than in the centre.

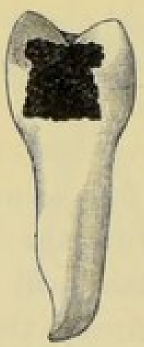


FIG. 559.—Showing cavity full.

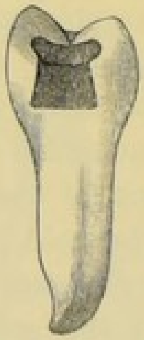


FIG. 560.—Showing the filling trimmed and completed.

"*crown cavities*," and having looped the foil over the edge, it is an excellent plan to chop off with the mallet (electric or hand) any superfluous material—this is equivalent to burnishing the

gold against the edge. Too much care cannot be bestowed on this part of the cervical edge, as it is the most important part of the filling.

This operation having been satisfactorily completed, fresh pieces of foil should be added until the cavity is full, care being taken to keep the gold flat, and, if anything, a little higher against the walls than in the centre, and a little higher on the contour surface than towards the median line of tooth. The edges are built over as the cavity fills, the crown surface and edges being completed last.

In filling these cavities, build out the contour so as to carry out the principles enunciated on p. 431. The finishing of these fillings is accomplished as follows:—

The cervical edge and upper part of the plug are first roughly trimmed down with plug trimmers, care being taken to use these instruments so as to cut in a direction from the gold to the tooth substance, for the reasons previously stated. Strips of emery tape are used for finishing. The lateral margins can be trimmed with discs, but, in finishing, care must be taken not to destroy the "contour." To make sure that the cervical edge is thoroughly finished, it is necessary, as in the case of crown cavities, to test with probes, and, wherever a catch is discovered, the tape and plug trimmers must be again brought into use.

If discs are used to finish the cervical margin, a depression is very likely to occur, and is, indeed, difficult to prevent. The occluding surface is trimmed in exactly the same way as in crown cavities. The contour surface is polished with either a little pumice on ordinary sewing tape, or with rubber cups or discs on the engine. Figs. 556 to 560 represent the various stages and steps above described.

(iii.) **Approximal Fillings in Anterior Teeth.**—In these cavities great care must be taken to get the gold into absolute contact with the front wall of enamel in order to avoid that bluish-black appearance sometimes seen in front teeth filled with gold. In filling, the method of procedure should be as follows: First, fill the retaining pits or grooves in the cervical wall, and build over the cervical edge as recommended above. Next, build the filling down a little way, contouring to the required shape, and taking special care that the filling is well against the posterior

wall (as shown in fig. 563). Now, finish filling in the actual cavity, paying particular attention to the opposing point. (This stage is represented in fig. 564.) Next, build over the posterior wall and edge, carrying the filling out to the required contour (fig. 565), and, this accomplished, fill the tooth in, first building over the anterior edge and out to the required shape. Building over the posterior edge first is recommended principally because the tendency is for the operator to build the filling out to the contour of the tooth in front, leaving the posterior wall, which is excessively difficult of access when the filling is completed in front.

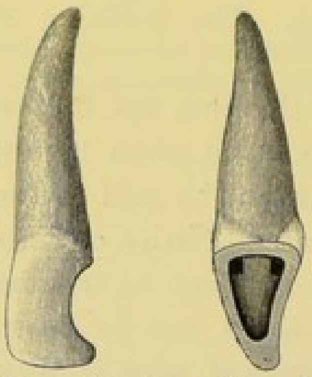


FIG. 561.—Showing side and front view of cavity.

FIG. — 562. Showing retaining points filled and bridged between.

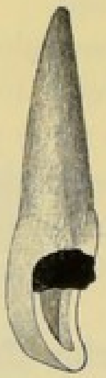


FIG. 563.—Showing filling built down slightly and contoured.

FIG. 564.—Showing actual cavity filled in.

These fillings are best finished with plug trimmers and tape at the cervical edge, discs and tapes for the approximal surface, small carborundum wheels for trimming the anterior surface, oval finishing burrs, and small corborundum wheels for the posterior surface. Pumice or rubber points, or ordinary sewing tape, should be used for polishing.

The foregoing description must be regarded as a synopsis of the usual order of procedure, and not as an attempt to explain in detail the filling of cavities. There are, of course, many other shapes of cavities besides those described, but the method is practically the same in each, viz.: (1) To start filling from grooves or retaining pits when these are present; (2) to build over the cervical edge; (3) to build the filling up as level as possible, keeping it, if anything, a little higher against the walls than in the centre of the cavity; (4) to build over the edge as the filling advances; (5) to fill the most inaccessible parts of the cavity first.

(β) **Non-cohesive Method.**—For this method, as with the cohesive, the gold is prepared either in sheets or as cylinders. The sheet is usually introduced in one of three forms, viz:—

Tape or ribbon.
Rope.
Stars or strips.

Fig. 565.—Showing posterior wall built over.

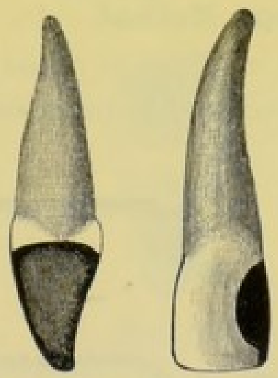


Fig. 566.—Showing filling completed.

Whichever form is selected, there is one golden rule to be invariably followed, viz., that **the folds of sheets or cylinders must be placed parallel to the walls of the cavity.**

(i.) Sheet

Tape Method.—In using the tape method, a sheet of No. 4 foil is cut into three pieces, and each folded with the foil knife until its breadth is about equal to that of the cavity. The strip is then taken up by the conveying forceps in the left hand and conveyed to the cavity, and, with a suitable instrument in the right hand,

pressed down into folds parallel with the walls, each fold being left projecting slightly above the orifice of the cavity. When a few folds are arranged, they should be firmly compressed against the side of the cavity with suitable instruments.

When one length of tape is exhausted another is introduced, and so on, until the cavity is as full as possible. The filling is then thoroughly condensed. This step completed, the surface should be tested by endeavouring to force into the gold an instrument of wedge shape. If it can be "riggled in" by moving it in a lateral direction, the hole made should be filled up with tape or very small cylinders. This process (viz., forcing in the wedge-shaped instrument) is continued until it requires some considerable force to introduce the plugger into any part of the filling. The surface of the plug is now thoroughly burnished with either a band or engine burnisher. The filling is then trimmed down in exactly the same manner as recommended above, with the exception that after the use of the pumice the surface should be burnished.

Rope Method.—In this method the sheet, instead of being folded in strips, is rolled into a form resembling rope. The "rope" is introduced in practically the same manner as the "tape."

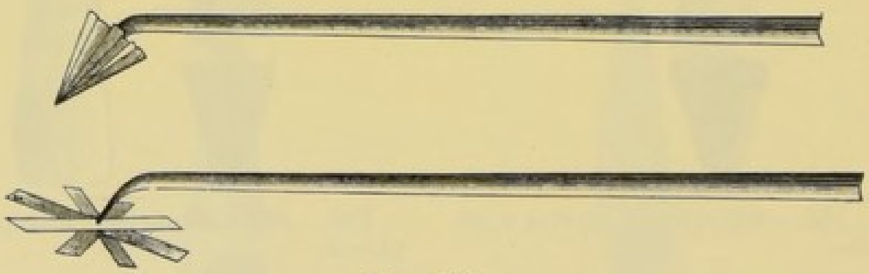


Fig. 567.

Stars and Strips.—In this variety the sheet is folded into broad strips of from a half to three-quarters of an inch in breadth, and cut at right angles into narrow strips. These are arranged as shown in fig. 567, and inserted, with the central portion downwards, into the cavity, the projecting ends being folded downwards and inwards, and compressed. Fresh portions are added in like manner until the cavity is full, the plug being finished in the usual way. This process is useful for small, deep cavities, and for introducing the finishing portions into larger fillings.

(ii.) Cylinders

Cylinders are the most convenient form in use for introducing non-cohesive gold, and one of the most serviceable makes is that known as Ash's Non-cohesive, Style C. Non-cohesive gold cylinders should be introduced as follows:—

Take three, four, or more (the number depending upon the breadth of the cavity) between the blades of the conveying forceps and, compressing them laterally, place them in position towards the posterior part of the cavity (fig. 568), holding them in place with an instrument in the left hand; condense them first on one

Fig. 568.

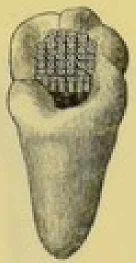


Fig. 569.

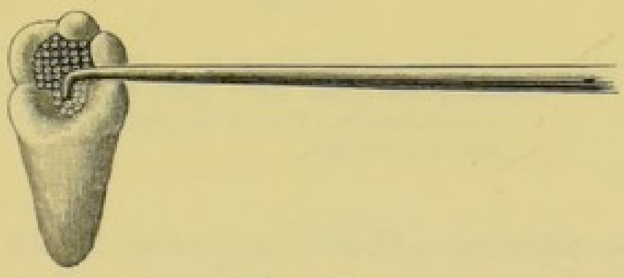


Fig. 570.

Fig. 571.

side, then on the other, and finally in the centre. Continue to introduce and condense fresh rows of cylinders until the cavity is a little over two-thirds full (fig. 569). A different mode must now be adopted. The cylinders should be placed round the side of that part of the cavity which is still unfilled, and condensed by wedging from the centre (fig. 570), the last portion of the filling being introduced in the form of tape. The surface is then condensed, and the plug treated in exactly the same way as described under the tape method. The rows of cylinders introduced first are very often difficult to keep steady for condensing, and when this is the case it is best to add a second or even a third row before condensing is commenced.

Non-cohesive gold can be most advantageously employed in crown cavities and in the upper portion of interstitial cavities in combination with cohesive. The advantages claimed for cohesive gold are that it adapts itself better to the walls of the cavity than cohesive, and that it is more quickly worked—a point of great importance in practice.

(γ) **Combination of Cohesive and Non-cohesive Methods.**—The combination of cohesive and non-cohesive gold is a very favourite plan with many operators. Cavities in **approximal surfaces of premolars and molars** are those usually filled by this method, the mode of procedure being as follows:—

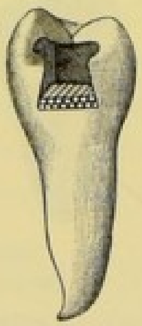


FIG. 572.—Showing non-cohesive cylinders in position.

FIG. 573.—Showing the cavity completed, the light part being the non-cohesive, the dark part the cohesive portions.

Take two or three non-cohesive cylinders, according to the breadth of the cavity, and place them along the cervical wall so that the ends project outwards, not downwards. Condense gently so as to get them steady, and then add another row. Condense again, first on one side, then on the other, and finally in the middle. This process will prevent the gold from tilting. The procedure is continued until the cavity is about one-third full (fig. 572), when the cohesive gold is started by wedging up a large uncondensed cohesive cylinder; tape is attached to the cohesive cylinder and the filling completed in the manner described under the cohesive method, the plug being finished in the usual way.

The advantage claimed by those who advocate a combination of the methods is that a better joint at the cervical edge is obtained than with cohesive gold alone, while those who oppose

the combined methods maintain that the non-cohesive gold is forced out by the power of mastication and forms a ledge for the lodgment of food, &c., at the cervical edge. This objection only holds good if too much non-cohesive gold is used. A useful mode of starting the cohesive gold is as follows: Before placing the last row of non-cohesive cylinders in position, insert a strip of tape as shown in fig. 574, then place the last row of non-cohesive cylinders, condense them and bring the ends of the cohesive strip across as shown in fig. 575.

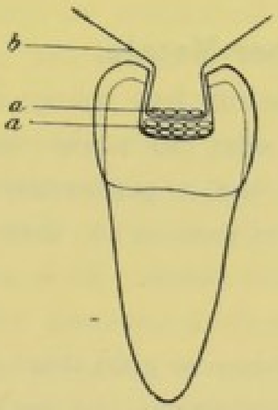


FIG. 574. — (a) non-cohesive cylinders; (b) strip of cohesive gold foil.

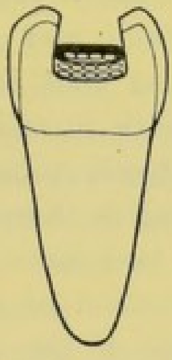


FIG. 575.—Strip of cohesive gold foil condensed over the non-cohesive cylinders.

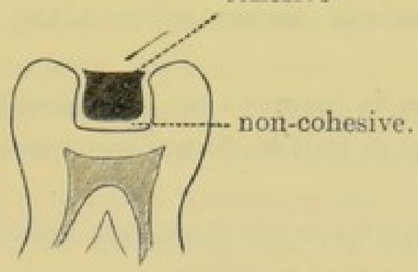


FIG. 576.

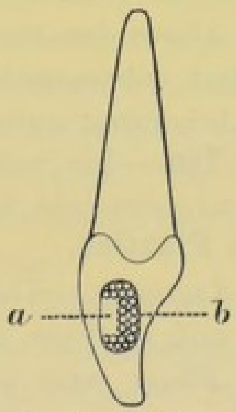


FIG. 577.—(a) cohesive; (b) non-cohesive.

Another mode of combining cohesive and non-cohesive gold is shown in fig. 576. The floor, walls of the cavity and edges are filled with non-cohesive gold, the centre of the plug being completed with cohesive, the idea being that the non-cohesive adapts itself better to the walls of the cavity than the cohesive, but, on

the other hand, the latter allows the filling to withstand mastication better than the former.

In **approximal cavities in anterior teeth**, a combination of cohesive and non-cohesive gold will be found useful, especially in cavities which do not involve much of the labial and lingual walls. In such cavities the cervical margins, lingual wall and portion towards the cutting margin can be filled with the non-cohesive, leaving only the portion towards the labial wall to be filled with cohesive (fig. 577). Operators skilled in the use of the non-cohesive gold method find no difficulty in filling such cavities entirely by that process.

(δ) **Gold in Combination with other Metals.**

(i.) *Gold and Tin.*—This combination has many advocates who claim that it is comparatively easy to make water-tight fillings with it, and that, moreover, it has a preservative action on the tooth substance. The chief objection is that it turns black and is therefore unsightly in front teeth. It is principally used in two ways, viz.: (1) similar to that pursued when using a combination of cohesive and non-cohesive gold (the tin taking the place of the latter); (2) by intermixing the tin with the gold as follows: One sheet of tin is placed between two of the non-cohesive gold and the whole folded up into either tape or rope, the material being introduced into the cavity as recommended above for the non-cohesive gold. Tin and gold works softly, but subsequently some chemical action takes place, the surface becoming quite hard.

(ii.) Tin.—Tin, when used alone, is inserted on the same plan as non-cohesive gold, but, in working, it will be found more plastic.

(iii.) Plastics.

(*a*) *Amalgam.*—There are many ways of inserting amalgam fillings, and, of these, three call for special mention.

Mr. Flagg, who was a great authority upon plastic fillings, objected to the method of burnishing in the separate portions, maintaining that it was impossible to get union between successive pieces. He recommended that each piece should be worked into place with serrated pluggers, the force used being a succession of light blows.

Mr. Bonwill's method has many advocates. A small quantity is introduced into the cavity, and over this a pad of bibulous paper

is placed and firmly pressed against the amalgam with suitable instruments, burnishers, tweezers, &c. The pad is then removed and is seen to contain a small amount of mercury, while, at the same time, a large amount of mercury is also seen upon the surface of the filling. The mercury is removed, and another portion of amalgam inserted and treated in the same way, much pressure being used in its insertion. By these means the cavity is filled, great care being taken to remove the surplus mercury from the surface.

Mr. Kirby adopts the following plan, which yields excellent results: Two portions of amalgam are mixed, the first by taking equal parts by weight of mercury and filings. This is the soft mix; the second or dry mix is made by taking three times as much filings by weight as mercury. The first half or two-thirds of the cavity is filled with the soft amalgam which is worked into position with a burnisher without any undue pressure; the upper half or third of the cavity is then filled with the dry amalgam in much the same manner: the filling is then trimmed into shape. Mr. Kirby lays great stress upon having the smallest possible portion of mercury in the last part of the amalgam.

Mr. Kirby's method aims at obtaining an equal distribution of mercury throughout the filling, and he maintains that the change seen in amalgam is due to the fact that the mercury tends to disseminate equally throughout the filling, causing contraction in the part it goes from and expansion in the portion it goes to.

Matrices should always be used in approximal cavities, as it is extremely difficult without their use to insert good fillings in these situations. When the filling is inserted, the amalgam should be carefully trimmed, silk being used for the cervical edges and suitable burnishers for the other surfaces.

The Combination of Oxy-phosphate Cement with Amalgam.—Clinical experience shows that this combination leads to excellent results. The *modus operandi* is as follows: The cavity is thoroughly dried and lined with oxy-phosphate cement mixed fairly thin. A ball of amalgam is next inserted and pushed well home into the cement so that the whole surface is covered with a layer of amalgam. The cement is now allowed to set slightly and all surplus is very carefully trimmed away from the margins of the cavity, the remainder of the cavity being filled on the lines suggested by Mr. Kirby. In this way, fillings can be made which

withstand the ink test. The osteoplastic seems in some way to lessen the alteration in shape of amalgam, besides which it is a non-conductor and prevents staining of the tooth substance.

Some operators combine the oxy-phosphate and amalgam as follows: The amalgam is mixed in the usual way, care being taken to avoid an excess of mercury; the osteoplastic is then mixed a little thinner than usual and the two thoroughly blended together, the filling being inserted like an ordinary osteoplastic filling. The amalgam in the mixture should vary between one-third to one-half of the whole bulk.

Mixing Amalgams.—In mixing amalgams, it is desirable to ascertain the proportion of mercury to filings, which is necessary to produce a mass of a certain consistency. The required amount of mercury and filings should be weighed out, and thoroughly incorporated by mixing in a mortar with a pestle.

(*b*) *Osteoplastics.*—For the insertion of these fillings, it is important to exclude the saliva, and the rubber dam should therefore be applied whenever practicable. For mixing, a glass slab with square edges should be used; the spatula should be stout, quite flat and with square edges. The question of the consistency of the osteoplastics to be used must, to a great extent, be determined by experience; they should not be inserted too dry, a fairly plastic condition being the best.

The filling material should be dropped into the cavity and worked into place with as little disturbance as possible. When in place, the less the filling is manipulated the better, and it is a good practice to allow thorough hardening to take place before trimming the edges, &c.; indeed, the finishing is better accomplished at a subsequent visit. Attempts to manipulate the filling while in a semi-plastic condition tend to destroy its homogeneity and so render it less resistant to the solvent fluids in the mouth.

Mr. Humby has shown that it is possible to retard the setting of these cements by mixing them on a slab of metal with a metal spatula, the slab being made of pure copper, covered with thin layers of pure nickel. It is supposed that the setting is retarded by the absorption of the heat generated by the combination of the liquid with the powder. A large quantity of powder insufficiently mixed makes a poor filling, but it is useful for temporary work.

(*c*) *Translucent Cements.* — Translucent cements should be mixed with an agate spatula on an agate slab. In mixing, the powder should be gradually incorporated with the fluid until a "mix" of the constituency of stiff paste is obtained. The mixing must be carried out thoroughly and no particle of powder or superfluous free acid should be allowed to remain in the "mix" when ready for insertion in the cavity.

In the preparation of the cavity, the enamel margins must be left straight and not bevelled and the dentine must be undercut, as translucent cements do not possess adhesiveness.

The cement should be introduced into the cavity with ivory or bone instruments for preference, but nickel-plated instruments may be used. The disadvantage of the latter is that they are likely to cause slight staining, but as the staining is superficial it can easily be removed. The cement should be gently pressed or patted into place, the instruments being coated with vaseline to prevent the adhesion of the filling. If practicable, the filling should be finished with suitable burnishers and then coated with a varnish. In cases where this is not possible, the filling should be trimmed with fine cuttle-fish discs coated with a plentiful supply of vaseline.

A disadvantage of some of the types of translucent cements is that they set too rapidly after insertion, in consequence of the absorption of the moisture in the filling by the tooth substance. This too rapid setting may, to a certain extent, be overcome by mixing the cements on a thick slab of nickel covered with a layer of agate.

Translucent cements withstand the action of the mouth secretions better than osteoplastics. The tendency for cements to break away round the edges is due partly to imperfect mixing and working and partly to preparing the cavity with bevelled rather than straight edges. The discoloration at times seen is a distinct disadvantage and is probably in direct ratio with the density of the filling. The discoloration is stated to be only superficial and easily removable and to be more marked in the mouths of those who do not regularly use tooth powder and where there are amalgam fillings undergoing discoloration.

(*d*) *Gutta-percha.*—To insert this material, the following plan should be adopted: The variety to be employed must be cut into

small pieces and heated over a hot-water bath ; if softened by being passed through a flame the gutta-percha is not evenly heated, and its properties are impaired. The cavity should be thoroughly dried, and some operators wipe it round with a solution of gutta-percha or shellac in chloroform, evaporating the chloroform with a blast of hot air before inserting the gutta-percha. By this means, the filling is made to adhere to the walls of the cavity. The heated gutta-percha is then conveyed and packed into the cavity with suitable instruments. The cavity should be somewhat over-filled, the surplus being removed with thin spatulæ heated nearly to redness. The surface should then be smoothed with a polished burnisher, or by rubbing the surface with a pledget of cotton-wool dipped in chloroform. The objection to the chloroform is that the surface is rendered more porous than when the filling is finished with a burnisher. In practice, better results are obtained by trimming the filling to a point just below the enamel margins.

(2) THE OPERATION OF EXCISION

In the operation of excision, the diseased part is cut away and the surface polished. It is applicable in very few cases, the most suitable being the approximal surfaces of the molars and premolars when the caries is quite superficial and the surfaces are exposed.

(3) THE USE OF DRUGS

The progress of caries may be considerably retarded and sometimes arrested by the application of certain drugs, the most useful of which is nitrate of silver. Drugs can be employed with advantage for superficial caries of the cementum.

The **nitrate of silver** is applied in the form of a saturated solution, or, still better, the solid drug is rubbed over the surface. Two or three applications, at intervals of about a week, will effect a considerable hardening of the surface. The nitrate of silver precipitates the albumin in the tubules and forms an albuminate of silver which is a powerful antiseptic. The discoloration produced is an objection to its use on the anterior teeth. In cases of general softening of the cementum often seen in patients where

the gums have receded, the application of nitrate of silver to the back teeth and **phosphoric acid** to the anterior teeth, with the regular use of **alcohol,** will retard and often arrest the condition. The alcohol should be used as follows :—

The teeth are to be dried and absolute alcohol applied to the roots either on a brush or cotton-wool, the saliva being kept away for about two minutes. The alcohol precipitates the albumin in the tubes and in evaporating helps to dehydrate the dentine. The application should be made at least once a day. In the extensive caries at times seen in the deciduous teeth, the application of nitrate of silver every two or three months and the regular use of the alcohol will often arrest the caries and give the patient the use of a masticating surface—a point of the greatest importance.

(4) THE OPERATION OF CROWNING[1]

The operation of crowning may be resorted to in cases where the destruction of the crown by caries is so extensive as to prevent the introduction of reliable fillings.

Teeth or roots to be crowned must be rendered quite free from periodontitis, and the root canals made absolutely aseptic. The apex of the root canal should be filled before any reaming of the canal is carried out ; in this way, the infection of the periodontal membrane by foreign matter is prevented.

There are many **varieties of crowns and methods of crowning.** Broadly, they fall under two headings : (1) crowns without collars ; and (2) crowns with collars. In the crowns with collars the neck of the root is embraced by a ring of metal, which gives additional strength to the crown. A disadvantage of the collar is that the margin of the periodontal membrane is often injured and destruction of that tissue occurs. It is often better, if sound tissue exists above the neck of the tooth, to employ contour amalgam fillings to restore the lost tissue. The periodontal membrane is by this means not interfered with, a

[1] It is only intended in this section to draw attention to the more salient points to be observed in crowning. The advantages, disadvantages, and manufacture of the varieties of crowns cannot, owing to space, be included in this book. The student should consult the works specially dealing with this subject.

point of importance. Collar crowns should not be used where general periodontal disease is present. Increased clinical experience has taught that collar crowns should only be employed under exceptional conditions. Teeth that cannot be restored by contour amalgam fillings are not suitable teeth for collar crowns, or, indeed, for any other type of crown. It is certainly possible to restore badly broken-down teeth to act as efficient masticating organs by means of crowns, but the gain to the masticating area is overbalanced by the injury caused to the periodontal membrane and the crown thus becomes a focus of infection. Again, if teeth are present on one or both sides of the crowns, "spaces" are sure to form which will lead to injury of the approximal teeth and hasten their loss. It is far better to lose the masticating area which the crown gives and keep the periodontal membrane of the approximal teeth healthy.

If it is considered necessary to use crowns then crowns without collars should be used, so that a "clean joint" can be obtained, the lodgment of *débris* prevented and injury to the periodontal membrane considerably lessened.

In preparing roots for crowns the student must be guided by the class of crown to be employed. If using a metal or porcelain-backed crown, the labial edge of the root should be cut immediately below the free edge of the gum, the remainder of the root should be left flat and cut to leave the margin, if possible, well above the free edge of the gum. In enlarging the root canal to receive the pin of the crown, the tissue should be removed mainly from the posterior portions, as this will permit the pin to clear the tooth and so add to the strength of the crown. For porcelain crowns the surface of the root should be left flat, as a better adaptation of the crown to the root will be obtained. For collar crowns the walls of the root should be shaped so that they diverge slightly from the neck towards the apex, the top surface of the root being made flat. With the posterior teeth the buccal and lingual margins can be shaped with carborundum stones and finished with enamel cleavers. The approximal surfaces are best shaped with thin wheels or V-shaped dividing files. The angles of the root are best rounded off with enamel cleavers. On the correct shaping of the root depends, to a large extent, the success of collar crowns. If plain

metal crowns are to be used as much tissue as possible should be left.

The correct measurement of the root is best carried out by means of Herbst's bands. These bands are made of fine gold, graduated in size, and correspond to similar sizes on a flat gauge. The method of measuring with graduated bands is superior to that usually employed, namely, twisting a piece of soft copper wire around the root.

In fixing crowns the root should be dried as thoroughly as possible. In crowns without collars a wafer of gutta-percha should be placed over the surface of the diaphragm, the crown forced well home, then removed and all excess gutta-percha cut off. The crown should then be fixed in the root with an oxy-phosphate cement. Crowns with collars are best fixed with oxy-phosphate cement.

(5) THE OPERATION OF EXTRACTION

In all cases of caries where one of the above methods cannot be employed the tooth should be removed. For the methods of extracting teeth, see chapter xxvii.

CHAPTER XIV.

Destruction of Teeth from Causes other than Caries

Erosion—Attrition—Abrasion

IN caries of the teeth, the tooth substance is gradually destroyed by the action of acids and micro-organisms. Progressive destruction of the tooth substance may, however, be caused by other agencies, which will be referred to as erosion, attrition, and abrasion. The destruction of tissue may be rapid or slow, and may vary in intensity in the same individual. The lesion may be arrested in its progress. It is probable that the different lesions met with are merely varieties of one condition, but until their pathology is definitely ascertained it seems advisable to retain the terms erosion, attrition, and abrasion, limiting the first to conditions where the causes are not defined, the second and third to conditions where the causes are to some extent known. In all these conditions there is a gradual disappearance of a portion of the substance of the tooth, the surface left being smooth in character.

(A) EROSION

(1) Character of the Lesion.—The appearances presented by erosion vary considerably. The labial surfaces of the anterior teeth may be attacked, the condition being limited to one tooth, or involving several. The first indication is a slight depression which gradually deepens and extends towards the incisive margin.

In time a cup-shaped depression is formed, which is deepest towards the cervical margin and becomes gradually shallower as the incisive edge is reached. Fig. 578 is an example of an advanced case.

In some patients, the teeth look as if they had been pared down with a knife in a direction sloping from the labial to the

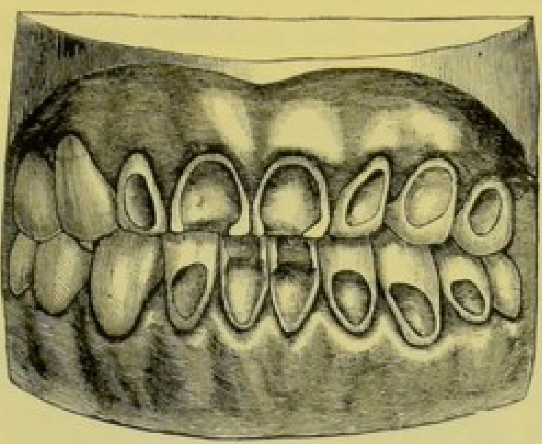


FIG. 578.[1]

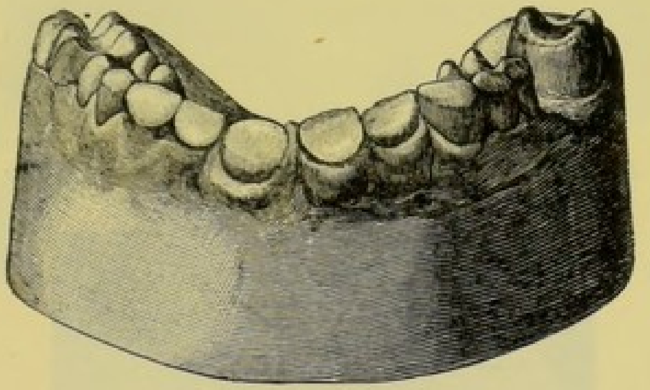


FIG. 579.—Maxillary teeth.

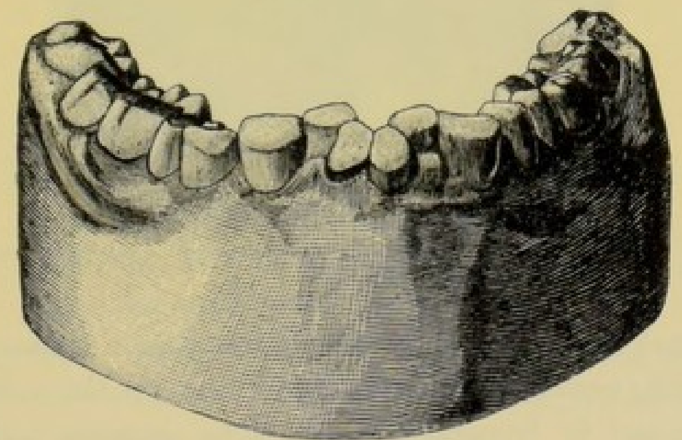


FIG. 580.—Mandibular teeth.

[1] From "The American System of Dental Surgery."

lingual surfaces, and when the mouth is closed a considerable interval is left between the maxillary and mandibular teeth (figs. 579 to 581).

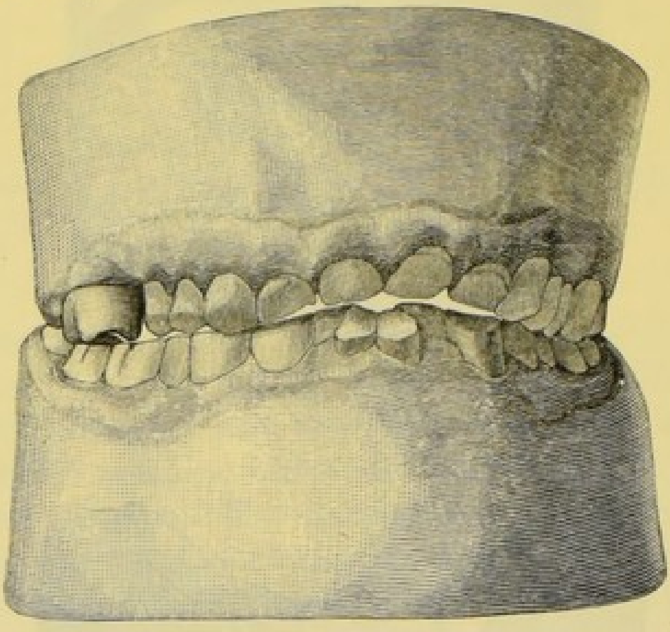


FIG. 581.—Showing occlusion of the teeth.

FIG. 582.[1]

To the naked eye, teeth attacked by erosion appear hard and polished, with, occasionally, a darkish film on the surface. The dentine exposed is hypersensitive. The erosion usually commences on the enamel.

[1] From *Journ. Brit. Dent. Assoc.*

Microscopical Appearances.—In the enamel of eroded teeth, Mr. A. S. Underwood[1] has met with an appearance suggestive of interglobular spaces (fig. 582). He states that he has never seen this condition except in enamel which had been attacked by erosion.

Sections of the dentine simply show the fibrils or tubes ending abruptly as if cut with some sharp instrument. The tooth substance adjacent to the eroded surface cannot be stained, and this is a fact worthy of attention.

Changes in the Pulp.—In teeth undergoing erosion, formative activity occurs in the pulp, resulting in the formation of adventitious dentine at the pulp end of the affected dentinal fibrils. If the eroding process is rapid, the dentine may be destroyed more quickly than the protective dentine is formed, in which case the pulp becomes exposed and a septic inflammation occurs.

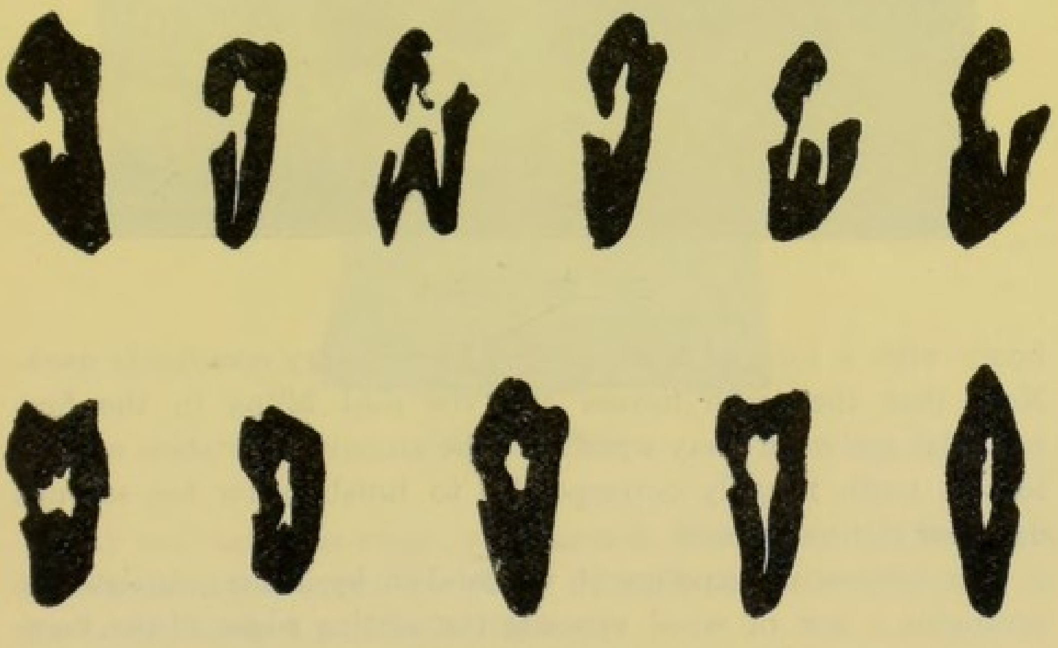


FIG. 583[2] (Miller).

(2) **Experimental Investigation.**[3] **Mechanical Action.**—If a tooth is subjected experimentally to the action of the toothbrush and powder, defects can be easily produced, the loss of tissue depending largely on the character of the powder used.

[1] *Journ. Brit. Dent. Assoc.*, p. 470, 1898.

[2] From *Dental Cosmos*.

[3] The student is advised to read Dr. Miller's articles on this subject in the *Dental Cosmos*, January, February and March, 1907.

The tooth to be experimented upon should be fixed in plaster of Paris, with gutta-percha on either side to represent the approximal teeth and prevent the brush acting too much on the sides of the teeth.

In fig. 583, from Miller, is shown the comparative effect on the teeth of different tooth powders applied with a brush for two hours. In fig. 584 is shown the result of brushing for eighteen

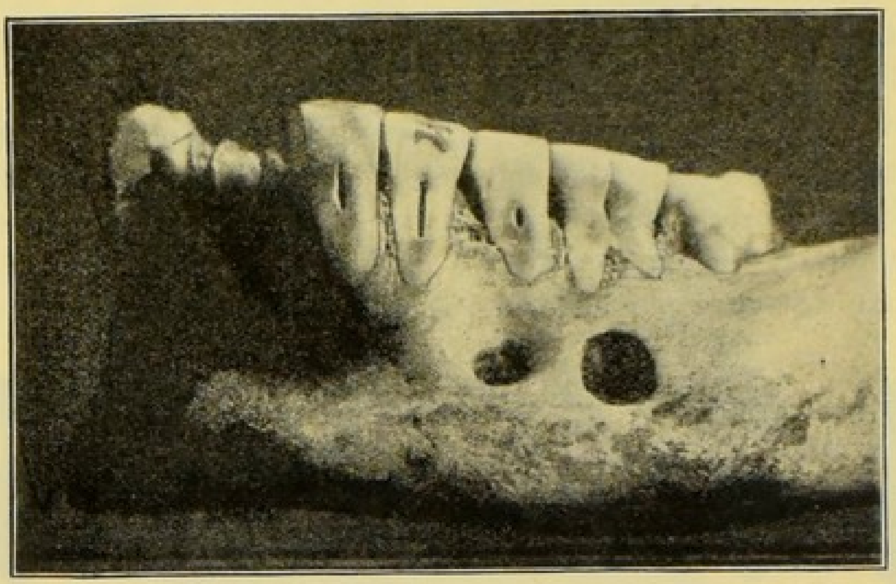


FIG. 584[1] (Miller).

hours with a form of tooth-paste which is very commonly used. Note that the tooth tissues and the gold filling in the first premolar are worn away equally. The amount of friction applied to this tooth roughly corresponded to brushing for ten seconds daily for eighteen years.

An interesting experiment, undertaken by Miller, consisted in arranging a bar of wood opposite the cutting edges of the mandibular front teeth at a distance of from 2 mm. to 3 mm., and brushing for eighteen hours with an English tooth-paste. The result is shown in fig. 585.

Not only have grooves been cut near the necks of the teeth, but considerable loss of tissue has taken place at the cutting edges. This experiment approximately simulates the action of those people who bring the teeth almost edge to edge when cleaning them, with the result that the bristles of the brush

[1] From *Dental Cosmos*.

work freely along the cutting edges of the teeth and produce abrasion. It is possible that conditions similar to those shown in fig. 581 are due to a process like that indicated above.

The Action of Chemical Agents.—The action of acids varies on the different tooth tissues. "Some acids form soluble and other insoluble compounds which may be precipitated upon the surface of the tooth or in its superficial layers." Certain acids, *e.g.*, hydrochloric, nitric, lactic, &c., decalcify dentine more rapidly than enamel; other acids, such as oxalic, tartaric, or mucic, act with equal intensity on both enamel and dentine. The surface

FIG. 585[1] (Miller).

left by acid action is rough, and there is therefore no difficulty in distinguishing between the effect of acid action and erosion, as the latter leaves a polished surface.

In dynamite manufactories the workers often suffer from a loss of the crowns of the lower incisors and the cutting edges of the upper incisors, the defective portion of the teeth presenting a smooth polished surface. Miller found that a similar condition could be produced by exposing teeth to the vapour of sulphuric and nitric acids (the acids used in the manufacture of dynamite), and then slightly brushing the affected surface. The eroding body is nitrogen peroxide.

[1] From *Dental Cosmos*.

Water charged with carbonic acid has a marked decalcifying effect on dentine and enamel, and it is conceivable that, when carbonic acid is present in the saliva in excess, it might have a deleterious effect on the teeth.

If teeth be acted upon by a constant stream of dilute acid solution, destruction of the tooth substance will ensue, but the surface will be rough, showing acid action, and not smooth as in cases of erosion.

In one experiment undertaken by Dr. Black[1] two fresh healthy premolars were placed with their approximal surfaces together, the roots being enveloped with gutta-percha so that only the crowns were exposed; these were then placed in a jar containing dilute hydrochloric acid (1 in 400), and, by means of an ingenious apparatus, a current was obtained, the teeth being arranged in such a way that the current, in impinging upon their outer surfaces, struck one surface with greater force than the other, the result being the disappearance of the cusps and the formation of a groove between the teeth; this groove was more marked upon the surface which received the greater force of the current. A large number of other observations were carried out, and it was found that strong solutions produced general softening, while a solution of 1 of acid in 5,000 of water had not an appreciable effect after three months' trial.

Dr. Head[2] has investigated the action of acids on enamel, and he has shown that this structure resists the decalcification of acids and acid salts most unevenly and erratically. In experiments with 1 : 20, 1 : 2,000 and 1 : 20,000 solution of acid sodium phosphate, he found that while with 1 : 20,000 (solution) decalcification of the enamel did not start so quickly as with 1 : 20, the action of the 1 : 20,000 was more uniformly progressive and ended by cutting the enamel much more deeply than the 1 : 20 solution. Dr. Head has also shown that the saliva considerably inhibits the action of carbonic acid and many other acids, such as lactic, citric, &c.

The Action of Acid in Combination with Mechanical Action.—In these experiments, the teeth were subjected to

[1] "American System of Dental Surgery," vol. i, p. 1004.
[2] *Dental Cosmos*, vol. xlix, p. 801.

action of the acid by means of a thin layer of cotton-wool placed on the surfaces of the teeth and the friction with tooth-brush then applied. Every precaution was taken to simulate the condition met with in the mouth and various acids were tried. In one of Miller's experiments, "six teeth, central, lateral, canine, premolar, first and second molars, were placed in a curve to reproduce the natural arch, and were bathed with 5 per cent. solution of phosphoric acid for thirteen hours, brushed hourly for two minutes with 50 per cent. pumice, and then for eleven hours brushed hourly for three minutes, and for seventy-three hours four minutes hourly." The result of this experiment is seen in fig. 586. The canine and premolar were filled with gold and gutta-percha, respectively, and these fillings project above the surrounding dentine.

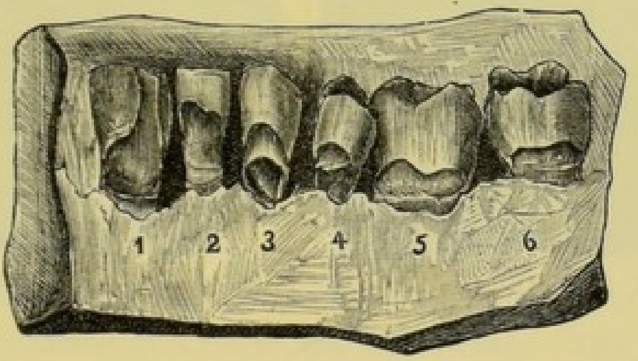
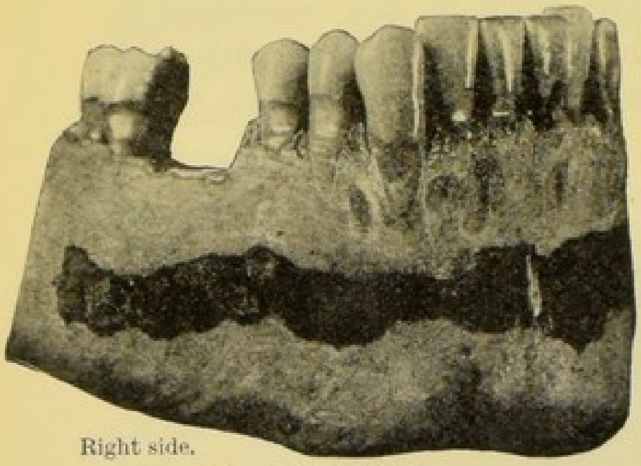


FIG. 586[1] (Miller).

A point clearly demonstrated by Miller's experiments is that acid action does not by itself produce wasting of the enamel as seen in erosion, but in conjunction with mechanical agencies considerably accelerates the process. With dentine, the action of the acid is to convert the tissue into a soft but tough material which naturally resists friction more than the hard and brittle uncalcified tissue. The influence of the acid on the dentine, however, varies. Acids which rapidly decalcify the dentine, such as hydrochloric and lactic, exert most influence in retarding the effects of friction; while those which act slowly on the dentine (oxalic, tartaric, &c.), as well as those which have a macerating effect on decalcified dentine, exert but little influence.

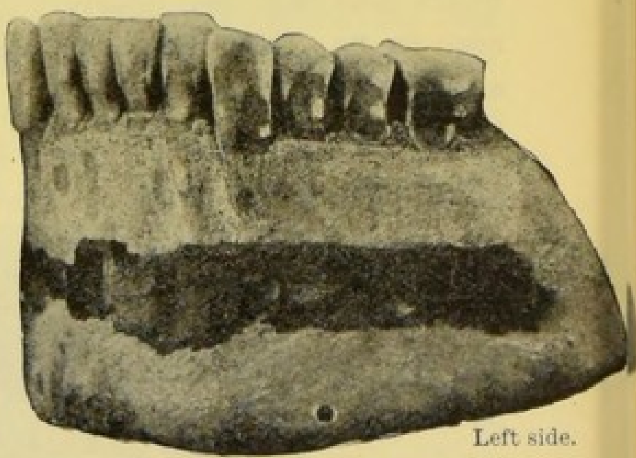
[1] From *Dental Cosmos*.

The result of an experiment undertaken to show the difference between mechanical friction alone and mechanical friction plus acid action is shown in figs. 587 and 588. The teeth in the left half of the mandible were treated with a $\frac{1}{2}$ per cent. to 1 per cent. solution of acid calcium phosphate applied on cotton-wool[1] and the right half with water, also applied on cotton-wool. Both sides were brushed twice a day with different powders for two and one-third years. The destruction is much more marked on the left side which was treated with acid calcium phosphate.



Right side.

FIG. 587[2] (Miller).



Left side.

FIG. 588[2] (Miller).

(3) **Etiology.**—Experimental evidence suggests that erosion is mainly due to the mechanical action of the tooth-brush and powder, aided possibly by the action of an acid or acid salt on the tooth tissue. The question arises: Is it possible that acid agents may be present in the mouth in certain pathological conditions? Many authors maintain that erosion is intimately associated with "gout," and that in gouty subjects acids capable of affecting the tooth tissue are produced in the mouth. Clinical observations on patients in private practice certainly tend to show that tooth wasting is more marked in those of gouty diathesis than others. On the other hand, Miller and S. P. Mummery examined patients in the hospitals of London and Berlin, and found in twenty-four cases of gout and ninety-nine

[1] Miller in this experiment does not say how long the acid calcium phosphate was allowed to remain in contact with the tooth.

[2] From *Dental Cosmos*.

of rheumatism (eighty-nine chronic and ten acute) no case of erosion. Caries at the necks of the teeth was found in many of the patients, but no disintegration of the enamel. Riegner, of Breslau, also examined amongst hospital patients two cases of gout and 115 cases of articular rheumatism and found no wasting. These data are interesting when considered in connection with the fact that hospital patients rarely use a tooth-brush.

Brubaker[1] considers that the source of the acid is to be found in an abnormal secretion of the mucous glands of the cheeks and lips. These glands are muciparous, and their secretion is composed of water, mucin and inorganic salts, the chief of which, sodium phosphate, imparts to the fluid its alkalinity. Under certain conditions, such as "gout," the secretion increases in quantity and is acid in reaction, the acid sodium phosphate which is formed acting as the decalcifying agent.

Sodium phosphate in the presence of carbonic acid readily parts with one atom of its sodium, forming acid sodium phosphate.

$$Na_2HPO_4 \quad + \quad H_2CO_3 \quad = \quad NaH_2PO_4 \quad + \quad NaHCO_3$$

Carbonic acid has not been demonstrated in the mouth, but a probable source is from the increased activity of gland cells leading to an excess of CO_2 in the cell tissue. The acid sodium phosphate, if formed, would theoretically be able to bring about a solution of the enamel as follows :—

NaH_2PO_4	+	$Ca_32(PO_4)$	=	$NaCaPO_4$	+	$2\ HCaPO_4$
(Acid sodium phosphate)		(Calcium phosphate)		(Sodium calcium phosphate)		(Acid calcium phosphate)

The acid calcium phosphate thus formed is acted on by another molecule of acid sodium phosphate as follows :—

NaH_2PO_4	+	$2\ HCaPO_4$	=	$NaCaPO_4$	+	$Ca2(H_2PO_4)$
(Acid sodium phosphate)		(Acid calcium phosphate)		(Sodium calcium phosphate)		(Diacid calcium phosphate)

In this way the calcium phosphate of the teeth undergoes decomposition firstly into first mono, and secondly into diacid calcium phosphate, the latter being freely soluble. The decalcified tooth is then removed by the action of the lips and cheeks.

[1] *Internat. Dent. Journ.*, p. 742, 1894.

Some authors doubt whether the action of the lips and tongue would provide sufficient friction to remove the decalcified tooth. An experiment by Head suggests that removal in this way is possible. "A tooth with sound enamel was wetted with saliva and pressed into a ripe strawberry. At the end of one and a half hours it was withdrawn, washed in running water and dried with an air-blast. The surface of the enamel which had been subjected to attrition was decalcified, but the cuticle-protected surface was unharmed. The tooth was then wetted with more saliva and replaced in the strawberry. At the end of four hours and a half it was again examined, when both cuticle and worn surface had lost their gloss through decalcification. A single rub with a napkin, however, restored the gloss to all appearances as bright as before."

Kirk,[1] who has carefully studied the question of the connection between the saliva and erosion, is of opinion that erosion is intimately connected with the gouty and rheumatic diatheses. In one extreme case of erosion, in which the incisor teeth were worn away at the cutting margin, a clinical consideration of the case suggested that lactic acid was the agent. In his investigation, he separated the salts of the saliva from the ptyalin and colloid substances by a dialyzer and then concentrated the salts over a water-bath. He considers that by these means he removed any possibility of the salts being modified in crystallizing by the presence of mucin and colloid substance. The possible combinations that lactic acid could form with the salts of the tooth were produced, as well as all combinations which acid sodium phosphate could make. These were examined by means of the micropolariscope and compared with the salts obtained from the saliva of the patient, and it was found that the salts from the saliva were lactates or lacto-phosphates. As a result of his investigation Kirk considers that when the erosion is "general," that is when it attacks the teeth generally, lactic acid is the solvent, but when the condition is localized the agent is acid sodium phosphate or acid calcium phosphate derived from abnormal secretion of the mucous glands.

Dr. Cook[2] contends that mucic acid is an important acid

[1] *Items of Interest*, July, 1902, and *Dental Review*, May, 1903.

[2] *Dental Review*, May, 1906, p. 461.

agent in the production of erosion, and considers that it is produced by a series of changes from lactose. It is, however, an open question whether mucic acid is ever present in the mouth.

A marked destruction of tooth tissue is occasionally seen in patients who consume a large amount of fruit in the form of oranges, grapes and lemons, but in these cases the effect produced on the teeth is not the same as in cases of "erosion." In the case of a patient under notice who was frequently sucking lemons and had acquired the habit of sweeping the tongue over the labial and then over the palatal aspects of the maxillary teeth, the enamel had almost disappeared.

Mr. Michaels[1] states that where erosion is found the saliva of the patient contains an increased amount of sulphocyanide in the form of the ammonium and potassium salts, and that by submitting the tooth to a slow drip of a solution of sulphocyanide of potassium for a few days he was able to produce conditions similar to erosion. Alkaline sulphocyanides (potassium and ammonium) are supposed "to dissolve the organic elements of the dental organs and lay bare the mineral elements, forming with them a sulphocyanide of calcium and soluble phosphates of potassium and ammonium."

From the foregoing statements it will be seen that varying opinions as to the cause of erosion are held by those who have investigated the subject. The facts elicited from a general review of all the information at present at our disposal would seem to lead to the conclusion that the condition is mainly due to the abrasive action of the tooth-brush and powders, assisted possibly, in a few cases, by the action of some acid agent, and the evidence would seem to suggest that the acid agent is either acid sodium or calcium phosphate.

(4) **Treatment.**—In the first place, tooth powders should be avoided and a soap with a soft brush used for cleansing purposes. The teeth must on no account be brushed "crosswise." If the eroded spots are painful, they may be touched with phosphoric acid, chloride of zinc, or, if in a place which does not show, nitrate of silver may be used, or a paint may be prescribed,

[1] "On the *Rôle* of Systemic Hyperacidity and of Sulphocyanides in the Saliva in Chemical Abrasion of the Teeth," *Internat. Dent. Journ.*, vol. xxi, p. 248.

the patient being instructed to dry the tooth and paint on the solution, keeping the tooth dry to allow the material to harden. The following will be found useful:—

℞ Gum-mastic (powder)	..	..	ʒi.
Chloroform	..	..	℥ss.
Zinc chloride	..	..	grv.

Mix. To be used as a paint.

Mr. Royston,[1] who assumes that the lesion is due to the abnormal labial glands, suggests the removal of the glands by means of cauterization. For this operation he recommends nitrate of silver. He states that he has tested this method many times by treating all the eroded teeth in a mouth with the exception of one or two. The cases were kept under observation for several months to ascertain the difference in the progress of the disease, and, almost without exception, the erosion in the untreated teeth became more pronounced, but remained stationary in the treated teeth.

(B) ATTRITION

Attrition is a wearing away of the tooth substance, caused by the grinding of one tooth surface over another. It is seen more frequently in the teeth of the aged and in the deciduous teeth. The amount of attrition depends to a great extent upon the character of the food, the density of the tooth substance, and the articulation. The surfaces of all the teeth may be affected, or only one or two teeth may be attacked. When localized to one or two teeth, the attrition is generally due to some irregularity of the bite. The case shown in fig. 589 is a good example. The attrition is attributable to an irregularity of the maxillary central incisors, their mesial angles impinging upon the mandibular central incisors.

Broca has suggested the recognition of **four degrees of wear**:—

In the **first**, the enamel alone is worn without any obliteration of the cusps.

In the **second** degree, the tubercles of the crown have disappeared, and the dentine is exposed.

In the **third** degree of wear, the height of the tooth is still

[1] *Dental Record*, vol. xx, p. 347.

further reduced, while in the **fourth** the wear has extended to the neck, the crown having entirely disappeared, and either the pulp cavities are invaded, or barriers of adventitious dentine have formed.

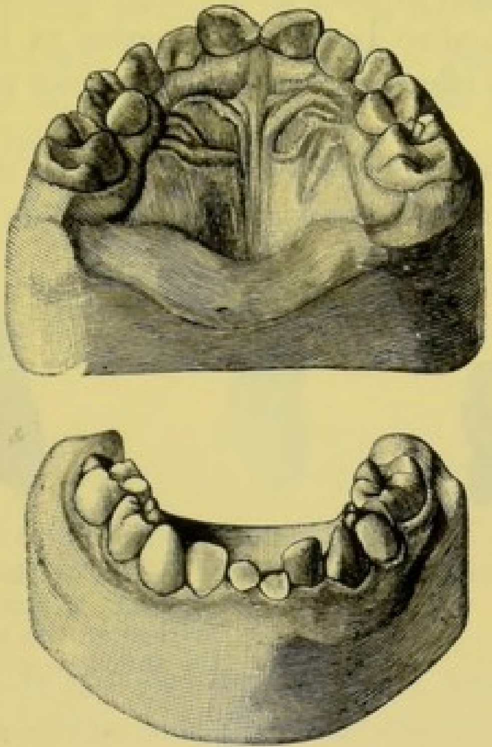


FIG. 589.

Involuntary grinding of the teeth, leading to undue attrition, frequently occurs in children. It also occurs in adults, more especially those with gouty or rheumatic tendencies. Dr. Marie and Pietkiewicz[1] state that the habit of grinding the teeth frequently develops in the course of disorders of the central nervous system.

Examined microscopically, the dentinal tubes will be seen to end abruptly upon the worn surface, while the pulp chamber will show the formation of adventitious dentine, though the adventitious dentine will not always be found to have kept pace with the destructive process.

Treatment.—In the majority of cases, treatment is not necessary. In those where the posterior teeth are absent, and the anterior teeth are being worn away through bearing the brunt

[1] *Revue de Stomatologie*, March, 1907.

of mastication, dentures should be inserted, and so arranged that the bite is taken off the anterior teeth. If the patient refuses to submit to dentures, the progress of the destruction can be arrested by filling the cavities with metal, and bringing the filling over the edges of the enamel in such a way that, in occlusion, the fillings come in contact and so arrest the progress of tooth destruction. This treatment is effectual, but the appearance produced is somewhat unsightly.

The hypersensitiveness of dentine, which at times accompanies rapid attrition, should be treated as indicated on p. 442.

Fig. 590.—Mandibular first molar, showing attrition.

Fig. 591.—Mandibular first molar, showing attrition, which is more marked on the posterior aspect than the anterior.

Fig. 592.—Maxillary central incisor, showing well-marked attrition on palatal aspect.

(C) ABRASION

The term **abrasion** is used to denote the destruction of the tooth substance through friction from a foreign body, such as a denture, pipe, or tooth-brush. Abrasion is more likely to be mistaken for erosion than for attrition. It may occur on nearly any tooth, and is very frequently caused by the presence of a clasp. It is the cause of most of the V-shaped cavities seen upon the anterior teeth near the gum margin, and is possibly the cause of most conditions classed as erosion. These cavities are mostly found upon the maxillary canines and the mandibular canines and

first premolars, their presence in these positions being probably due to the fact that these teeth form the prominent parts of the curves of the arch, and therefore the teeth most likely to be affected. Again, this condition is at times more marked upon the left than the right side, probably from the tooth-brush being used transversely, and from the fact that in a right-handed person more force would be applied in cleaning the teeth on the left than the right side.

FIG. 593.—Maxillary canine, showing abrasion from a wire attached to an upper denture.

Treatment.—If the abrasion is slight, treatment should be directed to removing the cause. When due to friction from the tooth-brush, the directions for the treatment of erosion with regard to powders, &c., should be carried out. Hypersensitiveness of the dentine, if present, must also be treated. If the abrasion is advanced, the cavities formed should be filled with either amalgam or gold.

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CHAPTER XV

Diseases of the Pulp

Acute Pulpitis — Chronic Pulpitis — Adventitious Dentines — Regressive Changes—Exceptional Pathological Conditions

(A) LOCAL REACTION TO INJURY—INFLAMMATION—PULPITIS

THE local adaptive changes resulting from injury to the pulp are generally known as "pulpitis." Two grades of inflammation are recognized, namely, the acute and the chronic; in the former, the development of the inflammatory process is rapid, and is accompanied by marked clinical symptoms, while, in the latter, the reaction is slow in development and is accompanied by feebly marked clinical signs, indeed, in some instances, no clinical signs are apparent.

(1) Acute Pulpitis

Causes.—Acute inflammatory reaction in the pulp may arise from *traumatism*, such as the rupture of the apical vessels from dislocation of the tooth, fracture of the tooth involving the pulp, and laceration of the pulp tissue in the preparation of the tooth for filling. Another group of causes is the injudicious use of *physical and chemical agents*, for example, the freezing of teeth with ethyl chloride, or the use of a drug like arsenic for the treatment of sensitive dentine. The commonest cause of acute pulpitis is injury from *bacterial toxins*, which reach the pulp tissue either through a carious cavity, or, more rarely, *via* the periodontal membrane, the latter being seen in advanced cases of periodontal disease.

Morbid Anatomy and Pathology.—The changes in the pulp tissue resulting from injury are similar to those which occur in other vascular structures. The process may terminate in *resolution* when the injury has taken the form of a concussion

or slight dislocation of the tooth. Resolution may follow after injury of the apical vessels, but this is rare, and in this connection the following case recorded by Mr. A. S. Underwood[1] is interesting. "Whilst performing immediate torsion on a superior lateral incisor, the tooth was completely dislocated and fell on the floor. It was sterilized and replaced. Two years afterwards the tooth responded to thermal changes and showed no degenerative changes."

In other cases the reaction in the tissues may be so intense in character as to lead to *gangrene* of the pulp. Injury to the pulp is frequently followed by gangrene, the reason being that this delicate tissue is enclosed by unyielding walls, and that the increased pressure in the cavity leads to vascular obstruction.

When the injury is due to bacterial toxins, *suppuration* usually follows, and, in cases where the infection is intense, "gangrene" may occur. When suppuration is once established in a part of the pulp, the remainder rapidly becomes involved and the whole of the tissue is destroyed. The early stages of suppuration of the pulp are shown in fig. 594.

In this section, in the zone bordering on the abscess (*f*), the cells show a tendency to the formation of fibroblasts, which would seem to indicate protective action on the part of the pulp to cut off the pus from the remainder of the tissue. In the tusks of elephants examples of the encapsulation of pus are often met with, and in man it would seem to occur occasionally. Gysi[2] records a case where an abscess in the cornua of a maxillary first molar had been isolated from the rest of the pulp by a wall of secondary dentine, and Miller[3] figures a tooth in which the appearances suggest that an abscess cavity had been bridged over and separated from the main pulp cavity.

Occasionally the pulp shows a wonderful power of recovery from injury, as shown in cases where an unsuccessful attempt has been made to remove a tooth, and a portion of the root containing a living pulp has been left behind, the superficial portion of the pulp in time being replaced by secondary dentine. A detailed account of a case of this type is given by Mr. C. S.

[1] *Trans. Odonto. Soc.*, vol. xviii, p. 98.

[2] *Schweizerische Vierteljahrsschrift für Zahnheilkunde*, 1900, p. 254.

[3] *Dental Cosmos*, vol. xliii, p. 850.

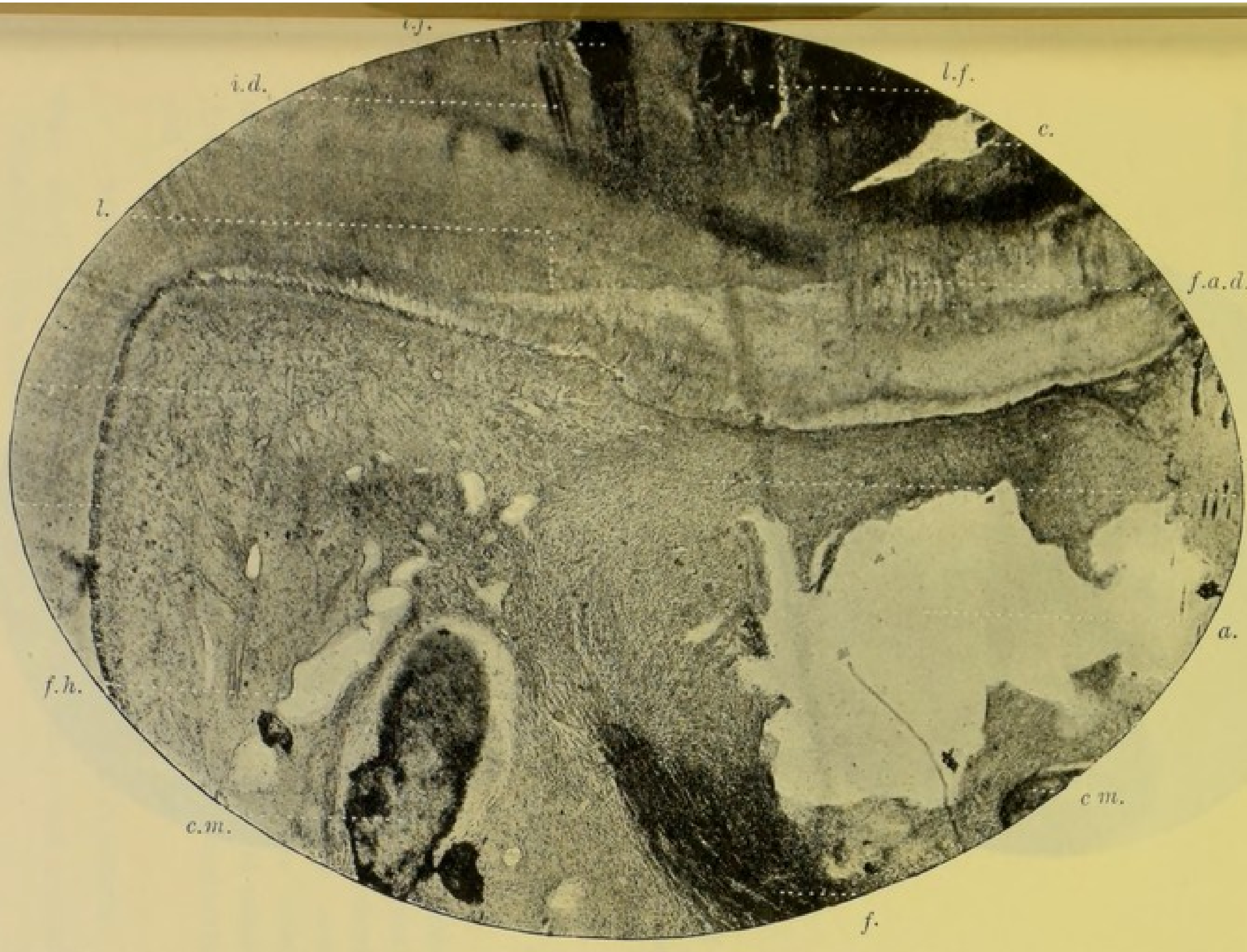


FIG. 594.—Vertical section of human molar tooth affected with caries and inflammation of the pulp. (*c.*) carious cavity; (*i.d.*) dentinal tubes infected with micro-organisms; (*l.f.*) liquefaction foci; (*l.*) original limit of the pulp cavity; (*f.a.d.*) fibrillar adventitious dentine; (*p.*) pulp tissue apparently but slightly affected by the inflammatory process; (*o.*) original odontoblasts; (*i.t.*) acute inflammation of the pulp tissue; (*a.*) abscess cavity; (*f.h.*) hyperæmic blood-vessel; (*c.m.*) deposit of calcoglobulin; (*f.*) fibroblasts.

From "The Histology and Patho-histology of the Teeth," by A. Hopewell-Smith.

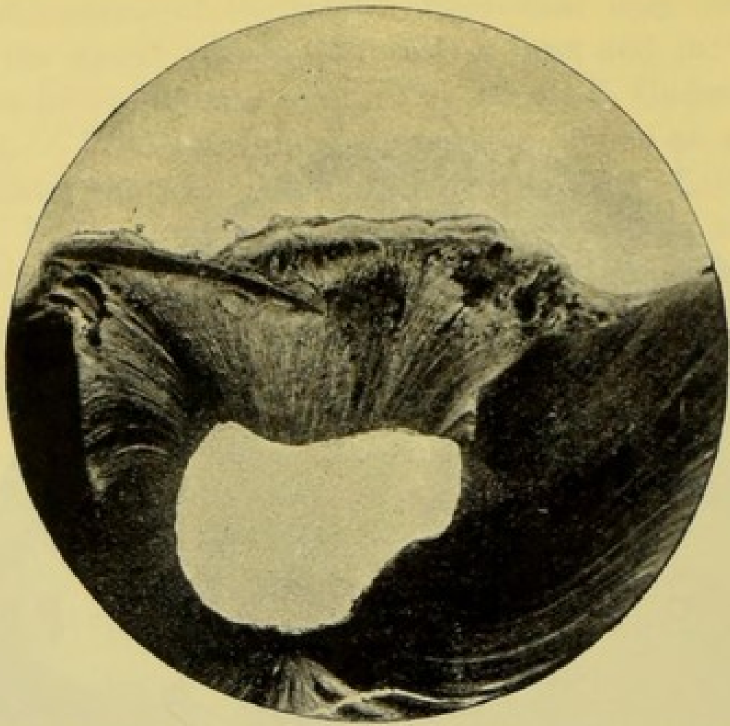


FIG. 595.[1]—General view of the secondary (adventitious) dentine, showing the pulp cavity beneath it and the dentine of the original tooth, which appears very dark. A thin strip broken off the old dentine is embedded in the secondary dentine.

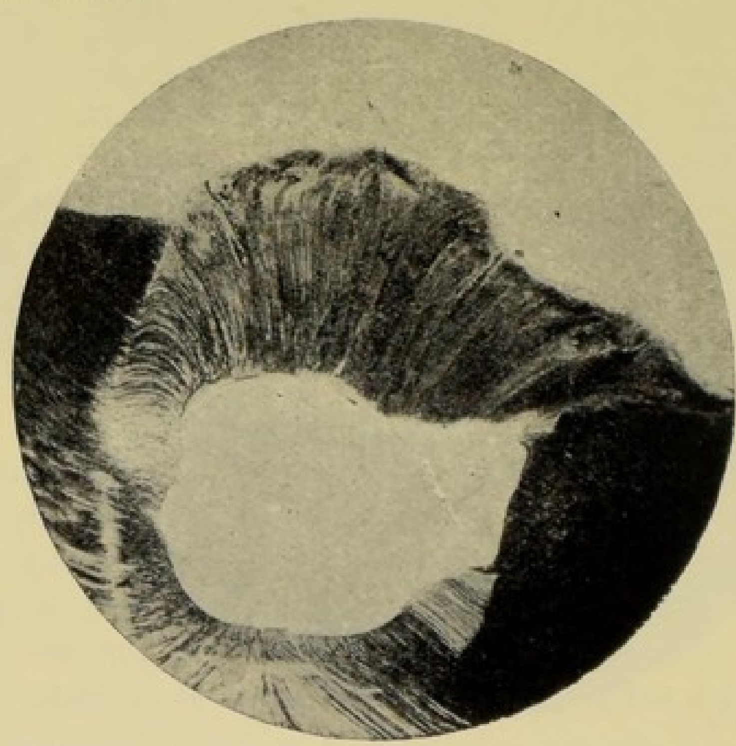


FIG. 596.[1]—Another view of the secondary (adventitious) dentine.

[1] From *Trans. Odonto. Soc.*

Tomes.[1] Sections of this tooth showed that the widely exposed pulp had been covered in by a layer of secondary dentine, and that, in places, fragments of the original dentine had become embedded in the new tissue (see figs. 595 to 597).

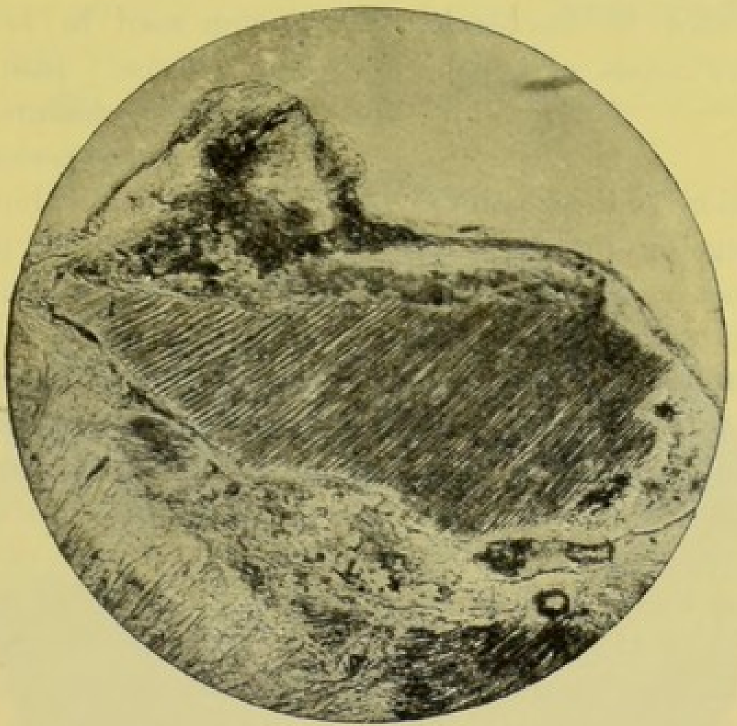


FIG. 597.[2]—A portion of the displaced original dentine embedded in the secondary (adventitious) dentine.

Symptoms.—The symptoms of acute pulpitis are pathognomonic—sharp shooting pain, often of a throbbing character, which is generally more severe at night when the patient assumes the horizontal position. Thermal changes also lead to severe paroxysms of pain, although in the early stages of acute inflammation cold produces relief by constricting the blood-vessels. Acute pulpitis must be distinguished from acute periodontitis, and the main points of difference are briefly as follows:—

ACUTE PULPITIS.	ACUTE PERIODONTITIS.
Pain sharp, throbbing, or lancinating — intermittent and reflected.	Pain dull, heavy, and constant.

[1] *Trans. Odonto. Soc.*, vol. xxviii, p. 183.
[2] From *Trans. Odonto. Soc.*

Thermal changes to the teeth cause pain.	Thermal changes do not cause pain.
Pressure or tapping on the tooth causes no pain.	Pressure or tapping on the tooth causes pain.
Slight pressure on a piece of cotton-wool in the cavity generally causes acute pain.	Slight pressure on a piece of cotton-wool in cavity does not cause pain, except through pressure transmitted to the periosteum.

Attention to these points will assist in diagnosis, but it must not be forgotten that with acute inflammation of the pulp there is at times a slight inflammation of the periosteum through continuity of the tissues.

Treatment.—When the inflammation is due to trauma or the action of physical and chemical agents, there is reasonable probability that resolution will occur. Therapeutic measures must be directed towards the avoidance of fresh injury to the tooth, and the application of counter-irritation, in the form of a drug—*e.g.*, strong tincture of iodine—to the gum covering the root of the tooth. If the dentine has been exposed by the trauma, the exposed surface should be treated with a strong solution of nitrate of silver. Should the pulpitis be the result of drugs used for treating sensitive dentine, the use of the drugs must be discontinued, and the cavity syringed and filled with a non-conducting and non-irritant filling, such as oxysulphate of zinc. If, however, the clinical features suggest that resolution is not likely to occur, the pulp must be immediately removed. With pulps injured by laceration during cavity preparation or by bacterial toxins, experience teaches that extirpation is the best treatment.

(2) Chronic Pulpitis

Chronic pulpitis follows on injuries similar to those leading to acute pulpitis. The reaction of the tissues in chronic pulpitis is different to that seen in the acute form, due to the fact that in chronic pulpitis the injury is constant, though of lesser intensity.

Morbid Anatomy and Pathology.—The character of the reaction of the pulp tissue, as a result of injury long continued,

varies considerably. We will in the first place deal with the condition where the pulp cavity is exposed, and the pulp tissue injured by constant doses of bacterial toxins. In these cases suppuration usually occurs, and the pulp tissue is destroyed by a progressive ulceration. In other cases the effect of the irritant is to cause an overgrowth of tissue (**hyperplasia**), giving rise to a flesh-like mass in the carious cavity. A section through the growth will show that it is mainly composed of granulation

× 40.

FIG. 598.—Hyperplasia of the pulp—productive pulpitis. Longitudinal section. (A) granulation tissue; (B) epithelial surface; (D) columns of epithelial cells extending deeply into the growth.

tissue, which has a tendency to develop into fibrous tissue. The surface is often covered with a layer, or several layers, of squamous epithelium (fig. 598). The presence of the epithelium has been attributed to "skin-grafting," but an explanation which seems more likely to be correct is that given by Mr. Hopewell-Smith[1]—namely, that the epithelial cells of the gum in the neighbourhood of an approximal carious cavity, irritated by a

[1] *Brit. Dent. Journ.*, September, 1909.

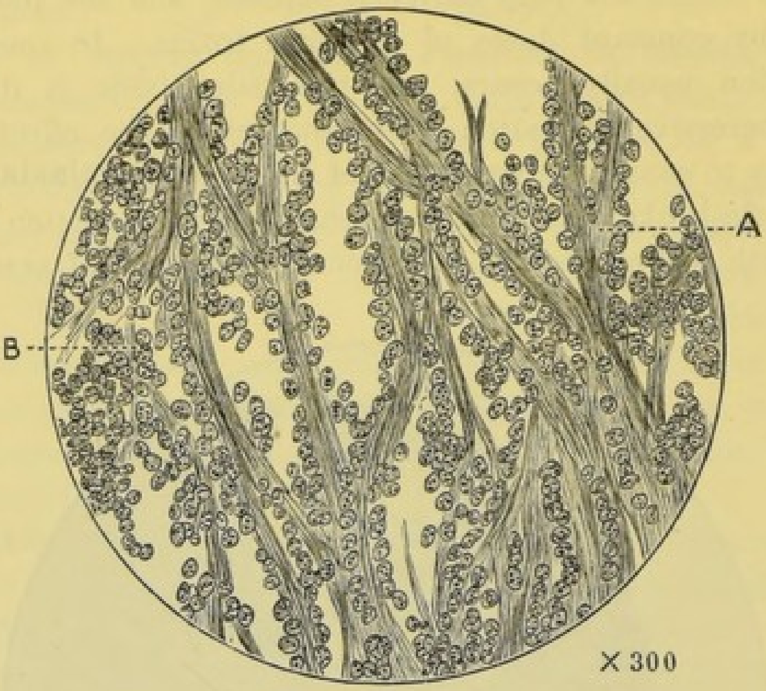


FIG. 599.—Hyperplasia of the pulp—productive pulpitis. Longitudinal section, highly magnified. (A) fibrous stroma; (B) large granular cells (no capillaries visible).

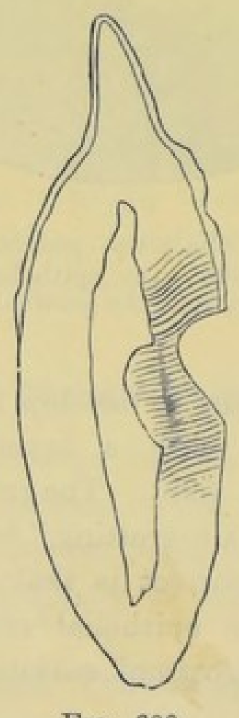


FIG. 600.

sharp edge of dentine, proliferate and extend by direct continuous growth on to the surface of the exposed pulp.

In cases where from any reason such as caries, abrasion, &c., the dentine is exposed, and the dentinal fibrils are injured, a definite reaction takes place in the pulp in the neighbourhood of the pulp end of the dentinal fibrils which have been injured (fig. 600). It is interesting to note that the fibrils affected appear to be more calcified, as is shown by the difficulty experienced in staining them compared to the staining of other portions of the tooth pointing to the probability that a definite reaction to the injury takes place in the fibrils.

The new tissue formed has been termed by Mr. Hopewell-Smith "**adventitious dentine**" (secondary dentine).

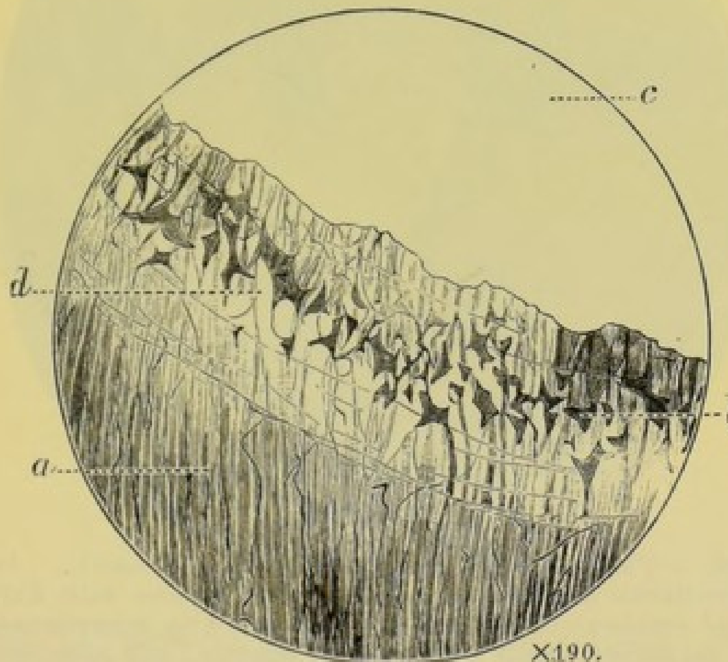


FIG. 601.—Areolar adventitious dentine. (*a*) carious dentine; (*b*) interglobular spaces; (*c*) pulp cavity; (*d*) newly formed and irregular tubed dentine.

The structure of adventitious dentine varies considerably under different circumstances, and the variation is probably dependent to a great extent upon the nature of the irritant, this, in its turn, affecting the rapidity of formation. Thus, **five varieties** have been observed and described.[1] These are known

[1] See *Trans. Third International Dental Congress*, Paris, 1900.

as **areolar, cellular, fibrillar, hyaline, and laminar** adventitious dentines. The first named is the commonest variety, and the least frequently found is the hyaline.

The **areolar** variety (fig. 601), which in its general characteristics resembles a dentine filled with interglobular spaces, would seem to occur when the new tissue has been formed quickly as the result of rapid caries.

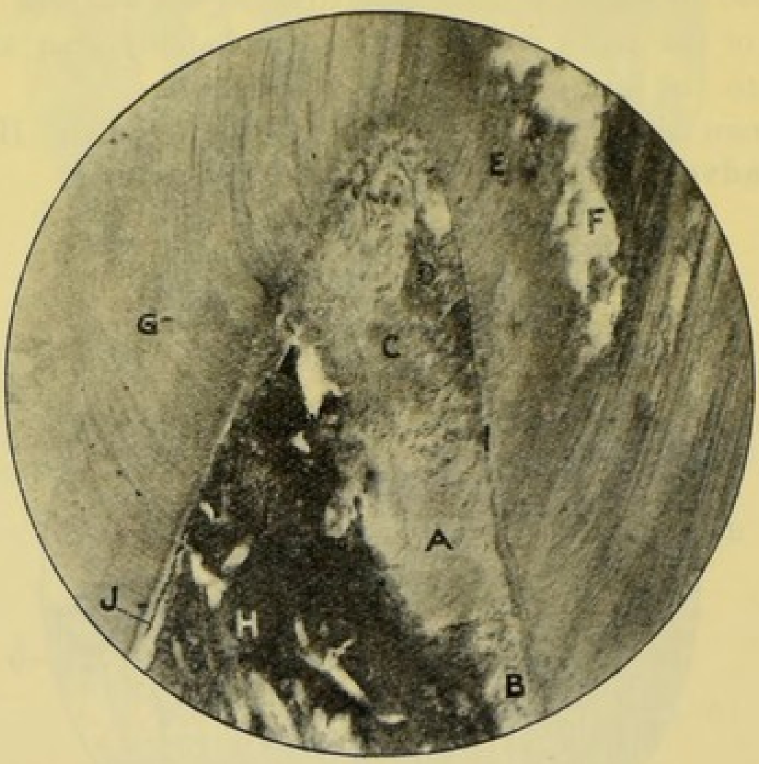


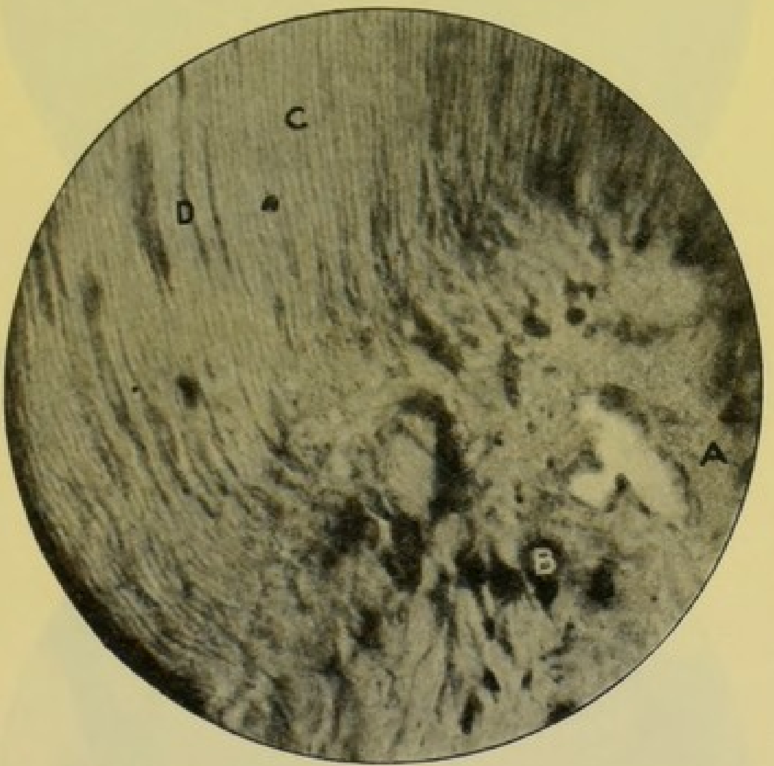
FIG. 602. — Photomicrograph by Mr. Hopewell-Smith. Areolar and fibrillar adventitious dentine. (A) adventitious dentine with fibrillar structure at B, and areola at C, which at D is infected with micro-organisms from caries at E; (F) carious cavity; (G) primary dentine; (H) pulp tissue showing signs of reaction; (I) junction of primary and adventitious dentine; (J) layer of odontoblasts.

In fig. 602 the carious process has attacked the new dentine, and shows that the newly formed tissue is quickly infected.

The **cellular** type differs from the areolar variety in containing in the matrix, cells which may be fusiform or round (fig. 604).

The **hyaline** variety is a clear, homogeneous, structureless deposit of dentine (fig. 605); and the **laminar**, as the name suggests, is tissue with a laminated form (fig. 606).

In the **fibrillar** form the tissue may approximate to normal fine-tubed dentine, a slight abrupt bend of the tubes being all there is to mark the junction of the two tissues. (See fig. 607.) In many specimens, however, the tubes are not quite so regular and plentiful as in normal dentine, but the boundary line between the normal and the new dentine is generally well marked. A few fibres are generally seen continued from the ordinary dentine, and these, instead of traversing through the whole thickness of the new deposit, end in fine-pointed extremities. The fibrillar

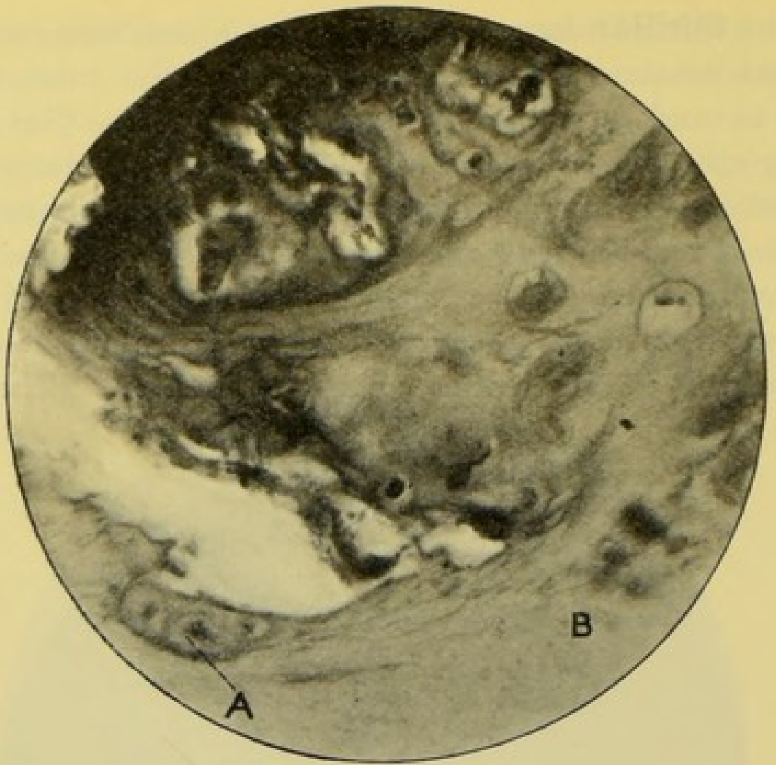


× 300

FIG. 603. — Photomicrograph by Mr. Hopewell-Smith. Adventitious dentine infected by micro-organisms from the primary dentine. (A) adventitious dentine; (B) masses of micro-organisms; (C) primary dentine; (D) carious dentine.

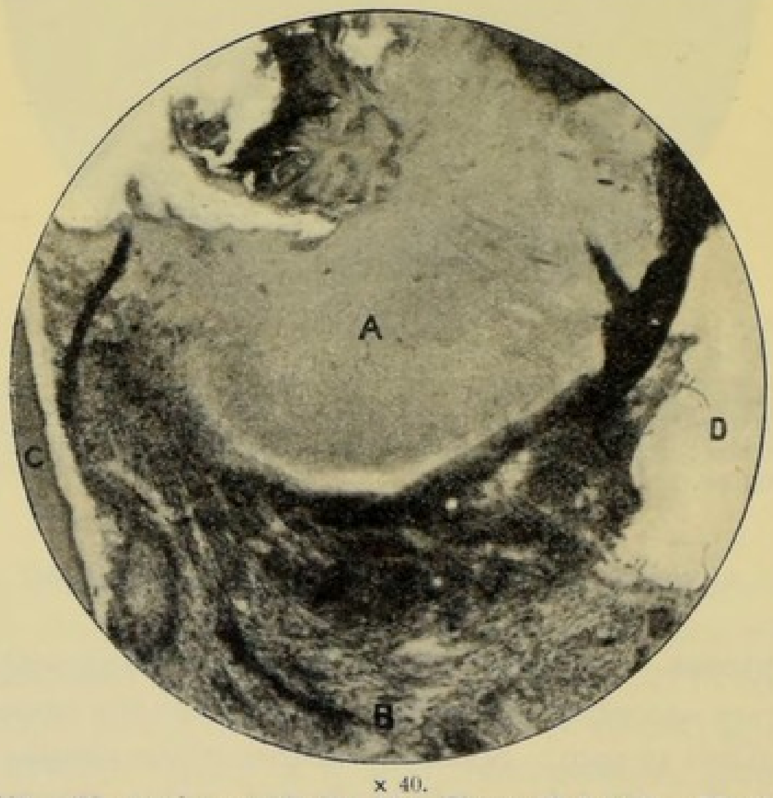
variety of adventitious dentine follows prolonged injury of a low intensity.

Symptoms.—The symptoms arising in connection with chronic pulpitis vary according to the type of injury and the susceptibility of the patient to pain. Some individuals whose mouths contain several teeth with chronically inflamed pulps experience no objective symptoms, while others suffer severe pain, both local



× 250.

Fig. 604.—Photomicrograph by Mr. Hopewell-Smith. Cellular adventitious dentine. (A) encapsuled cells with nuclei; (B) structureless matrix.



× 40.

Fig. 605.—Photomicrograph by Mr. Hopewell-Smith. Hyaline adventitious dentine. (A) ground-glass-like dentine; (B) pulp tissue showing reaction; (C) primary dentine; (D) abscess cavity.

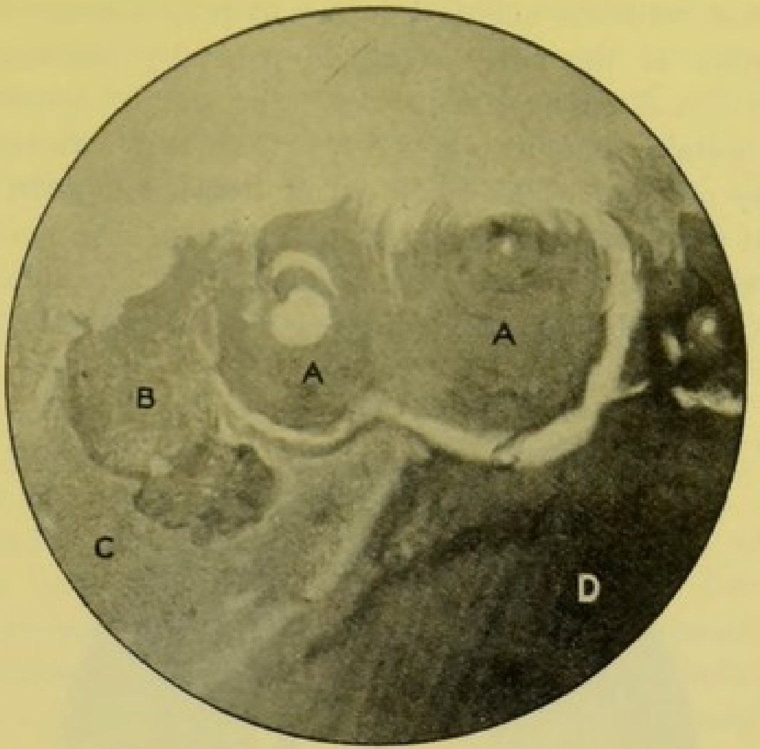


FIG. 606.—Photomicrograph by Mr. Hopewell-Smith. Laminar adventitious dentine. (A) laminar dentine; (B) cellular dentine; (C) pulp tissue showing signs of reaction; (D) primary dentine.

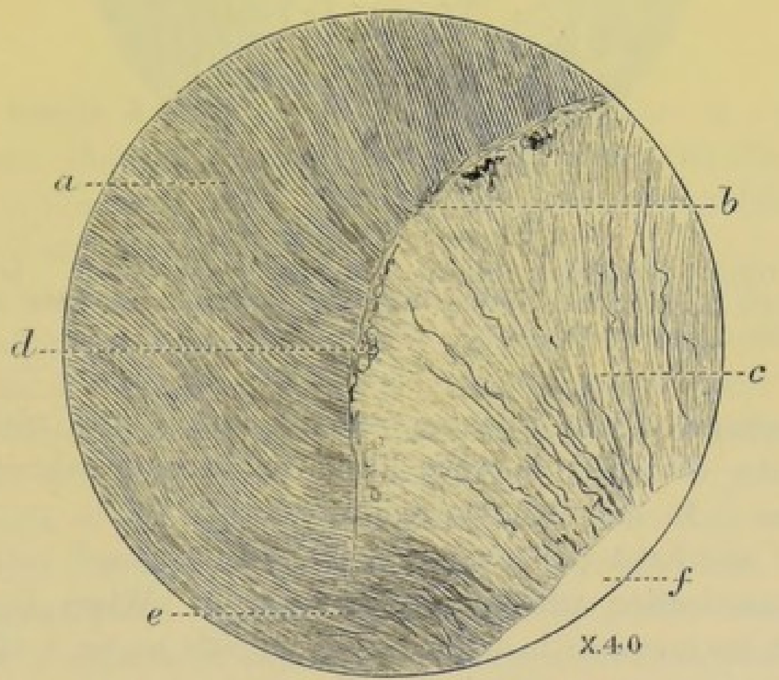


FIG. 607.—(Longitudinal section.) (*a*) normal dentine; (*b*) limit of original pulp chamber and line of demarcation; (*c*) adventitious dentine; (*d*) group of interglobular spaces; (*e*) tubules intermingling freely; (*f*) pulp chamber.

and referred, with the slightest injury to pulp tissue. Suppurative pulpitis in the early stages is generally accompanied by pain to thermal changes. In the later stages, however, cold gives a certain amount of relief, while heat causes intense paroxysms of pain. This symptom of **increased pain to heat is almost diagnostic of a suppurating pulp.** As the suppuration approaches the apex the inflammation spreads to the periodontal membrane, and symptoms of inflammation of that

FIG. 608.—Adventitious dentine containing few tubes. (*a*) normal dentine; (*b*) adventitious dentine tubes are few and very fine; (*c*) line of demarcation; (*d*) pulp chamber.

tissue appear. Pain is more marked during the night than during the day, and is very likely to become wandering in character. It may be referred to another tooth, or to other parts of the head (see chapter xxiv). In exposed cavities the act of mastication will usually cause pain. When the pus is confined, for instance in suppurative pulpitis under a filling, the pain may be intense. It is usually constant in character, with acute exacerbation on the application of heat to the tooth. Opening the pulp chamber in these cases gives almost instant relief.

In cases where there is overgrowth of the pulp, symptoms may be altogether absent, the surface of the pulp being insensitive to touch. When the overgrowth of the pulp has encroached on the carious cavity and is fibrous in character, it must be diagnosed from localized hypertrophies of the muco-periosteum.

The points of difference are: In the former, absence of pain to pressure, and no great liability to hæmorrhage; in the latter, extreme sensitiveness to pressure and liability to hæmorrhage on slight injury. A careful examination will show that the growth in the one springs from the pulp chamber, and in the other from the gum around the neck of the tooth.

When the inflammatory process follows an injury other than bacterial toxins, the only symptom may be slight discomfort to thermal changes, and even this symptom may be absent.

Treatment.—When the chronic pulpitis arises from infection *via* the tooth cavity or periodontal membrane, the pulp must be removed. In cases where suppuration is present, the surface of the pulp should be rendered as aseptic as possible before removal is attempted.

(B) REGRESSIVE CHANGES

(1) **Senile Atrophy.**—In senile atrophy there is a tendency to fibrotic changes throughout the body, and a similar process occurs in the tooth pulp. These changes have been ably described by Wedl[1] and Hopewell-Smith.[2]

The latter has shown that complete fibrosis of the pulp—in which all the elemental tissue has degenerated or been changed, the cells, the vessels, the nerve fibres, &c.—may occur in teeth of the deciduous series.[3] To the naked eye the pulps appear flattened and shrivelled and are often brittle in consistency. The colour is grey-yellow or reddish-brown according to whether it contains a smaller or larger amount of necrotic blood.

Microscopical Appearances. — Under low magnifying powers a superficial reticular network is seen, at the edges of

[1] "The Pathology of the Teeth," p. 237.
[2] *Journ. Brit. Dent. Assoc.*, March, 1892.
[3] *Dental Cosmos*, December, 1909.

which the odontoblasts appear shrunken, while, if the atrophy is far advanced, they will have disappeared. The blood-vessels appear larger than usual and have thin walls, so that it is impossible to distinguish between arteries and veins. The nuclei

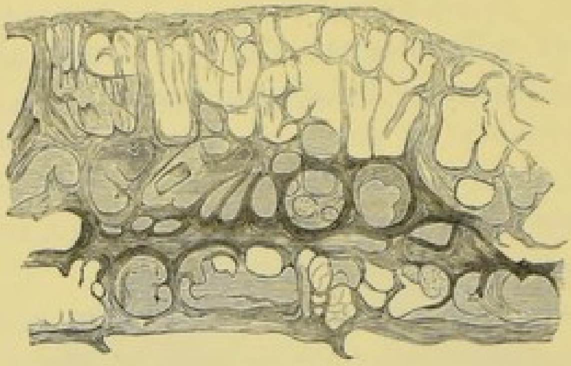


FIG. 609 (Wedl).

FIG. 610 (Wedl).

in the sheath have also disappeared. The vessels are seen to take an irregular course and to intertwine freely, marked constrictions due to the contraction of the connective tissue trabeculæ being present in places. **Under higher powers** (300 diameters) the network becomes more plainly visible, the bundles of tissue

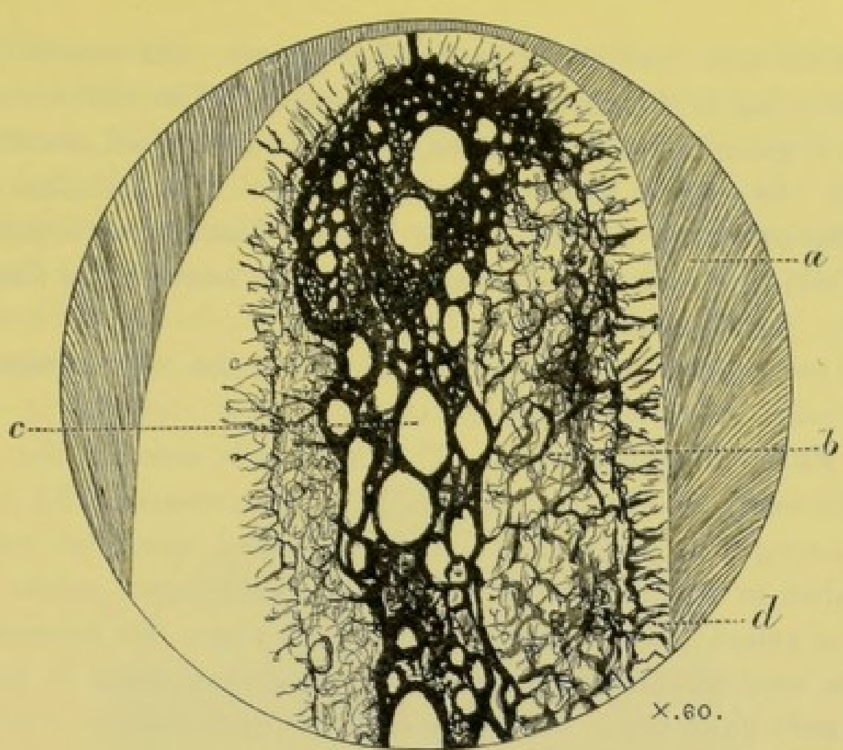
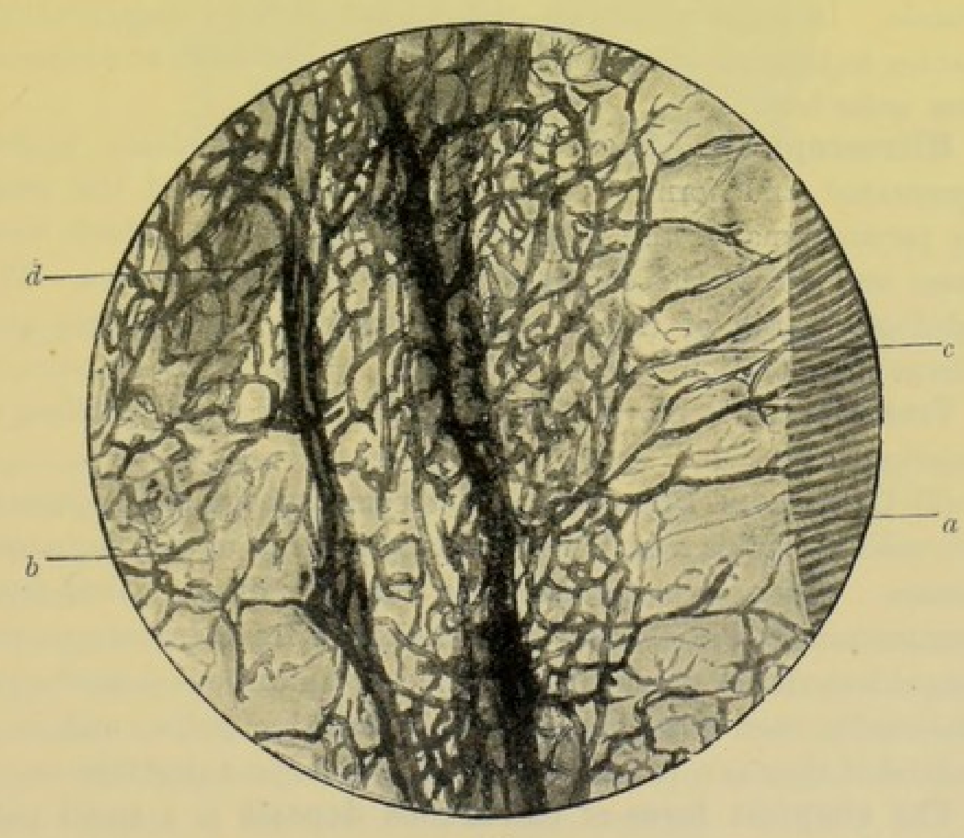


FIG. 611.—(Transverse section.) (a) dentine; (b) reticular pulp tissue; (c) areolæ; (d) degenerate odontoblasts.



× 220.

FIG. 612.—(Longitudinal section.) (a) dentine; (b) reticular pulp tissue; (c) degenerate odontoblasts; (d) fibrous cylinder.

interlacing and forming alveolar-like spaces, the central ones corresponding to the shrunken blood-vessels. The nerve sheaths are fatty, granular, and, in places, covered with small concretions of lime. In various places staining is seen. The staining arises from the colouring matter of the blood. Calcareous deposits of round, elliptical, cylindrical shapes are also seen in the tissue of the pulp (figs. 609 and 610).

In the sections shown (figs. 611 and 612) the cellular elements of the pulp are totally absent.

(2) **Fatty Degeneration.**—This is usually seen in the pulps of senile teeth, and in teeth which have been treated with a view to retaining the pulp alive. To the naked eye, the pulp is diminished in volume and is of a pale reddish-grey colour with traces of yellow. Occasionally it is of a cheesy-like consistency, while in very advanced conditions a soft greasy mass is present in the pulp chamber. According to Wedl, this mass is composed merely of a dirty brownish-yellow detritus, with traces of a fibrous structure, together with clusters of stellate fatty-acid crystals. In pulps which are the subject of fatty degeneration, reaction to thermal stimuli is much diminished and, in advanced cases, quite lost.

Microscopical Appearances.— The odontoblasts appear degenerated and form a layer upon the surface of the pulp. The parenchyma of the pulp contains fat globules which form chains and follow the course of the vessels and nerves. The medullary sheath of the nerves and walls of the vessels also undergo degeneration.

Treatment.—Removal of the pulp and, subsequently, filling of the pulp canals.

(3) **Calcareous Deposits.**—Calcareous deposits are frequently met with in pulps which have been the seat of inflammatory reaction. These deposits must be carefully distinguished from adventitious dentine, that is, the addition of fresh dentine to the original boundaries of the pulp chamber. Calcareous deposits are occasionally met with in apparently healthy pulps, and it is doubtful if they are, in such cases, of pathological significance.

The simplest form of calcareous deposit is a small pulp nodule. On examination of the tooth after its extraction, these nodules are just visible to the naked eye, and, under a low

magnifying power, are seen to be concentrically laminated; in some, not fully calcified, the central portion presents an irregular appearance. Pulp nodules are formed near the periphery of the pulp, and, though developed in its tissue, eventually become included in any secondary dentine that may be formed, the dentinal tubes bending round the nodule. Fig. 613 represents two small pulp nodules from the tooth of a child, aged 14, which was removed for irregularity. In fig. 614 the pulp nodule is seen to be projecting from the wall of the canal, having become

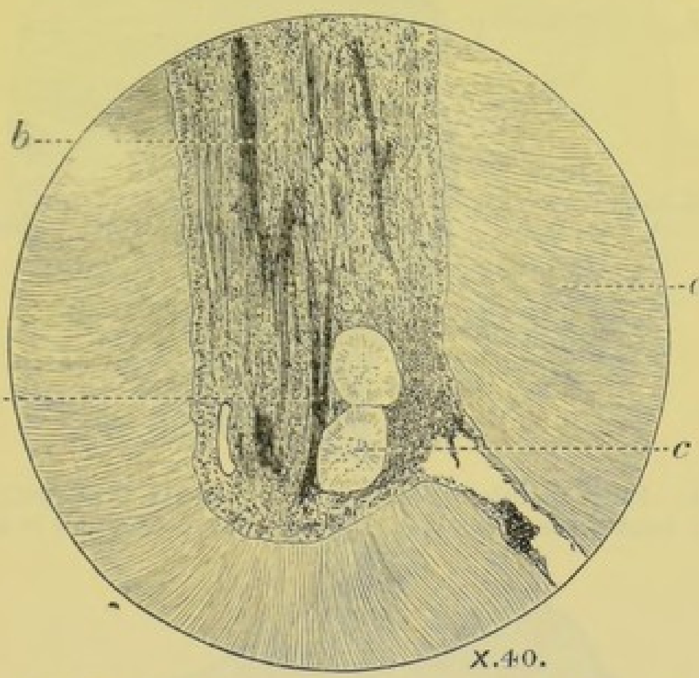


FIG. 613.—Pulp nodules (longitudinal section). (*a*) dentine; (*b*) normal pulp tissue; (*c*) pulp nodules; (*d*) nerve bundles.

enclosed by the new formation of dentine. In the coronal pulp of the molars, the nodules reach a much larger size, and, viewed under a very low magnifying power, are seen to be lobulated in outline; on section many are apparently composed of a number of small nodules joined together by a structureless material (fig. 615). These pulp nodules occur amongst the tissues of the pulp, and must be differentiated from calcification of the tissues of the pulp. Dr. Black considers that the deposits of calcoglobulin bear some relation to the formation of pulp nodules.

A curious form of **calcareous deposit** is frequently seen **in the roots of molars.** To the naked eye, the pulp is stiff,

retaining its shape when removed from the canals and resuming its shape after being bent. To the touch the pulp feels gritty; under the microscope it is found to be fibrous in character, the cellular elements having to a great extent disappeared, while

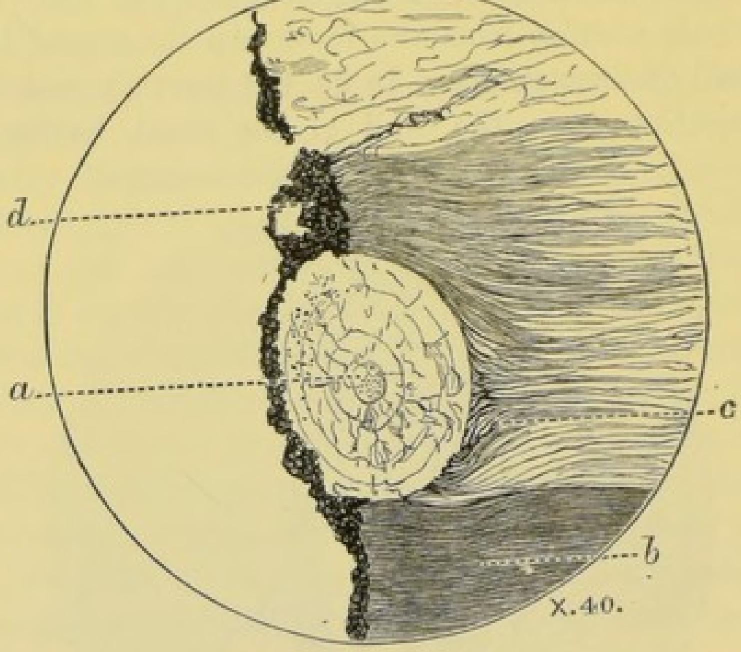


FIG. 614.—Pulp nodule fixed to wall of cavity. (*a*) pulp nodule; (*b*) dentine; (*c*) bent tubes of dentine; (*d*) soft tissue adherent to specimen.

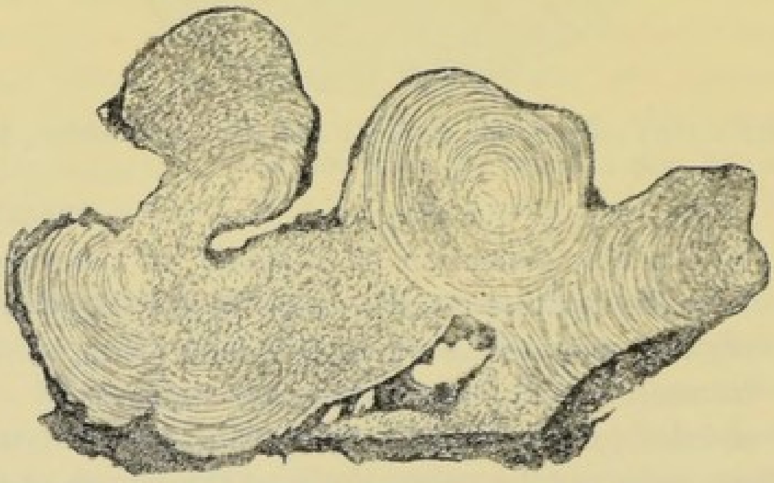


FIG. 615.—Semi-diagrammatic.

lying parallel with the fibres and attached to them are little cylinders of calcareous material (fig. 616). In advanced stages the cylinders coalesce, being jointed in an irregular manner.

Under such conditions there is an obliteration of the cells, nuclei and connective tissue of the pulp.

The whole tissue of the pulp may undergo calcification (fig. 617). To the naked eye the deposit differs from the pulp nodule in being non-nodulated. It is, as a rule, regular in outline and presents a smooth surface. Microscopically, the appearances vary. In some the calcified tissue element of the pulp is

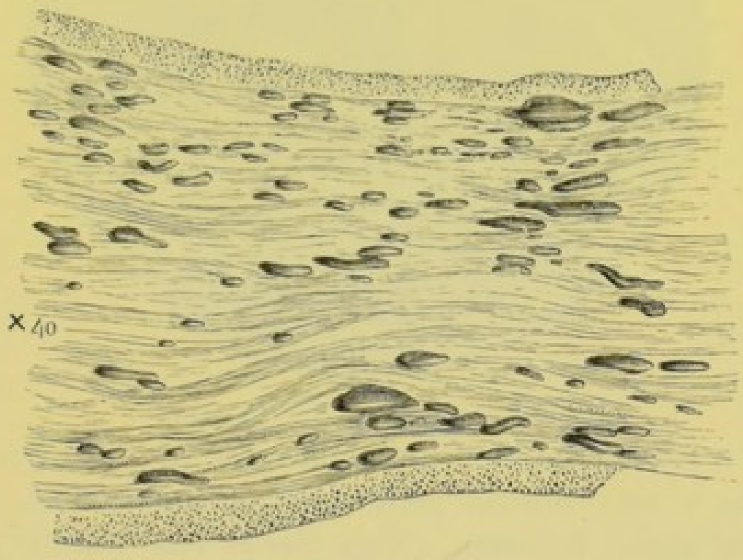


FIG. 616.

FIG. 617.—(*a*) calcified pulp.

apparent, others appear granular on section with a few irregular tubes scattered here and there, while others exhibit virtually no structure at all.

(C) EXCEPTIONAL PATHOLOGICAL CONDITIONS

There are a few exceptional pathological conditions of the pulp which have from time to time been described, but the nature of which is by no means clear. Under the title of "Pink Spots on Teeth," Mr. J. A. Fothergill [1] records a case in a female,

[1] *Trans. Odonto. Soc.*, vol. xxxii, p. 213.

aged 19, "where the maxillary central incisor presented on the labial surface a pink spot, commencing near the upper termination of the mesial border and extending about one-third across the tooth" (fig. 618). The enamel over this portion of the tooth appeared to be very thin, and the pink colour to be due to some vascular body showing through.

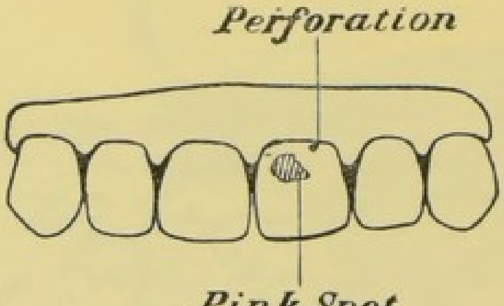


FIG. 618.[1]

To the left of the pink spot, and quite near the gum margin, there was a very minute perforation of the enamel, in which soft tissue could be seen. This tissue was slightly sensitive. The edges of the perforation were quite thin and fragile, and gave the impression that absorption had taken place. There was not the slightest sign of caries about the tooth, which was quite firm, and, with the exception of the above described peculiarities, perfectly healthy in appearance. The patient first noticed the discoloration about a month before being seen. There was no pain, but slight tenderness on biting hard substances and when brushing the teeth. There was no history of injury. Rather more than three weeks after the patient was first seen, the perforation was considerably larger, the pink spot had also increased in size, and there were two minute perforations of the enamel within its area. On removing the thin bridge of enamel from between the perforations, a mass of vascular tissue was disclosed which was directly connected with the tooth pulp.

Sections of the tissue showed a structureless mass of small cells, but in one part the section showed papillæ covered with epithelium (see figs. 619 and 620).

[1] From *Trans. Odonto. Soc.*

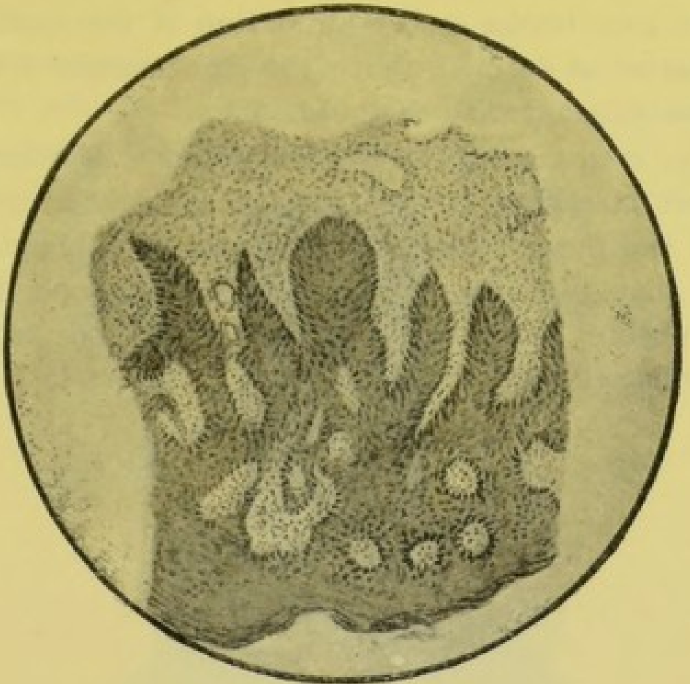


FIG. 619.[1]—Zeiss, ½ obj., 3 oc.

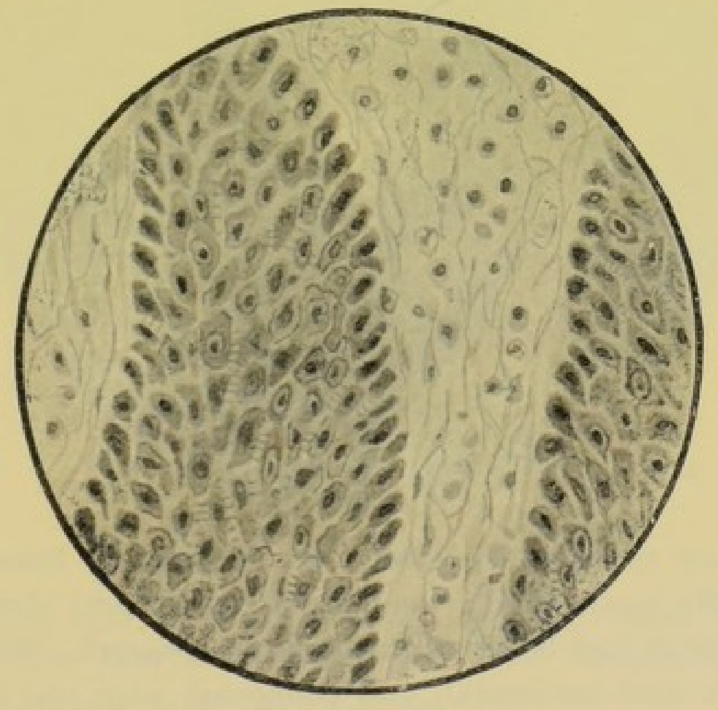


FIG. 620.[1]—Zeiss, ½ obj., 4 oc.

[1] From *Trans. Odonto. Soc.*

Subsequently, the right central showed signs of a slight rosy tinge at the gum border, and examination of the tooth disclosed, about a quarter of an inch above the gum margin, a tiny cavity, which communicated with the pulp.

A similar case came under my own notice. The tooth affected was the left maxillary central incisor, and there was a small opening in the mesio-labial aspect of the root about an eighth of an inch above the enamel margin. The fleshy point projecting from the opening was exquisitely sensitive and proved to be directly connected with the pulp.

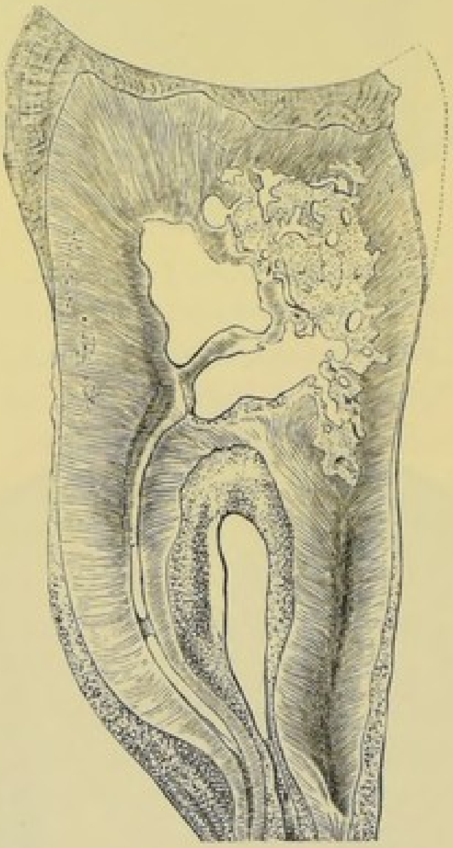


Fig. 621 (Salter).

The case recorded by Salter [1] would seem to belong to this group. The tooth was a mandibular molar and showed three small openings just below the edge of the enamel. These canals were short and horizontal, and connected with the interior of the tooth. Sections through the tooth showed that a con-

[1] "Dental Pathology and Surgery," p. 79.

siderable portion of the dentine had been absorbed and replaced by bone.

A case is recorded by Dr. P. Hirsch[1] of a mandibular first premolar in which a channel existed between the pulp and periodontal membrane (see fig. 622).

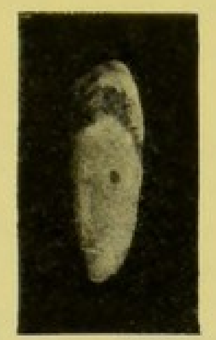


Fig. 622.[2]

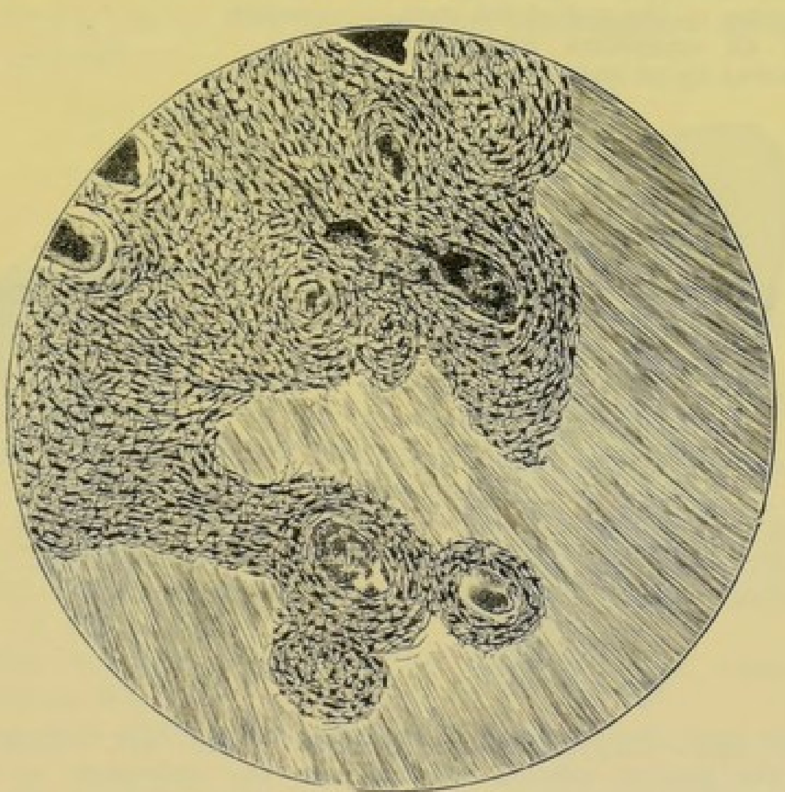


Fig. 623.

A similar case is recorded by Thiel, the tooth being the maxillary right first premolar. Lepkowski [3] has shown that in

[1] *Journ. Brit. Dent. Assoc.*, vol. xxiv, p. 60.

[2] From *Brit. Dent. Journ.*

[3] *Die Vierteilung der Gefässe in den Zähnen des Menschen* (Anatomische Hefte), H. liv.

rare instances there are, in the embryo, anastomoses between the pulp vessels and the vessels external to the tooth germ, and it seems likely that these anastomoses may occasionally persist

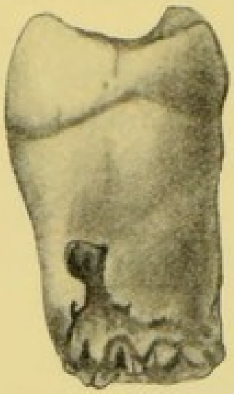


FIG. 624.[1]—View of the exterior of the tooth, showing the pitted character of the end of the root, with an excavation running a little way up on one side.

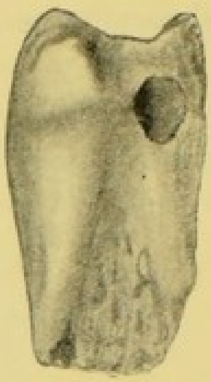


FIG. 625.[1]—View showing position of the carious cavity.

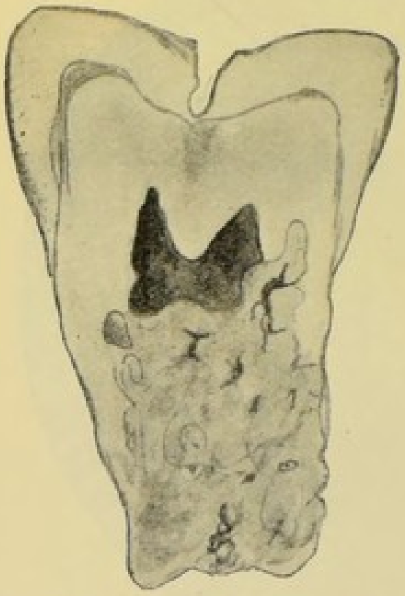


FIG. 626.[1]—Longitudinal section showing the general relation of the new tissue to the pulp cavity.

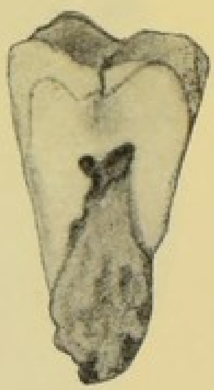


FIG. 627.[1]—View showing the extension of the new tissue upwards into the dentine by the sides of the pulp cavity.

and give rise to abnormalities similar to those described by Thiel and Hirsch.

Another interesting pathological condition is to be found in

[1] From *Trans. Odonto. Soc.*

cases of absorption of the dentine from within outwards, and the replacement by tissue of an osseous type. In one case recorded,[1] the dentine in a maxillary premolar had been replaced by bone, the greatest changes being towards the base of the tooth. This tooth was removed from a man, aged 33, and had only partially erupted, the root being only about two-thirds formed (fig. 623). In another specimen, a misplaced unerupted third molar had been the seat of suppuration. In this specimen there was extensive absorption of the dentine and redeposition of bone.

Mr. Hopewell-Smith[2] figures a maxillary central incisor, showing internal absorption of dentine and deposition of bone; and Mr. Tomes[3] records a similar condition in a maxillary premolar which had become loose. Views of the latter tooth are shown in figs. 624 and 625, and sections showing the extent of the absorption of the dentine and replacement by bone in figs. 626 and 627.

[1] *Trans. Odonto. Soc.*, vol. xxv, p. 66.
[2] "Histology and Pathology of the Teeth," p. 382.
[3] *Trans. Odonto. Soc.*, vol. xxxi, p. 172.

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TOMES, C. S. "Notes on Two Teeth which Presented Unusual Diseased Conditions," *Trans. Odonto. Soc.*, vol. xxxi, p. 172.

WATSON, G. W. "Degenerative Condition of the Dental Pulp," *Dental Record*, vol. xxvii, p. 1.

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"A Case of Absorption of Dentine," *ibid.*, vol xxiii, p. 193.

CHAPTER XVI

Operations connected with the Pulp and Pulp Canals

The Operation of "Capping"—Devitalization of the Pulp—Mummification of the Pulp—Immediate Removal of the Pulp—The Treatment of Septic Pulp Canals—Methods of Bleaching Teeth

(A) WHEN THE PULP IS NOT EXPOSED

In deep cavities where it is intended to insert a metallic filling, the floor should be covered with a layer of non-conducting material such as oxysulphate of zinc. The same procedure should always be adopted in any cavity where the dentine appears to be unduly sensitive.

(B) WHEN THE PULP IS EXPOSED AND LIVING

(1) The Operation of "Capping"

In performing this operation attention must be paid to the following points: (*a*) To render the parts thoroughly aseptic; (*b*) to use a cap of non-irritant material; (*c*) to insure juxtaposition between the cap and its contents and the pulp; (*d*) to avoid pressure upon the pulp; (*e*) to prevent the conduction of thermal changes to the pulp.

The best mode of procedure in capping is as follows: Stop all bleeding from the pulp by syringing with hot water, swab out the cavity with a solution of a mild, unirritating antiseptic, and carefully dry the cavity. Mix a thin paste of the powder of the oxysulphate of zinc and oil of cloves, introduce it into the concave side of the cap, and place it in position over the exposed pulp, care being taken that the margin of the cap rests upon the dentine and not on any part of the exposed pulp. Hold the cap in

position with an instrument until it is fixed, then fill the cavity with gutta-percha or some plastic filling. The cap employed may be made of metal. Caps can be easily constructed by cutting out with scissors a circular piece of the material used and giving it a "cup-shape" by pressing upon it with the butt end of an excavator. At times it is very difficult to get the cap into position, especially with the conveying forceps. The difficulty may be overcome by punching a small hole in the cap so that the little flap formed by punching will be on the convex side of the cap, and if this flap is held with the conveying forceps, the cap may be easily conveyed to the cavity and kept in position. The flap will resume its place with the slight pressure used in filling the remainder of the cavity.

(2) Devitalization of the Pulp

(*a*) **Application of the Drug.**—For devitalizing the pulp, arsenious acid is used, either alone or in combination with other substances. About one-sixteenth of a grain will suffice. The objection to the use of arsenious acid is the pain caused during its action. The pain can be alleviated by employing sedatives with the arsenic and by avoiding pressure on the pulp. The following preparation will be found useful :—

℞ Acidi arseniosi
Cocainæ hydrochlor.
Acidi carbolici glacialis } āā partes æquales.
Misce, et fiat pasta.

The mode of application is as follows : The cavity is opened up and all *débris* syringed out with warm water. The carious dentine is next removed. It is not always possible to remove all the carious tissue owing to the pain caused, but the portion bordering the edge of the cavity and the part covering the pulp must be removed and a free exposure obtained. It is important that the pulp should be freely exposed, as the resulting hæmorrhage relieves congestion and prevents discoloration of the dentine. The cavity should next be syringed with warm water and measures taken to exclude moisture during the subsequent steps. The cavity should then be dried and the pulp and adjacent dentine disinfected. The dressing is next applied in close contact to the pulp, and over the dressing a concave cap of

metal is placed. The cap should be large enough to cover the dressing without pressure, and to allow the edges to rest on the dentine. The cavity is then sealed with gutta-percha or oxy-sulphate of zinc.

Some operators use a solution of gum mastic or gum sandarac in preference to the gutta-percha, on the supposition that, in their application, the cap and dressing are less likely to be shifted. A great drawback, however, to the use of these gum resins is that they are liable to get under the cap and prevent the action of the arsenious acid. In applying arsenious acid on the approximal

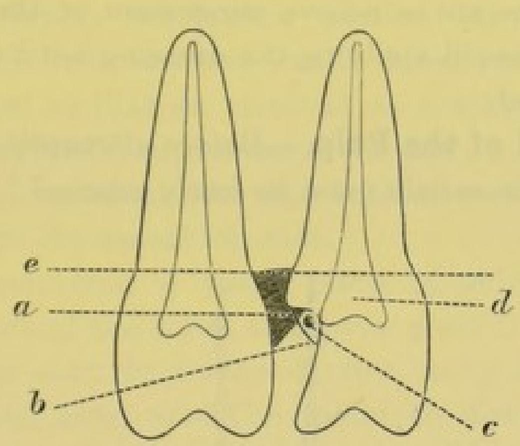


FIG. 628.—(*a*) gutta-percha; (*b*) metal cap covering dressing; (*c*) dressing of arsenious acid; (*d*) pulp chamber; (*e*) line indicating margin of gum.

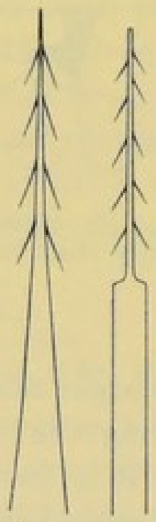
surfaces with the cervical margin near the gum there is a risk of the dressing shifting during the introduction of the filling material. In such positions it is best to place a rim of gutta-percha along the cervical margin beforehand. A small pit will thus be formed and the arsenious acid can then be applied without any risk of the dressing shifting. Fig. 628 explains this point diagrammatically. In cavities in isolated teeth where there is a danger of the dressing not being retained, an elastic band or silk ligature passed round the tooth will be found useful.

Arsenious acid, even with the precautions suggested, may cause great pain during its action. When necessary, counter-irritation to the gum in the form of poultices should be tried. In applying the poultice, contact with the tooth must be avoided. If the poultice is not effective a sedative should be administered.

The time during which an arsenical dressing should be retained varies according to the condition of the pulp. In acute inflammation twenty-four hours is usually sufficient, with chronic suppurating pulpitis three to four days, while the dressing may remain for at least a week, when a fibroid or calcareous condition of the pulp is present. When used for deciduous molars the arsenical dressing should be applied in the morning and removed in the afternoon. If allowed to remain for twenty-four hours there is always a liability of periodontal complications.

Discoloration of the dentine may follow the application of arsenical dressings, and is not always preventable. The precautions to be taken are to relieve congestion of the pulp as far as possible, and to avoid applying the dressing until the bleeding has completely ceased.

(*b*) **Removal of the Pulp.**—Before attempting the removal of the pulp, the pulp canals must be freely exposed,[1] and the prepara-



(Diagrammatic.)
FIG. 629. FIG. 630.

tion of the cavity finished; all *débris* should then be removed and precautions taken to exclude the saliva. The pulp chamber is then disinfected, and during the subsequent operation the canals and other parts must be kept free from infection. The extracting instruments should be made of fine spring tempered

[1] For the methods of opening up the pulp canals in the various teeth, see p. 433.

steel of the shape shown in fig. 629. The shoulder shown in fig. 630 is a source of weakness. The instrument should be insinuated up the side of the canal until the apex is reached, then rotated four or five times before retraction is attempted. It is important that the pulp tissue should be completely removed from the canals.

Fracture of the pulp extractor may occur in the canal. If the broken portion is near the orifice it can usually be easily removed. If the fracture has occurred well up the canal, an attempt may be made to entangle it with another barbed extractor, or, failing this, a wisp of cotton-wool on a fine broach may be used. Where the broken portion cannot be removed, a dressing of tinct. iodi. inserted in the canal will have the effect of rusting the steel so that its removal at a subsequent visit can be easily accomplished. Instruments broken in very fine canals should be allowed to remain, as they seldom cause trouble unless they pass through the apical foramen.

It may happen that a small piece of pulp tissue remains alive near the apex of the canal and gives great trouble. In such a case the tissue may be removed after being destroyed by an escharotic. Great care must be taken to distinguish a small piece of pulp from a large apical foramen. If any doubt exists, it is better to treat the case as one of a large foramen, as the escharotic treatment is liable to injure the periodontal membrane.

(*c*) **The Treatment and Preparation of the Root Canals Preparatory to Filling.**—Any hæmorrhage which may have followed the removal of the pulp must be arrested, and the canals dried as far as possible with cotton-wool. A solution of peroxide of hydrogen should then be passed into the canals, and the surfaces of the dentine scraped with a barbed instrument with a view of removing any shreds of pulp tissue that may remain. The peroxide is then removed and an antiseptic solution introduced—for example, perchloride of mercury 2 per cent. in absolute alcohol. This will assist dehydration. The canals can then be dried with a blast of hot air. By these means the greater part of the canal can be dried, and the portion near the apex may be treated with a root canal drier. The canal having been thoroughly dried, the root filling is introduced.

Considerable discussion has taken place during the last few

years as to the **advisability of employing coagulants in the treatment of root canals.** Certain authors think that the coagulants are self-limiting in their action, and do not penetrate the dentinal canals to any great depth. They are of opinion that a coagulum is formed only at the orifice, and that the coagulum effectually prevents deeper action and complete sterilization of the dentine. Against this statement it may be maintained that there is no proof that the contents of the tubes in the pulpless teeth are coagulable, but even if they are, the experiments of Dr. Kirk,[1] Dr. York[2] and Dr. Truman[3] furnish conclusive evidence that coagulants do penetrate the dentinal tubes. Dr. Kirk expresses a strong belief in the use of chloride of zinc, which he considers the best agent to procure an unchangeable condition of the contents of the tubules. If the apical foramen is large, a 10 per cent. solution should be employed; if fine, the strength of the solution may be 40 per cent.

The use of drills for enlarging the canals is seldom required in cases where the pulp has been devitalized or immediately removed. The canals in nearly all teeth are large enough to admit of easy filling, and, with drills, there is always the danger of forcing foreign matter through the apex in addition to the chances of breaking the drill in the canal. Drills are useful where calcification of the pulp has occurred.

(*d*) **Filling the Canals.**—For filling root canals, a large number of different materials are available, the chief being gutta-percha, osteoplastics, wood, wire, celluloid, gold, tin, and lead.

In filling a root canal the chief point is to plug the apex thoroughly. Gutta-percha is the material favoured by many operators. It is sold ready for use by the various depôts. The method of employing it is as follows: With cotton-wool wound round a broach, introduce some chloro-percha up the root or root canals, using a slight piston-like action; then pass a gutta-percha point up the canal as far as the apex, and by the side of it introduce one or more points as may be required. The points

[1] "On Coagulation in the Treatment of the Pulp Chamber and Canals," *Dental Cosmos*, March, 1894, p. 181.

[2] "The Diffusibility of Coagulants in Dentine," *Dental Review*, 1897.

[3] "The Relative Penetrating Power of Coagulants," *Dental Cosmos*, January, 1895, p. 33.

should then be left in position for about half a minute, after which, with suitable instruments, they should be condensed and thoroughly packed into the canal. On introducing the first point a slight twinge of pain will occasionally be felt. This generally indicates that the gutta-percha has passed through the apex owing to the point being too small. To meet this difficulty, remove the gutta-percha and cut off the end and re-introduce. It is a little troublesome at times to hold the points of gutta-percha in the forceps in a suitable position, but if the points of the forceps are slightly warmed the gutta-percha adheres to them, and can be easily carried to any situation. The canals being filled, the remainder of the pulp chamber should be filled with osteoplastic cement, so that, if anything goes amiss with the filling in the cavity, the osteoplastics will protect the gutta-percha in the canals and prevent them becoming septic.

Gutta-percha for canal fillings answers satisfactorily in all but very small canals, and it is found quite easy to get it to the apex. An argument against its use is that it is liable to become septic, but if the canals are cleansed properly and filled there should be no danger in that direction.

The osteoplastics make excellent root canal fillings. They can be introduced into the canal as follows: Loosely wrap a wisp of cotton-wool round a broach and pass this into a moderately thin mix of the filling, then insert into the cavity. A minimum amount of wool should be used and the filling forced up the canal with a slight piston-like action. Of the osteoplastics, oxychloride possesses marked antiseptic properties and sets rapidly, but it is liable to irritate the periodontal membrane. Oxysulphate makes a good filling and the following mixture gives excellent results:—

$$\left.\begin{array}{l}\text{Oxide of zinc}\\\text{Sulphate of zinc}\\\text{Loretin}\end{array}\right\}\quad \bar{a}\bar{a}\ ʒij.$$

Mix into a paste of creamy consistency with solution of gum arabic.

Wood is useful in small canals and can be obtained from the depôts ready for use. The *modus operandi* is as follows: The length of the canal having been obtained, a peg is selected which fits loosely in the canal. The canals should then be swabbed with the mixture suggested above, and the peg then forced into position. A rotary motion is then given to the wood peg, and this causes the portion in the canal to break off. An

argument urged against wood is that it is liable to expand from absorption of moisture and split the tooth. To avoid this contingency, the points should be well soaked in paraffin during the process of manufacture. Wood as a filling for root canals has the great advantage of being easily passed to the apex of the canal, and is capable of being introduced into the finest canals.

Gold and copper wire and lead are used in much the same way as wood. With wire, there is greater certainty of filling the apex than with any other material, but its use requires caution, as it is possible to push the wire through the apex, and so injure the periodontal membrane.

Where the apical foramen is large, great care must be taken to prevent the filling passing through and acting as an irritant. In these cases **sponge grafting** may be used. The operation consists in pushing up to and through the apex a small piece of sterilized sponge. It is important that the sponge should pass through the apex and come in contact with the soft tissues, otherwise no graft is obtained. The canal is filled in the usual way. The whole operation must be carried out under strict aseptic precautions.

(*e*) **The Treatment of Difficult Canals.**—Two classes of canal come under this heading :—

(1) Very small canals in normal-shaped roots.

(2) Canals in twisted and curved roots.

Included in the first group are the canals in—

(i.) The maxillary premolars, especially the first where two canals exist instead of one.

(ii.) The buccal roots of the maxillary molars.

(iii.) The root of mandibular incisors.

(iv.) The anterior roots of the mandibular molars, especially the first.

If these canals can be cleared with a fine instrument, but are not large enough to permit of treatment with drugs, the following procedure may be adopted : Absolute alcohol containing 2 per cent. of perchloride of mercury is introduced as far up the canals as possible and the canals dried with a blast of hot air. No attempt to fill the roots should be made, but little pellets containing oil of cinnamon and perchloride of mercury should be placed over the orifices.

For the treatment of small canals Dr. Callahan (*Dental Cosmos*, 1895) recommends **the use of sulphuric acid** 50 per cent., and his method has been warmly advocated by many, including Dr. Bönnecken. A drop of the sulphuric acid is conveyed to the orifices of the canals and gradually worked in by the aid of fine Donaldson bristles. The acid dissolves the lime salts, forming calcium sulphate, and so enlarges the canal. Sodium peroxide is next introduced into the canal, a bristle very slightly moistened being passed into the powder and then into the root. The sodium peroxide in the case of putrescent canals forms soap, and destroys the fatty contents of the canal, and the rapid evolution of H_2O_2 ejects the contents into the pulp chamber.

$$H_2SO_4 + Na_2O_2 = Na_2SO_4 + H_2O_2$$

The latter is in a nascent condition, and effects prompt sterilization. The procedure of alternately using the sulphuric acid and sodium peroxide is repeated until the canal is quite clear. By this method it is possible to cleanse and fill canals which by the ordinary treatment are inaccessible. Pumping the acid through the apex must be avoided.

In twisted and tortuous canals the pulp is to be removed as far as possible, and one of the methods suggested for mummifying the pulp should be adopted.

(3) Mummification of the Pulp

This operation consists in first applying a devitalizing agent to the pulp, and, at a subsequent visit, removing the coronal portion and applying medicaments to the portions remaining in the root or roots and filling the cavity permanently (fig. 631). It is important that all the stages of the operation should be carried out under strict aseptic precautions.

The following preparation suggested by Söderberg[1] gives good results :—

$$\left.\begin{array}{l}\text{Aluminis exsiccati}\\ \text{Thymol}\\ \text{Glycerini}\end{array}\right\} \quad \text{āā ʒi.}$$

Zinc. oxid. q.s. to make a stiff paste.

In this paste the thymol acts as the antiseptic, the alum as

[1] *Dental Cosmos*, November, 1895, p. 922.

the mummifying agent, the zinc oxide as the conveying medium, and the glycerol as the binding and penetrating agent.

Miller suggested a mixture of perchloride of mercury ·0075 grm., thymol ·0075 grm., made in the form of little pellets. The perchloride of mercury at times causes pain, and also has the disadvantage of staining the tooth structure, but in the case of posterior teeth the staining is immaterial. With this combination the living portions of the pulp are rapidly killed by coagulation of the cell protoplasm and then impregnated with the sublimate and thymol and so sterilized. Dr. H. Bönnecken[1] has devoted attention to this question and gives an account of two cases in which he was able to make a microscopical examination. He found the pulps in a state of fatty degeneration, globules of colloid and calcareous

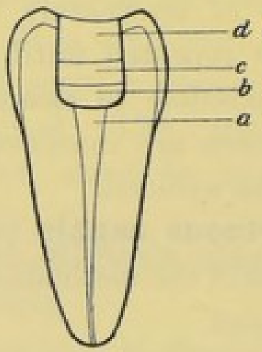


FIG. 631.—(*a*) devitalized pulp; (*b*) mummifying paste; (*c*) osteoplastic cement; (*d*) metal filling.

matter being present in the bundles of connective tissue, and the capillaries thrombosed. He suggests the following preparation, and carries out the treatment forty-eight hours after the application of the arsenical dressing:—

℞	Cocainæ } Thymol }	āā ʒi.
	Misce exactissime terendo et adde—	
	Formaldehydi soluti (40 per cent.) ...	♏xl.
	Zinci oxidi	ʒii.
	Misce, fiat pasta.	

When cocaine and thymol are rubbed together in the mortar they deliquesce, taking up moisture from the air. Therefore, after the addition of ten drops of formalin a relatively large amount of

[1] *Oesterreich. Ungarische Vierteljahrsschrift für Zahnheilkunde*, vol. xi., &c. Translated in *Dental Record*, vol. xviii, p. 158.

oxide of zinc must be added to give the mixture the consistence of a paste. Dr. Bönnecken finds that the preparation does not give rise to pain and that there is no discoloration. With a stronger percentage of formalin pain is liable to occur.

Pulp mummification is useful in (*a*) fine canals from which the pulp cannot be removed; (*b*) nervous and weak patients unable to undergo tedious root filling; (*c*) canals which are twisted and tortuous.

(4) Immediate Removal of the Pulp

Extirpation of the pulp with the aid of "**pressure anæsthesia**" is now generally adopted. This proceeding is carried out as follows: The cavity is freed of carious dentine as far as possible, and the surface of the pulp uncovered and swabbed with hydrogen peroxide. A small pellet composed of cocaine and adrenalin[1] is then placed on the pulp and covered with a piece of unvulcanized rubber, and lightly pressed. As soon as the immediate pain caused by the application has disappeared the pressure may be gradually increased. Pulps vary considerably in their responsiveness to cocaine. In some cases the application of cocaine for a few seconds is sufficient to produce anæsthesia of the whole pulp, while in other cases it may be necessary for the application to last five or even ten minutes. The amount of anæsthesia can be gauged by passing a broach up the canal. The preparation of the cavity should next be completed and the pulp then removed. The bleeding that usually follows must be arrested and the pulp canals filled at once. Clinical experience shows that trouble is less likely to follow if the canal is filled immediately after the removal of the pulp.

The periodontitis that occasionally follows immediate extirpation of the pulp is probably due to infection, the direct result of the pressure, and is likely to follow in cases where active suppuration is present. This complication may be avoided to a great extent by treating the pulp with an antiseptic dressing for twenty-four hours.

At this stage the **comparative value of the methods of treating the exposed living pulp** may be reviewed. The operation of capping is uncertain, and should be limited to the treatment of

[1] A convenient form is supplied by Messrs. Parke, Davis and Co. Each pellet contains $\frac{1}{8}$ gr. of cocaine hydrochlorate and $\frac{1}{300}$ gr. of adrenalin.

healthy pulps exposed during the preparation of cavities for filling. Extirpation of the pulp under pressure anæsthesia is by far the best method of removing pulps, and the success attending this operation increases with experience. Arsenious acid may with advantage be employed where, owing to nervousness on the part of the patient, it is impracticable to carry out the preliminary stages of pulp extirpation, such as removal of carious dentine, and where pulps contain large deposits of calcareous matter. "Mummification" is useful in cases where, owing to calcareous deposits in the canals, it is impossible to clear them of pulp tissue. It may be said with truth that each of these four methods has its use in its proper place.

(C) WHEN THE PULP IS DEAD

If the contents of the pulp cavity in which the pulp is dead be examined, they will be found to vary according to the pathological conditions that have caused the death of the pulp.

(i.) The gangrenous pulp may be entire, or may have undergone disintegration, leaving the contents moist and in a sloughing condition, which, in most instances, terminates in complete disorganization.

(ii.) The contents may be dry and granular.

(iii.) The pulp tissue may be transformed into a cheesy mass. This condition, which is probably due to a form of fatty degeneration, is often found in those pulps which have been "capped," or have died under fillings.

Teeth with dead pulps may be divided into—

(1) Those uncomplicated with periodontitis.

(2) Those complicated with periodontitis.

The treatment of pulpless teeth is a matter of great practical importance, and opinions are divided as to which is the best method to adopt. There are two methods advocated: in the one the canals are cleansed, rendered aseptic, and filled at one sitting; in the other the canals are dressed frequently before filling.

The first method, or **immediate root filling**, is carried out as follows: The cavity must be cleared of all carious material and the pulp chamber opened up freely, frequent syringing with warm water being useful to remove the *débris*. Access to the canals

should be gained and the preparation of the cavity completed. The rubber dam, or some other method for excluding saliva, should be used, and the cavity, having been dried with cotton-wool, should be swabbed out with peroxide of hydrogen. With hooked nerve extractors the canal should be carefully freed of *débris*, and in carrying out this part of the operation a word of caution is necessary. There is a danger of septic material being forced through the apical foramen, and to obviate this the cleansing process should gradually proceed from the orifice of the canal to the apex, sodium peroxide followed by peroxide of hydrogen being frequently introduced into the canal to sterilize the pulp tissue and prevent septic inflammation, should any of the pulp tissue pass through the apex. The canals should then be treated with some antiseptic solution introduced on a wisp of cotton-wool, a rotatory rather than a pumping action being employed.

The pulp tissue having been removed as far as possible, the advisability of enlarging the canals with reamers must be considered. The canals should be enlarged in all cases where a septic condition exists. The dentine bordering the canal is the part most infected, and is therefore removed in the process of enlarging. The canals should then be thoroughly sterilized and treated as suggested on p. 535, and the canals filled. **The success of immediate root filling depends upon the thoroughness with which the various steps of the operation are carried out.**

Those who do not pursue the immediate method adopt practically the same mode of procedure, but instead of filling the root at one sitting they insert dressings, changing them until the canal is considered to be aseptic.

Dr. Schreier has recommended a mixture of **sodium and potassium** for dealing with septic roots. The mixture consists of two parts of sodium to one of potassium, and is used as follows: The cavity is prepared and the pulp chamber opened up so as to allow free access to the root or roots. The rubber dam should always be applied. With a warm instrument an opening is made through the wax covering the mixture. A fine broach—iridio-platinum for preference—is introduced into the preparation and withdrawn; the broach with the adherent mixture is then introduced into the canal. This step is followed by a slight hissing or explosion. One application is usually sufficient for each root,

but this depends upon the amount of septic matter in the canal and the quantity of kalium-natrium introduced. "Potassium and sodium hydroxides are formed which, in combination with the fat of the pulp, form soap. A portion of the alkalies renders the albuminous substances in the canal soluble, and in this way tissue adherent to the walls is dissolved and access easily obtained to the dentinal tubes." The kalium-natrium is said to possess germicidal properties, partly by the heat set up and partly by the new product formed. The introduction of the kalium-natrium should be followed by the use of sodium or hydrogen peroxide. In practice the method yields good results, and its use is indicated in canals the contents of which are very putrid.

(1) Cases Uncomplicated with Periodontitis

In these cases immediate root filling should be adopted.

(2) Cases Complicated with Periodontitis

In cases complicated with acute periodontitis it is important, if possible, to remove the contents of the canals, but this can seldom be thoroughly carried out. An entrance, however, should be made into the pulp chamber. If the tooth is free from caries, or a filled cavity is present, an opening should be made into the pulp cavity by the most direct route, and treatment for acute periodontitis prescribed. If a cavity exists, the pulp cavity should be opened and the contents removed and the canal freely syringed with antiseptics. The pulp chamber should be syringed daily, and, when the inflammation has subsided, the canals sterilized and filled. In opening up teeth with acute periodontitis much pain may be saved by keeping the tooth steady.

In cases complicated by chronic periodontitis, if no suppuration is present, the canals should be thoroughly cleansed, and a dressing, formalin for preference, inserted, and the cavity filled temporarily, fresh dressings being used until the chronic periodontitis has subsided. The canal may then be filled. Dr. H. Simms,[1] in a series of experiments, has shown that of the materials used in the treatment of septic canals, formalin would appear to be the most efficacious, and he suggests a mixture composed of one part of formalin to two parts of tricresol, creosote, or glycerine.

[1] *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. ii, p. 99.

If suppuration exists but the pus is confined, the canal must be freed of all septic matter. The abscess cavity should then be opened by trephining through the alveolar process (see p. 556) and the suppurating surface scraped. If the canal is free from pus, it should be thoroughly disinfected and dressed before it is finally filled. The abscess cavity should then be packed with an antiseptic gauze and made to heal by granulation.

If a sinus is present on the gum a similar line of treatment should be adopted.

(D) THE EMPLOYMENT OF DRILLS IN CANAL TREATMENT

Before using root drills it is well to pass up the canal a fine unbarbed instrument on the shank of which is a small piece of rubber—this will indicate roughly the direction of the canal and its length, the length being marked by the position of the piece of rubber. The drills should be used on the engine. Care should be taken that they are spring tempered, and that when in use, they are in a direct line with the root to be filled. They should be employed with a "touch and go" movement, and persuasion, not force, used, the pointed head of the drill guiding the instrument along. Frequent withdrawals should be made to allow the removal of *débris*, and the depth to which the drill has gone should be tested with a broach. It is important to start with a small drill at first, substituting larger ones from time to time. The first drill should reach the apex; the larger ones should, however, not reach quite so far. The subsequent treatment of the canals is essentially the same in all respects as that previously described. The use of drills is sometimes attended by accidents.

The causes leading to fracture of drills are:—

(1) The use of rusty drills.

(2) Pushing the drill up too rapidly, and thus causing it to become fixed.

(3) Through not having a sufficiently large opening into the cavity, and so trying to work the drill round the corner.

Perforation of the apex with a drill is caused by using a small drill with too much force.

Perforation of the side wall of the canal may occur. This

is often due to the employment of large drills in small canals—for example, in the maxillary lateral incisors, buccal roots of maxillary molars, &c. It may arise from attempting to drill round the corner, especially when injudicious force is employed to make the drills advance.

Treatment.—Should the drill break in the canal, efforts should be made to remove it. The canal should be first enlarged and an attempt made to get hold of the broken drill with a pair of forceps specially designed for the purpose. If the attempt fail, a strong barbed instrument should be passed up the canal and an endeavour made to hook down the broken drill. Cotton-wool at the end of a broach to entangle the drill may be tried. If the drill cannot be removed by these methods, it must be left in the canal or rusted out by applications of iodine.

With regard to **perforation of the apex,** the best treatment is to syringe the canal with a solution of peroxide of hydrogen, arrest the hæmorrhage, and then disinfect and fill the canal. When the side of the canal has been perforated there is but slight chance of saving the teeth.

(E) METHODS OF BLEACHING TEETH

Pulpless teeth often become discoloured. In some cases the discoloration is hardly perceptible, while in others it is marked, being often of a bluish black. Teeth in which the pulp has died from the effects of injuries seem to discolour most, and the teeth of the young are more liable to be discoloured than those of adults. The discoloration is said by some writers to be due to the passage of the colouring matter of the blood into the dentinal tubes, but until the nature of the product formed in the dentinal tubes is definitely known it is difficult to decide if this view is correct. Staining of the tooth structure may also be due to the use of amalgam as a filling, and this is referred to under Amalgam.

To remedy the unsightly appearance of discoloured teeth the process of bleaching is recommended. The results obtained are not, as a rule, satisfactory, but this is said by Dr. Truman[1] to be due to defective manipulation. **Chlorinated lime** is advocated by Dr. Truman, who adopts the following method: Cleanse the

[1] "American System of Dental Surgery," vol. ii, p. 297.

canals and cavity of all softened and decayed dentine, and fill the upper third of the canal with some form of root filling. The remaining portion of the canal and the cavity should then be washed with a solution of bicarbonate of soda, borax, or ammonia, as these will remove all fatty material. Another washing with distilled water is then given, and the rubber dam applied, the cavity being thoroughly dried. The chlorinated lime is then rapidly packed into the cavities by dipping the instrument in a 50 per cent. solution of acetic acid and taking up the lime upon the moistened instrument, the cavity being sealed with gutta-percha or osteoplastic. At the end of two or three days the dressing of lime is renewed, the dressing being repeated until the tooth is bleached. It is most important to use distilled water at all times for syringing, and to avoid the use of steel or iron instruments. The acetic acid is used to set free the chlorine from the chlorinated lime. The bleaching of the tooth will be first observed near the cutting margin, that portion of the tooth towards the neck occupying a longer period. When the tooth is brought into a satisfactory condition, the remaining part of the canal must be filled with oxychloride, and the walls of the cavity also lined with this material before the filling is inserted. The reason for using the oxychloride is that the tubuli are filled with decomposable material, and the oxychloride, being a more powerful antiseptic than the oxyphosphate, is more efficacious.

Dr. Kirk suggests a method based upon the activity of **sulphurous acid** (SO_2) as a bleacher. Sodium sulphite (100 gr.) and boracic acid (70 gr.) are desiccated separately, and then intimately ground together in a warm, dry mortar, after which they are stored until required in a securely stoppered bottle. The powder is packed into the cavity and a drop of water is added to the powder immediately before the cavity is sealed. The sulphurous acid is set free as a result of the chemical reaction—

$$Na_2SO_3 + 2HBO_2 = 2NaBO_2 + H_2O + SO_2.$$

Dr. Harlan recommends the use of **aluminium chloride.** The rubber dam is applied and the cavity swabbed out with peroxide of hydrogen and then dried. Chloride of aluminium is moistened with peroxide of hydrogen and allowed to remain in the cavity for five minutes, after which the cavity is syringed with a

solution of bicarbonate of soda and dried. This method gives fair results. The chemical reaction is as follows :—

$$Al_2Cl_6 + 3H_2O_2 = Al_2O_3 + 3H_2O + 3Cl_2.$$

Hydrogen peroxide 100 vols. gives good results. The tooth must be isolated with rubber dam. The drug is placed in the cavity on a pledget of wool and decomposed with an air-blast from the hot-air syringe. The treatment needs to be continued for about a quarter of an hour, when a small amount of hydrogen peroxide may be left in the cavity and the filling of gutta-percha or oxyphosphate inserted. It is well to seal the apical foramen before applying the drug.

In teeth discoloured by metallic stains, little improvement can be anticipated from bleaching. In the majority of cases it is better to remove the discoloured dentine as far as is safe, and then to fill or line the cavity with some light-coloured osteoplastic.

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CHAPTER XVII

Diseases of the Periodontal Membrane

Acute Local Periodontitis—Chronic Local Periodontitis—Acute General Periodontitis—Regressive Changes—Necrosis of Teeth —Granulomes—Anchylosis of the Teeth to the Jaws

(A) LOCAL REACTION TO INJURY; INFLAMMATION—PERIODONTITIS

THE local adaptive changes resulting from injury to the tooth membrane are generally known as "periodontitis." Two grades of inflammation may be recognized, namely, the acute and the chronic. In the former, the development of the inflammatory processes is rapid, and is accompanied by marked clinical symptoms, while, in the latter, the reaction is slow in development, and the clinical signs are either very feebly marked or absent altogether.

(1) Acute Local Periodontitis

Causes.—In a few instances, acute periodontitis may arise from *traumatism—e.g.*, a blow, too rapid separation of teeth preparatory to filling, the application of too much force when teeth are being regulated by mechanical appliances, or the passage of an instrument into the membrane during the treatment of the root canal. The commonest cause, however, is injury from the *toxic products of bacteria*, which may reach the membrane *via* the pulp canal or the gingival margin, a good example of the latter being seen in cases of suppuration in connection with partially erupted mandibular third molars. Injury to the membrane leading to acute periodontitis may also arise from the injudicious use of strong *chemical agents* in the treatment of the pulp canal.

Generally speaking, the reaction set up by injury from chemical

agents or trauma terminates in "resolution," while the reaction started by the toxic products of bacteria invariably ends in suppuration.

Morbid Anatomy and Pathology.—The primary effect of the injury is to cause a temporary contraction of the arteries, and this is succeeded by a slow but progressive arterial dilatation which eventually extends to the capillaries. The increased flow of blood to the part causes the tooth to be slightly pushed from its socket, and the result shows itself clinically by the tooth appearing to the patient to be too long. The further development of the inflammatory process consists of a slowing of the blood current accompanied by increased outflow of lymph from the vessels and migration of the leucocytes. If the injury is not of a bacterial character, the reaction may not reach beyond this stage, the stasis in the blood-vessels disappears, the fluid exudate passes into the lymphatics, the *débris* of any dead tissue is removed by the leucocytes and the parts return to their normal condition.

When the injury is bacterial in character, the inflammatory process is characterized by a marked attraction to the part of leucocytes of the polymorphonuclear variety accompanied by a rapid liquefaction and digestion of the tissue elements. A zone of tissue around the tooth is thus destroyed, and its place is taken by a cream-like fluid, "pus." Adami[1] points out that in suppurative inflammation there is a period of incubation during which the bacteria multiply, and that the migration of the leucocytes to the part does not occur until after the cells of the part have become swollen, and the vessels full of blood. The delay in the attraction of the leucocytes is, he thinks, due to the fact that some little time must elapse before sufficient toxins are formed by bacteria to attract the leucocytes. Clinically this is shown about the second day by the rapid development of symptoms following the onset of a septic periodontitis. The bacterial growth continues until the organism is able to offer sufficient resistance, the liquefied tissue, "pus," being walled in by a dense layer of leucocytes, and a fully developed abscess is formed. When the pus has formed it may—

[1] "The Principles of Pathology," p. 393.

(1) Become circumscribed, and the condition more or less chronic.

(2) Work towards the surface and point.

(3) Burrow along the fascia and the muscles.

When the pus becomes circumscribed the inflammatory process subsides, and a zone of granulation tissue forms around the pus and encloses it. The abscess may then remain inert, but more commonly the suppuration slowly spreads and gives rise to a type of chronic abscess.

When the pus works towards the surface, it follows the direction of least resistance.

It may escape at the gingival margin, but in the majority of cases it works its way through the outer alveolar wall and points on the gum over the affected tooth. As long as the pus is confined in the bone, the muco-periosteum is only slightly œdematous, the cellular tissue of the face being unaffected. But when the pus has gained an exit through the alveolar process a rapid swelling of the cellular tissues takes place owing to a diffuse cellulitis. The extent of the swelling is determined by the virulence of the organisms producing the suppuration and by the resistance of the tissues. The abscess may discharge spontaneously, and, if the tooth or source of infection be removed, healing by granulation usually ensues. In the event of the source of infection remaining, the surface is kept constantly infected and a chronic sinus results.

When the pus burrows along the fascia and muscles it may lead to troublesome complications. It may pass to the gingival margin through the outer alveolar plate. In suppuration around the maxillary central and, occasionally, the lateral incisors, the pus may make its way into the nasal fossa. Pus from the region of the maxillary lateral incisors is prone to burrow under the muco-periosteum of the hard palate, and form a large fluctuating swelling which usually points at the junction of the hard with the soft palate. Although this condition occurs most frequently in connection with the lateral incisor it may arise from the second premolar, the first molar, or indeed any tooth in the maxilla. The pus may take a direction towards the antrum, invade this cavity and lead to antral suppuration. This occurs generally in relation with the second premolar or the molars, but may arise

from any tooth in the maxilla. Pus around the canine may burrow upwards towards the inner canthus of the eye, and in one case seen, an abscess in connection with the maxillary first premolar pointed near the angle of the mouth.

In the mandible, the pus, instead of working its way through the outer alveolar plate, may penetrate the inner side of the alveolar process, and open on the floor of the mouth. From the incisors and canines, the pus, especially if penetrating the outer alveolar plate low down, may strip up the periosteum and eventually open under the chin. The insertion of the buccinator influences, in many cases, the direction taken by the pus. If the pus penetrates the bone outside the attachment of the buccinator, it will burrow into the tissues of the cheek, and finally, perforating the skin, open on the face. In rarer examples, the pus may continue to work among the planes of connective tissue in the neck, producing a diffuse cellulitis (*angina Ludovici*). Several cases of this type have been recorded. The onset of the cellulitis is attended by a marked increase of the temperature, rigors often occur, and there is great prostration. There is marked œdema of the tissues forming the floor of the mouth, the mucous membrane being pushed up so as frequently to suggest a second tongue. The swelling increases rapidly over the front of the neck, spreads backwards to the parotid region, upwards to the orbit, and in the later stages involves the thorax. There is usually œdema of the larynx. The brain may become involved by extension of phlebitis along communicating venous branches. The condition nearly always terminates fatally. A case of extreme severity which, however, terminated favourably, was recorded by Mr. A. Kendrick.[1] The trouble arose in connection with a first left mandibular molar which one year previously had been fractured. The left eye was closed, and pus escaped from the lower orbital margin and from the upper eyelid, a large sloughy opening being present in the centre of the cheek. There were several sinuses along the border of the mandible. The pus had travelled down the anterior border of the sterno-mastoid to the clavicle, where several sinuses opened; there was also a large sinus over the sternum. Pus had burrowed upwards along the ascending ramus into the temporal fossa, so that the whole temporal region was œdematous. The

[1] *Journ. Brit. Dent. Assoc.*, October, 1900.

tooth was removed. The temporal region was incised and the sinuses freely opened up and packed with iodoform gauze, the patient making a steady recovery. The most severe form of dento-alveolar abscess would seem to arise in relation with the mandibular molars. The pus at times burrows under the masseter, and in other cases under the internal pterygoid, and finally into the deeper cellular tissue. Dr. R. Maclaren[1] has drawn attention to this variety of abscess, and records the *post mortem* of a case in relation with a second molar: "The neck of the root was found tightly embraced by the gum, which had prevented the escape of matter. As a consequence the pus had welled over the inner alveolar plate and had separated the periosteum and burrowed along the internal pterygoid and among the muscles and cellular tissue on the inside of the mandible." Dr. Maclaren states that he has constantly observed a similar condition. Whether the pus wells over the inner or outer edge of the alveolar border depends, he considers, upon the respective level of the two edges, and from an examination of 227 mandibles in the Museum of the Royal College of Surgeons of England he finds that in 86 the inner alveolar process was on a lowel level than the outer, and in 78 the reverse was the case. In 63, both inner and outer appeared equal in height.

Extensive necrosis of the maxilla or mandible may result from dento-alveolar abscess (see chapter xxx.). In severe cases general infection may occur.

Acute suppurative periodontitis may arise in connection with teeth with living pulps. Two very interesting cases of this character have been reported by Mr. A. E. Baker.[2] In one, a girl, aged 13, there was a small cavity on the lingual surface of the right maxillary lateral incisor. The pulp was exposed and a dressing of devitalizing material was applied for half an hour, when the cavity was enlarged and a fresh dressing applied. Five days subsequently the patient returned with a large dento-alveolar abscess pointing in the sulcus between the gum and upper lip. The abscess was opened. The next day the dressing in the cavity was removed and the cavity left open to allow the abscess to drain, the assumption being that the pulp was

[1] *Brit. Med. Journ.*, October 20, 1894, p. 866.
[2] *Journ. Brit. Dent. Assoc.*, May, 1895, p. 268.

dead. When seen five days later the abscess was apparently cured, but the pulp was found to be partially alive. It was removed and the canal filled. The second case was in connection with a left maxillary second premolar distal cavity. Remnants of pulp remained at the apices, and to these arsenic was applied. A mesial cavity in the first molar was prepared, and a layer of softened dentine left over the pulp. A dressing of sandarac varnish was packed into the cavities to press away the gum. After two days, the patient returned with a large abscess. The pulp of the molar was found acutely sensitive and arsenic was applied. The root canals of both teeth were subsequently cleared and filled. In both these cases, Mr. Baker considered that the periodontal membrane had probably been infected *via* the living pulp.

Bacteriology. (See p. 568.)

Signs and Symptoms.—In the early stage, the tooth causes the patient discomfort, is slightly raised in its socket, and pressure brings relief. At this period, the blood-vessels are in a condition of hyperæmia. The tooth then becomes still further elongated and loose, the gum around it being swollen and painful. Pressure now causes great pain. The vessels at this period are nearing the condition of stasis, and the surrounding tissues are infiltrated with inflammatory exudation, hence the increased rising of the tooth in its socket. Pressure now increases the pain, because the vessels can no longer be freed of their surplus supply of blood. Each act of mastication under such conditions only increases the pressure on the already hypersensitive nerves. If suppuration supervenes, the swelling of the gum increases, the tooth becomes more loose, and the pain dull and throbbing. Finally, a distinct fluctuating swelling appears in the sulcus between the gum and the cheek, the face swells quickly, and, the pus being no longer confined in a dense unyielding structure, the tension upon the nerve endings is relieved and the pain considerably lessened. Suppuration is usually accompanied by pyrexia.

Diagnosis.—The diagnosis is usually easy. In cases where suppuration has taken place, the surrounding teeth may have become implicated in the inflammation, but the tooth causing the trouble will be found looser than its neighbours and more sensitive to pressure and percussion.

Treatment. — *Local.* — The first step in treatment is to remove the cause, as far as this is practicable. If the condition is due to the passage of drugs through the apex of the tooth, the application of counter-irritants or hot fomentations to the gums will usually give relief. In those cases where the injury has been caused by instruments in the treatment of the root canal, an attempt may be made to retain the tooth by sterilization of the canal and the insertion of a non-irritating root filling, but teeth which have been injured in this way seldom recover completely.

When the periodontitis is due to bacterial toxins the first point to decide is the advisability of retaining the tooth. Teeth that are unsavable by conservative operations should be removed. In cases where there is a possibility of retaining the tooth, the septic matter in the pulp chamber should be removed. Care should be taken in performing this operation, as such teeth are extremely sensitive, and the tooth should be kept as firmly fixed as possible.

Although complete removal of the septic matter can be hoped for only in a few cases, an effort should always be made to gain an entrance to the pulp chamber, and for this purpose a small hole should be drilled through the tooth at the neck. This can be accomplished with a sharp burr without causing much pain. The pulp chamber should be syringed with an antiseptic solution (hydrogen peroxide 15 vols. is recommended). Counter-irritation of hot fomentations should be applied to the gum over the root, or the gums may be scarified. **If suppuration has occurred,** measures must be taken to remove pus as soon as possible. The removal of the pus may be hastened by the continued application of poultices over the situation of the tooth, and, as soon as the pus has pointed, the abscess should be opened. The cavity should be thoroughly irrigated with some unirritating antiseptic solution and drainage provided. The abscess should be dressed at least twice a day, and this is especially needful when it occurs in the mandible, as the opening is not then in the most dependent part. Acute dento-alveolar abscesses generally heal rapidly, especially if carefully dressed. In the case of extensive abscess, the patient must be anæsthetized, the suppurating tracts freely opened, irrigated, and packed with iodoform gauze; but this is a subject belonging rather to the domain of general surgery.

If the skin shows signs of being involved in the inflammatory process, it should be dressed with a compress dipped in some mild astringent solution (lotio plumbi). If the abscess threatens to open through the skin, the latter should be supported by covering the surface with a layer of cotton-wool painted over with collodion solution; by this means, aided by free opening of the abscess into the mouth, the opening on the surface can often be avoided. When an opening through the skin is unavoidable, an incision should be made at the earliest opportunity, and on no account should the abscess be allowed to burst spontaneously. If this precaution is taken, much disfiguration may be avoided. The incision should follow, as far as possible, the fibres of the platysma. A cut across the fibres leaves a gaping wound, whereas when the cut is parallel with them the resulting scar is almost imperceptible.

When the patient will consent, a much better course is to open the apical space through the alveolar process. An anæsthetic having being administered, an incision is made in the gum down to the bone. The hæmorrhage is arrested, the periosteum covering the part to be penetrated is scraped away, and the apical space opened with a trephine on the dental engine. The cavity is then syringed and the opening packed with an antiseptic gauze.

In opening an abscess connected with a mandibular molar, care must be taken to avoid injuring the facial artery. In cutting, the knife should be directed towards the bone and not away from it. In opening abscesses in the palate, the anterior or posterior palatine arteries may be injured. The incisions into palatal abscesses should therefore be made, as far as possible, parallel with the course of these vessels.

As soon as the active stage of inflammation has subsided the pulp canals should be treated in the usual way. **In those cases where suppuration is extensive** and the pus shows signs of burrowing in an unusual direction, the tooth should be removed immediately.

General.—In the early stages a smart saline purge will assist in clearing up a local periodontitis. If suppuration has taken place, the necessity of attending to the general health of the patient cannot be too strongly insisted on. The bowels should be carefully regulated, and, if needful, a tonic treatment

prescribed consisting not only of drugs, but plenty of fresh air and good wholesome nourishing diet.

(2) Chronic Local Periodontitis

(i.) Commencing near the Apex of the Tooth

Causes.—Chronic periodontitis follows on injuries similar to those leading to the acute form, the difference in the reaction of the tissues being due to the lesser intensity of the injury and its constant presence. By far the larger number of cases arise from infection *via* the pulp canal. In a few instances, the injury may be caused by the passage of a root filling through the apical foramen. Mal-occlusion or excessive use may also be cited as causes.

Morbid Anatomy and Pathology.—Where the injury is of slight intensity the change which occurs consists in a proliferation of the connective tissue leading to a thickening of the membrane, the portion immediately adjacent to the tooth tissue being replaced by cemental tissue. To this type of reaction the name of **proliferative periodontis** is given, and it is a process analogous to that occurring in a proliferative periostitis. The naked-eye appearances of the tooth are shown in figs. 632. When the

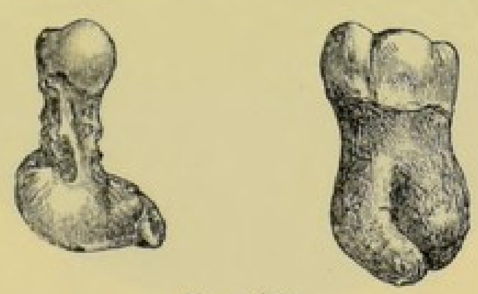


Fig. 632.

inflammation is continuous and productive, the surface of the new tissue usually presents a smooth appearance, as seen in fig. 633. On the other hand, when the condition alternates between a productive and a rarefying periodontitis, an irregular outline is usually seen, as in fig. 634. A section through the hard tissues of a tooth showing this condition is shown in fig. 635. It will be noted that the original layer of cemental tissue is intact, and that the lacunæ of the new tissue are fairly regular, the

intercremental lines of Salter being well marked. These lines are situated at the junction of the laminæ. The lacunæ in the new tissue are more numerous and are also slightly larger and coarser than in normal cementum.

Fig. 633.

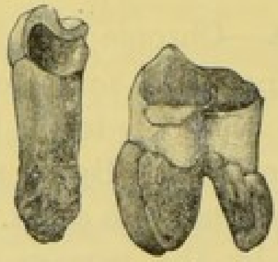


Fig. 634.

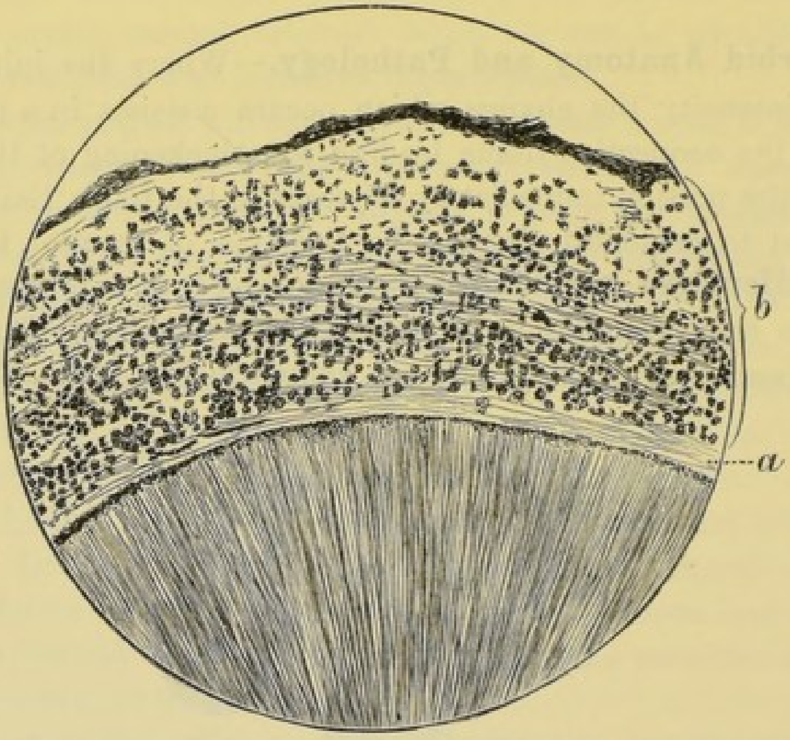


Fig. 635.—(*a*) original layer of cementum; (*b*) tissue of new formation.

Simultaneously with the formation of the cemental tissue, a rarefying osteitis occurs, which makes room in the tooth socket for the new tissue (fig. 637). In extreme cases, two or more teeth may be the subjects of proliferative periodontitis, the intervening septum of bone may be completely removed by a rarefying osteitis and the teeth become united by cemental tissue. This occurred in the case shown in fig. 638.

The new tissue, however, is often more irregular in character than that shown in fig. 636, the laminæ being absent and the lacunæ placed irregularly (see fig. 639). Vascular canals are at times seen.

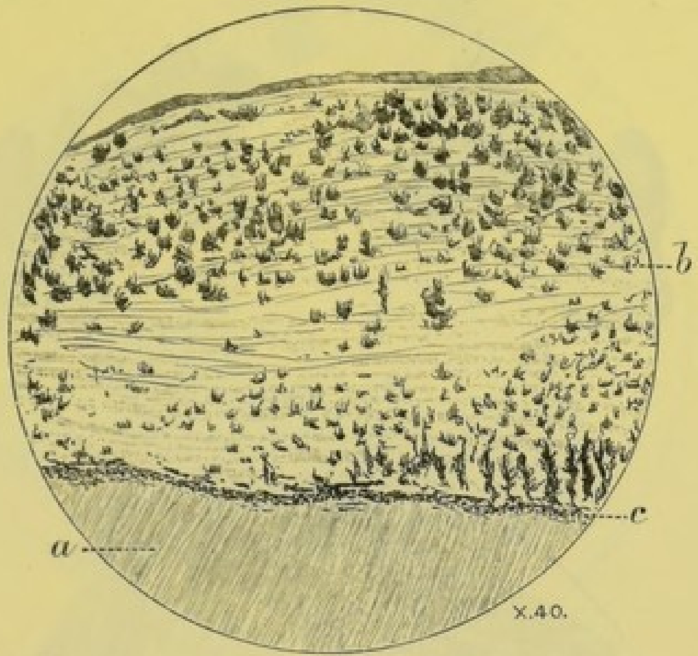
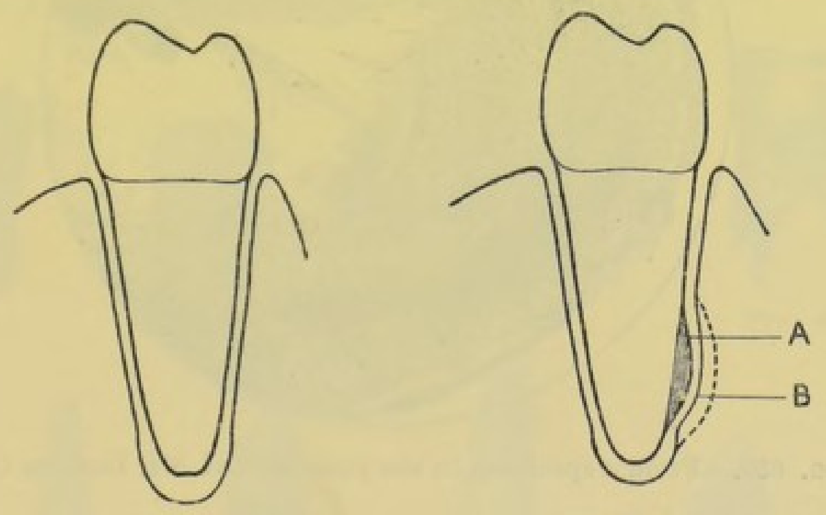


FIG. 636.—Longitudinal section, showing new tissue. (a) dentine (b) new tissue; (c) granular layer.



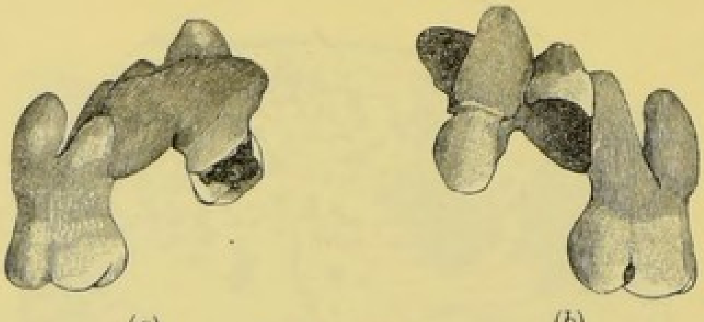
(a) Showing normal relation of tooth to the alveolar process.

(b) Showing changes which occur in productive periodontitis. (A) new tissue; (B) zone of rarefying osteitis.

FIG. 637.

It has been pointed out by Adami that substances which in larger amounts are toxic and lead to degeneration of the tissues

often in smaller amounts act as direct stimuli to the cells and increased growth. That is to say, the increased growth is not secondary to tissue destruction. Mechanical stimuli, or irritation, result in similar overgrowth.



(a) (b)

Fig. 638.

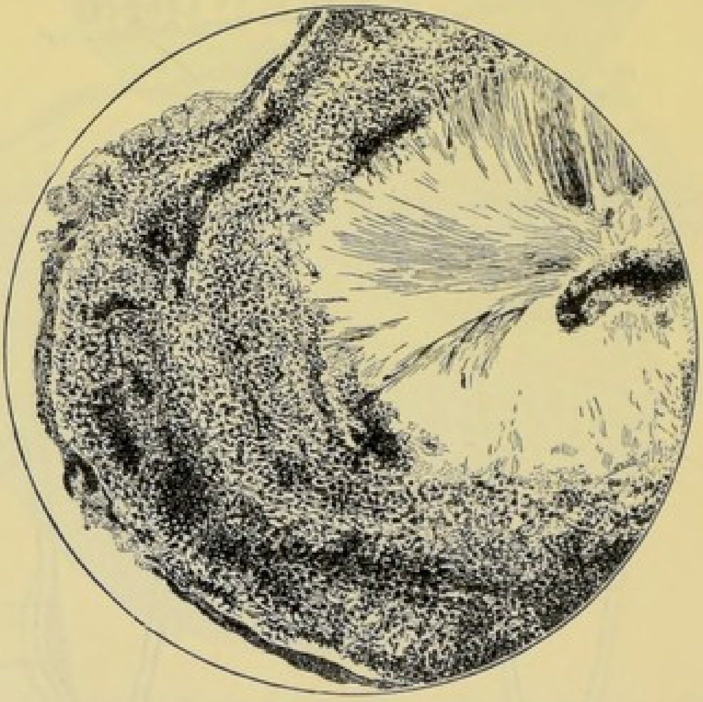


Fig. 639.—From a specimen in the possession of Mr. Douglas Caush.

Where the intensity of the injury is greater, the reaction in the tissues is characterized by cell infiltration of the parts in addition to the cell proliferation of the connective tissues. Among the latter are multi-nucleated cells (osteoclasts), which absorb the tooth tissue. To this type of reaction the name of **rarefying periodontitis** is given, and it is a process analogous

to rarefying osteitis. A section through the tooth shows a series of semi-lunar excavations (Howship's lacunæ) (fig. 640).

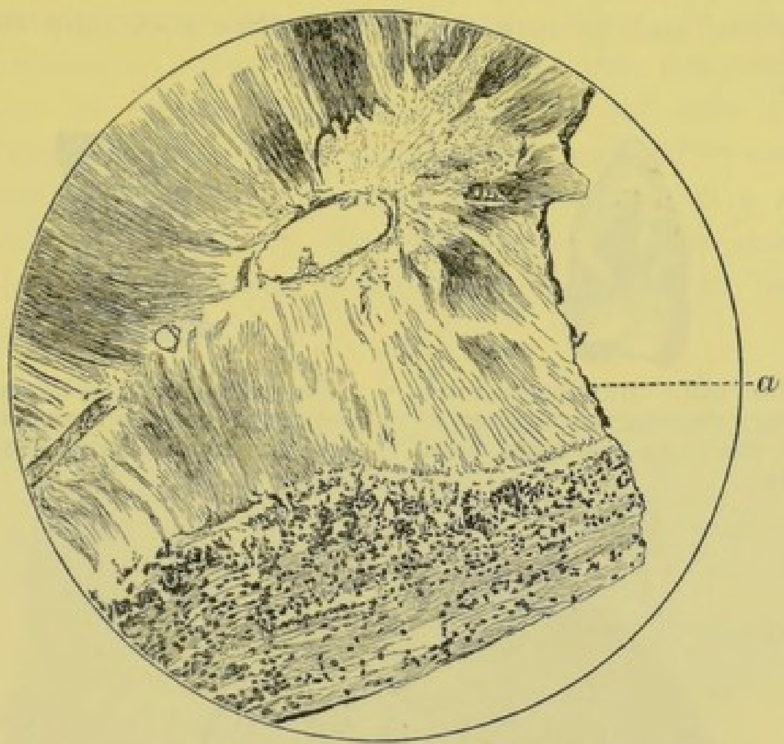


FIG. 640.—(a) margin of tooth, showing Howship's lacunæ. From a specimen in the possession of Mr. Douglas Caush.

FIG. 641.

FIG. 642.

FIG. 643.

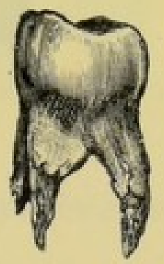


FIG. 644.

FIG. 645.

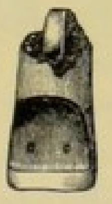


FIG. 646.

FIG. 647.

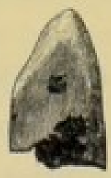


FIG. 648.

In each space a multi-nucleated cell is present, and in the neighbourhood are to be seen epithelial cells and small cells, the

appearances being in all respects similar to those seen in absorption of the deciduous teeth under normal conditions. As the absorption progresses, the cementum is first removed and then the dentine, and, in rare cases, the entire root may disappear.

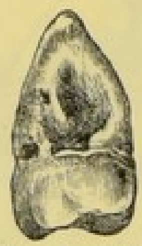


Fig. 649.—Maxillary second molar, showing absorption of root due to an unerupted third molar.

Fig. 650.—Mandibular second molar, showing absorption of root due to an unerupted third molar.

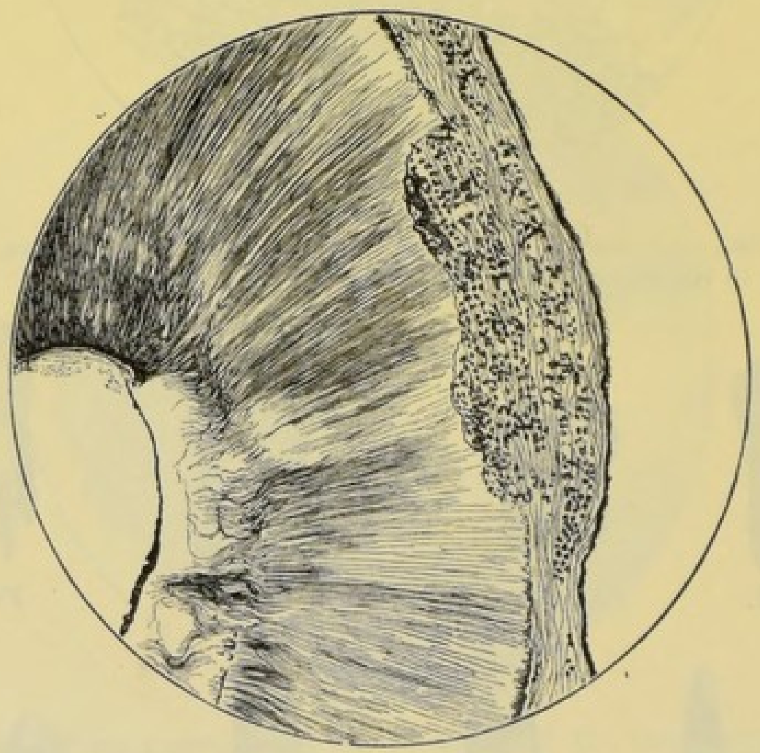


Fig. 651.—From a specimen in the possession of Mr. Douglas Caush.

The absorption of the teeth may take place evenly as seen in figs. 641 and 642, or in an irregular manner as seen in figs. 643 to 650. The difference probably depends upon the character of the injury and whether the injury is continuous or intermittent.

Under certain conditions, *e.g.*, the lessening in the intensity

of the injury, **the rarefying periodontitis may pass into the stage of proliferative periodontitis** and much of the lost tissue may be replaced, to be, perhaps, again removed if the inflammatory process becomes still more active. In other cases, the inflammation may cease altogether and the small-celled infiltration be replaced by cementum. In the case shown in fig. 651 the dentine has been absorbed and replaced by cementum. This specimen therefore indicates the existence of a rarefying periodontitis, followed by the replacement of the small-celled infiltration by cementum, a condition analogous to healing in soft tissue by granulation.

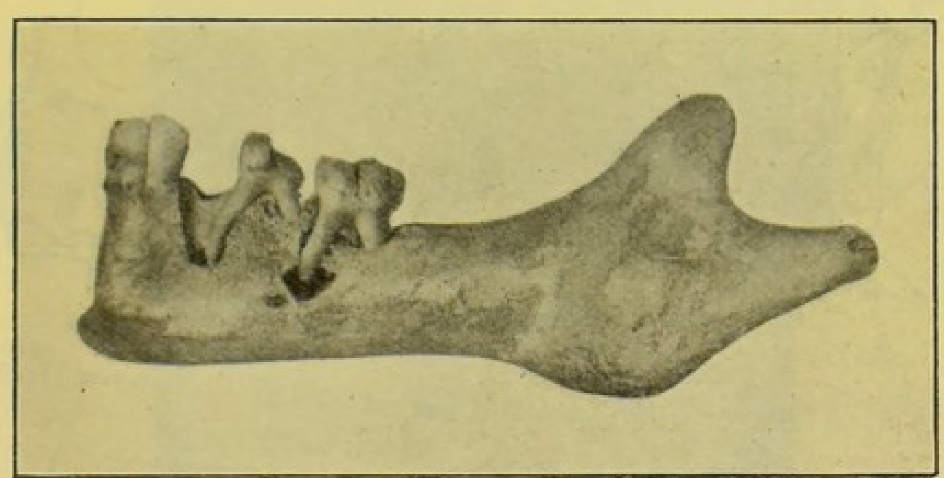


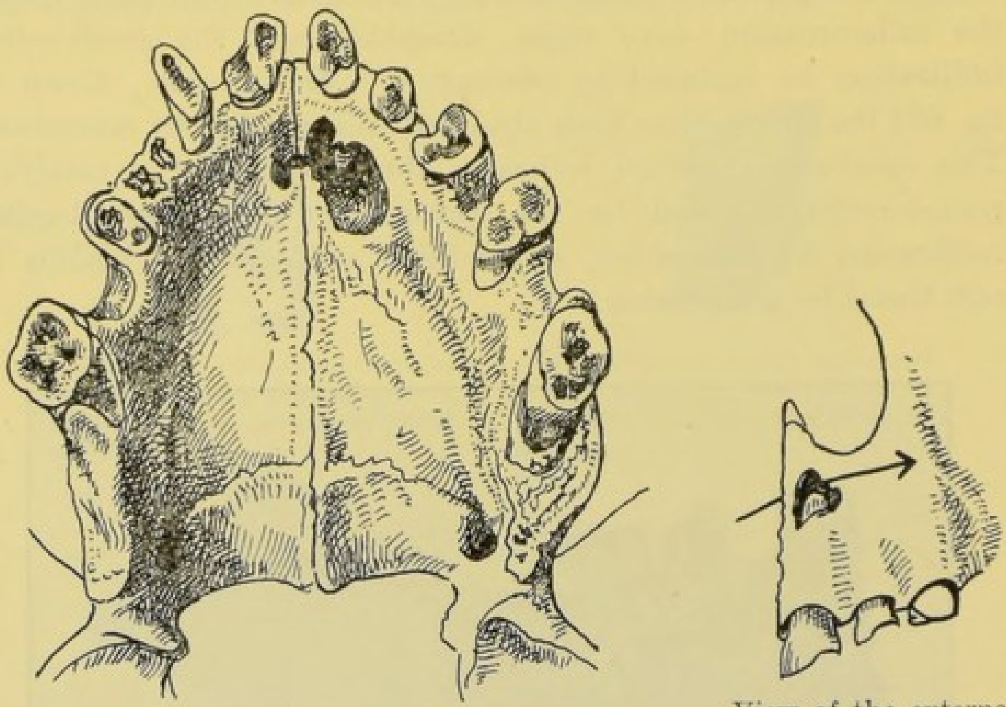
FIG. 652.—Mandible showing destruction of bone around the roots of the deciduous molars.

The tissue around the pulp canal possesses more resistance than other parts of the tooth.

Chronic injury to the periodontal membranes at times results in changes which are more marked in the surrounding osseous tissue than in the tooth. The bone in the neighbourhood of the tooth is removed and its place is taken by a mass of granulation tissue, the outer layer of which shows a tendency to fibrosis. These masses of tissue often come away with the tooth when it is extracted (see also p. 579).

When the injury is constant and of a septic or infective type suppuration ensues, and produces a condition commonly known as **chronic suppurative periodontitis.** The injury usually reaches the membrane through the apical foramen. It is doubtful

whether the microbes can pass through the tooth structure. There is, however, no reason to doubt that *toxins* generated in



Palatal view.

View of the external alveolar plate.

Fig. 653.

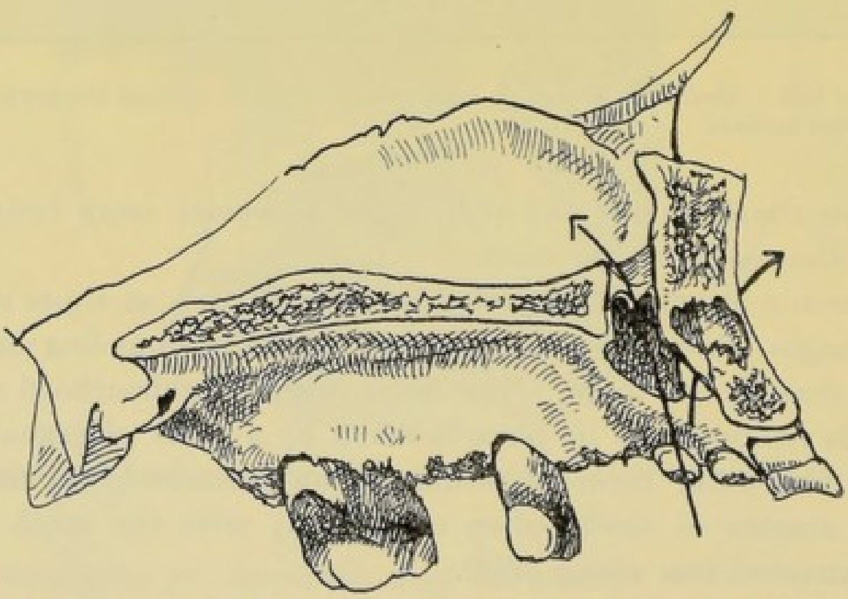


Fig. 654.—View showing the excavation of the body of the bone.

the pulp canal may easily diffuse through the tooth tissue and so injure the periodontal membrane. The pus formed from the

degeneration of the tissues may become more or less confined through being surrounded by a layer of granulation tissue the outskirts of which show a tendency to fibrosis, and the abscess thus formed may remain stationary and give rise to no symptoms. More often, however, there is a tendency for the suppurative process to extend slowly, generally in the direction of least resistance, with the result that the alveolar process is destroyed, an opening appears on the gum, and a sinus is formed.

In discussing acute suppuration it was explained at what positions the abscess might be expected to point (see p. 551). The

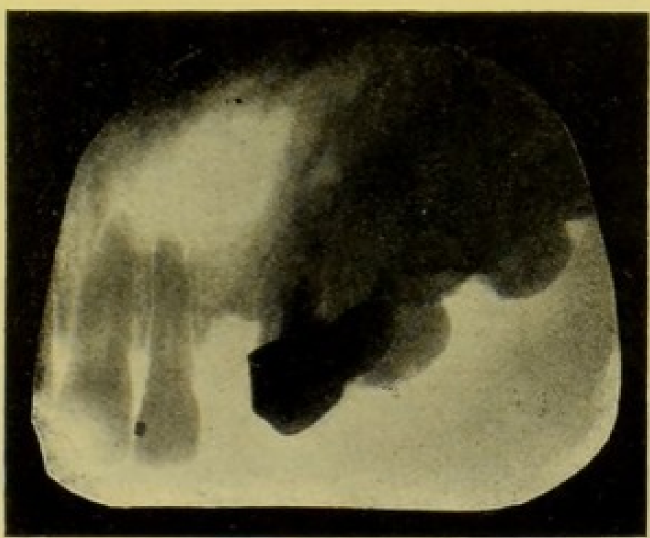


FIG. 655.—Radiograph showing extensive destruction of bone caused by suppuration in connection with a maxillary lateral incisor.

same positions may also be regarded as the probable sites of the pointing of chronic abscesses. The destruction of bone resulting from chronic suppuration is at times extensive, especially in the maxilla, which is more susceptible because of the cancellous character of the bone. In figs. 653 and 654 is shown a portion of a maxilla, in which a large cavity has been formed in the bone; the outer alveolar plate has been destroyed as well as a portion of the palate process. Fig. 655 is a radiograph of a dento-alveolar abscess in connection with a maxillary lateral incisor. At times suppuration from the maxillary incisor teeth spreads to the floor of the nose, leading to the formation of a sinus. In the premolar and molar region, the suppurative process frequently

extends to the antrum and gives rise to antral suppuration. In a few cases, suppuration around the palatine roots of the molars may extend to the nasal fossa. In the mandible, the extension of the abscess is more limited owing to the denser character of the bone. Very extensive excavation of the bone is, however, at times seen. With the extension of the suppuration, fresh bone is deposited by the periosteum, and, in this manner, the mandible may become considerably expanded. (Reference to excavation of bone by cysts is dealt with in chapter xxxii.)

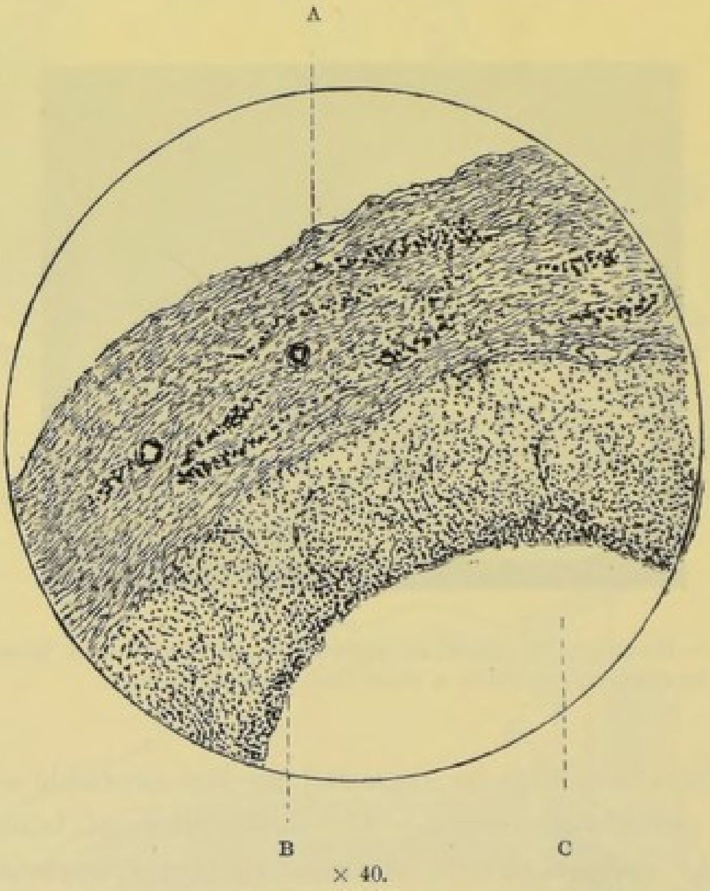


Fig. 656.—Section through the wall of a chronic abscess. (A) fibrous capsule; (B) cells breaking down into pus corpuscles; (C) abscess cavity. From a drawing by Mr. A. Hopewell-Smith.

A section through the walls of a chronic dento-alveolar abscess is shown in fig. 656.

In the process of suppuration, the periodontal membrane may be destroyed, leading to necrosis of the cementum. There is a somewhat rare form of abscess[1] which occurs in the jaws, and

[1] *Journ. Brit. Dent. Assoc.*, p. 551, 1899.

may be described under this heading, as it is in reality a sequel to suppurative periodontitis. Mr. J. G. Turner has drawn attention to it. The abscess may depend upon the presence of a small piece of root, and may be due to insufficient drainage after the extraction of septic teeth. Mr. Turner states that, "When the abscess occurs in the maxilla there is pain and tenderness, some swelling of soft parts, but no bony enlargement; the trouble may subside and occur again at intervals. If untreated the antrum may be involved. The nearest lymphatic glands may be enlarged. In the mandible, as in the maxilla, the alveolar process may be entirely absorbed, and there is pain and tenderness and some local swelling. Owing to the position of the inferior dental nerve there is often, especially in the premolar region, severe neuralgia. As in the maxilla, the nearest lymphatic gland may be enlarged and tender. The neuralgia is caused by the abscess in its enlargement opening up the canal of the nerve. Under these conditions there is very severe, continuous, heavy pain, and the more acute shooting pain which occurs at intervals without any necessary regularity; it is set up by any irritation, such as cold air, movement of eating, &c.; it spreads in anatomical order to the other branches of the fifth nerve, first to the ear and then up the side of the ear to the vertex, to the infra-orbital nerve, to the supra-orbital nerve, and down the neck. It lasts a varying time, from a few seconds to hours. It is unaccompanied by trophic changes, but there may be increased secretion of tears or saliva. It is confined to the one side, and appears always to start from the seat of mischief. If the abscess has not involved the inferior dental nerve, the neuralgia will be absent."

"The length of time during which things may lie dormant varies greatly; when, therefore, a patient complains of pain or neuralgia starting in a spot where there is now no tooth, there may yet be a chronic abscess, and the alveolar process may be normally absorbed."

In a series of cases recorded by Dr. Hugenschmidt, of Paris, the suppurative periodontitis was apparently due to a chronic suppurating localized pulpitis, the pulp not being exposed. In one patient, a girl, aged 17, a small abscess formed over the region of the right maxillary central incisor, and gradually increasing in size discharged spontaneously at the end of nine months. It was

decided to open the pulp chamber, but the tooth was found so extremely sensitive that drilling could not be proceeded with and arsenic was applied. By the following day the arsenic had had but little effect; cocaine was therefore injected under the gum and the pulp cavity opened. As soon as the drill was withdrawn, a bead of pus appeared at the opening. The remainder of the pulp was extirpated under cocaine and the canals filled. The suppuration in the periodontal membrane disappeared.

Dr. Kirk,[1] who has written a thoughtful paper on the subject, states that the majority of cases are met with in elderly people with teeth of hypercalcified structure and free from caries, and he regards the periodontal condition as a trophic abscess of the dento-alveolar articulation. This subject is more fully discussed on p. 631, under head of "Gouty Periodontitis."

Bacteriology. — The organisms found in dento-alveolar abscesses differ to some extent from the organisms found in abscesses in other parts of the body. Foulerton and Pryce Jones, and later Foulerton, have described a number of members of the streptothrix group which have been found present in the pus of abscesses about the jaw. The forms of streptothrix found did not correspond closely with any of the known varieties of streptotricheæ. The *Streptothrix buccalis* is by no means an infrequent inhabitant of dento-alveolar abscesses, particularly those abscesses associated with chronically inflamed roots where perhaps the abscess is more in the nature of a sinus than a true abscess. These chronic sinuses in connection with septic roots are often exceedingly persistent, and in connection with them the ordinary *Streptothrix buccalis* is frequently found in almost pure culture. In acute dento-alveolar abscesses one or other of the ordinary pathogenic cocci is usually present, namely, Streptococcus, Staphylococcus, or Pneumococcus, whilst very occasionally the *Micrococcus tetragenus* may be present. Where the abscess is associated with periodontal disease, the number of organisms present in the pus varies greatly. (See p. 616).

In dento-alveolar abscesses in which fœtid pus is present, the fœtid condition is probably not directly produced by the organisms causing the abscess itself, but by changes in the pus arising from

[1] *Dental Cosmos*, November, 1900.

the agency of organisms of an anaerobic type with which the pus becomes secondarily infected. The *Spirochæte* and the *Bacillus fusiformis* are to be found; a streptothrix may also be present.

Signs and Symptoms.—In teeth where the injury is slight, leading to a **proliferative periodontitis,** symptoms are often absent and, when present, seldom amount to more than a slight tenderness on percussion and, occasionally, attacks of pain of a dull, gnawing character. **When the inflammatory process is of a rarefying type,** the principal symptom will be slight pain and tenderness on percussion, and, if the inflammation is near the apex and the pulp is alive, there will usually be signs of pulpitis through extension of the disease to the pulp. The gum covering the tooth may be swollen. As the tooth substance disappears, increased looseness will be noticeable, the tooth becoming more tender, and the pulp and the gum more congested. In cases of doubt a radiograph should be obtained.

A chronic suppurative periodontitis accompanied by a sinus will exhibit but few symptoms. The tooth is frequently free from pain, the patient only complaining of the presence of the "gum-boil" which periodically swells and bursts. The sinus is usually situated over the root of the tooth. In cases of sinus on the face, some little difficulty may be experienced in tracing the offending tooth, especially if two or three are pulpless or septic. A digital examination of the sulcus will often disclose a fibrous-like cord running from the base of the root to the cheek. The root or tooth causing the trouble may be buried in the gum. A sinus in the mouth in connection with suppurative periodontitis must be diagnosed from sinuses connected with necrosed bone or foreign bodies. In cases of doubt, a radiograph will prove useful. When the sinus is on the face it will be needful to diagnose not only from cases due to necrosed bone or foreign bodies, but also from salivary fistula.

When a sinus is not present (chronic dento-alveolar abscess) the tooth is usually slightly tender to percussion, the amount of pain varying according to the activity of the inflammation. The gum over the root of the tooth is at times swollen and congested, but may be quite normal. A swelling can, as a rule, be felt well up over the apex of the tooth; this swelling is usually sensitive. In cases in which the maxilla or mandible are

much involved, there is often little or no pain or tenderness. A chronic dento-alveolar abscess must be diagnosed from dental cysts and other fluid swellings of the jaws (see chapter xxxiii.).

Treatment.—The treatment of chronic periodontitis must depend upon the cause. In those cases where the pulp is living and the condition is traceable to overstrain of mastication, relief can be obtained by "freeing the bite," and the application of counter-irritants to the gum. If the trouble arises from sepsis in the pulp canal, the tooth tissue should be thoroughly sterilized and the canal filled. Cases where the inflammatory process is of a rarefying type are often intractable to treatment and, unless the tooth can be rendered thoroughly functional, it should be removed.

The treatment of chronic suppurative periodontitis depends upon the condition present. The first point to decide is the question of the retention or removal of the tooth. As a rule, an attempt may be made to retain the tooth if there is reason to think that the canal can be rendered sterile and the tooth functional. **In cases where a sinus is present,** the tooth, if not savable, should be removed at once.

The sinus, if opening into the mouth, will usually heal spontaneously. If the sinus is on the face or on the neck, it may be necessary to stimulate the track with 10 per cent. solution of nitrate of silver, or a drug possessing a similar action. If this fails, an anæsthetic should be given and the surface of the track scraped. If the tooth is considered to be savable, the canals must be thoroughly cleansed, and, when possible, the sinus syringed *via* the apical foramen. The canals should then be thoroughly sterilized and filled. The sinus, if narrow, will usually heal spontaneously after this treatment, but, if this does not occur, it may be treated as suggested above. In cases where a cavity exists in the bone over the tooth, the sinus should be opened up, and the cavity scraped and packed so as to assist healing. Treatment of the sinus and the root canals does not always lead to healing, and when this is the case it will frequently be found that the failure is due to the presence of a piece of necrosed cementum, or the deposit of some calcareous material on the surface of the root. In the case of the incisors and the canines, if the necrosis is near the apex it may be advisable to

attempt excision of the apical portion of the root. With the molars and premolars, extraction is usually needful, but in a few cases, if the necrosis can be located, an endeavour may be made to cure the condition by excising the root. The excision of a root should be performed as follows: An incision is made over the root and the muco-periosteum reflected. The alveolar process is then trephined so as to expose the root. It is advisable at this stage to plug the cavity thus made with some gauze to arrest the hæmorrhage. When the bleeding has ceased, the plug should be removed and the portion of the root excised. A fine cross-cut fissure burr on the dental engine is the best instrument for excision, the cut being made from the distal to the mesial aspect of the root, the rough edges being trimmed with an excavator or small enamel chisel. The cavity is then syringed with an antiseptic solution and plugged with iodoform gauze. The cavity should be dressed at least once a day until it has healed by the formation of granulation tissue.

A depressed scar on the face may result from the healing of a sinus. In order to lessen the deformity, Dr. Black suggests the following operation: The cheek is drawn aside with the finger and the exact attachment of the scar determined. A tenotomy knife is then used to separate the cicatrix from the bone. "A long pin is passed through the most depressed portion of the scar, its centre, the long ends of the pin resting upon the face; strips of adhesive plaster laid upon the skin under the head and point of the pin will prevent the latter sinking into the soft tissues. The pin is retained for several days until the cut in the mouth heals" (Burchard).

In cases without a sinus (chronic dento-alveolar abscess), provided it is considered advisable to retain the tooth, the following treatment should be adopted: The abscess should be freely opened by trephining through the alveolar process and then scraped. The pulp canals should then be freed of all septic matter, thoroughly sterilized and filled. The cavity of the abscess should then be syringed and plugged with gauze and encouraged to heal by granulation. In cases where there is extensive destruction of the bone, the tooth should always be removed. Difficulty is sometimes experienced in healing palatal abscesses, and when this is the case a free excision of the

muco-periosteum covering them will often prove to be a satisfactory method of treatment.

Streptothrix Infection.—The question of streptothrix infection in connection with the lesions of the teeth may be conveniently discussed under "Chronic Local Periodontitis," inasmuch as the infection often takes place *via* the periodontal membrane.

Streptothrix infection in connection with lesions of the teeth may involve the bone itself or the soft parts, the latter condition being more usually met with.

Clinical Features.—A swelling appears on the lower, and, less commonly, the upper jaw, and gradually increases in size, invading the adjacent tissues. At first the mass has a regular and even surface, with the skin slightly hyperæmic. With the progress of the disease, the tissue at places softens and nodular excrescences appear of a yellowish colour; these burst, giving exit to a semi-glutinous fluid in which the characteristic nodules of actinomycosis can be seen. The nodules vary in colour, being yellowish, yellowish-white, or quite clear. The wound generally heals, to be followed by a fresh breaking-out at another spot. The cicatrization following the repetition of this phenomenon gives the surface a curiously characteristic puckered appearance. If left untreated the disease spreads, involving the tissues of the neck, and in some cases passes upwards to the temporal region. The sinuses formed by the breaking down of the tissue may persist and a probe passed down them will often show that they lead to bare bone, but not necrosed bone. On examination, the swelling is found to be of a hard, brawny nature, and to fade away gradually into the unaffected tissue. The disease is not accompanied by a rise in temperature, and there is usually an absence of pain. Should, however, acute suppuration supervene, the general symptoms of an ordinary septic abscess appear.

Diagnosis.—Streptothrix infection can be differentiated from dento-alveolar abscess by the hard, brawny character of the swelling, the long duration of the disease compared to that of a dento-alveolar abscess, and by the presence of the multiple sinuses or the puckered cicatrix, the latter of which is almost pathognomonic. From tubercle it may be differentiated by the fact that in the latter the situation usually affects the glands, and the swelling is generally well-defined and movable. From

necrosis of the jaw it may be diagnosed by the presence of bare and not necrosed bone. The presence of granules in the discharge and the demonstration of the streptothrix on microscopical examination, are positive evidence.

Pathology.—The disease is due to the presence of a form of streptothrix in the tissues, but the ray fungus of Bollinger (*Streptothrix bovis communis*) is an uncommon cause of human infection. The lesion produced by the growth of the streptothrix is of a chronic inflammatory character. A section through the affected tissue shows a number of rounded areas, in the centre of which is the streptothrix surrounded by a zone of granulation tissue. The tissue breaks down, and the streptothrix is expelled in the discharge. The importance of **streptotricheæ** in relation to disease is being constantly extended, and A. G. Foulerton[1] has identified six distinct species in man.

Method of Infection.—The infection is generally stated to be conveyed by straw, cereals, &c. The parasite probably gains an entrance to the tissue *via* the periodontal membrane, and from here spreads to the neighbouring soft tissue. In specimens of actinomycosis in oxen the invasion of the tissue *via* the periodontal membrane is often well demonstated.

Treatment.—Locally the softened spots must be incised and freely scraped, and the sinus packed with iodoform gauze. Internally, iodide of potassium must be administered in doses increasing up to 50 or 60 gr. three times a day. It is also useful to add 3 to 4 minims of liquor arsenicalis, as this is considered by Kelloch[2] to have some effect on the disease itself, in addition to assisting in preventing the skin lesions.

The prognosis is good, but the treatment may have to be carried out continuously for a long time.

(ii.) Chronic Local Periodontitis commencing at the Gingival Margin

When commencing at the gingival margin, chronic local periodontitis is always due to trauma, such as the injudicious use of ligatures, elastic bands or mechanical contrivances in

[1] *Lancet*, March 5, 1910, p. 626.

[2] "Actinomycosis of the Mouth and Face," *Trans. Odonto. Soc.*, vol. xxxvii, p. 29, 1904.

regulating teeth ; the too rapid separation of teeth for filling ; collection of food *débris* in the approximal space.

Morbid Anatomy and Pathology.—The whole of the periodontal membrane of the tooth may be attacked. This occurs when the irritant is a retained ligature or an elastic band. The gum around the tooth is swollen, congested and painful, the inflammation spreads to the periodontal membrane. By a process of ulceration, the membrane is gradually destroyed, the root laid bare, and in time the apical vessels are involved, leading to pulp complications. The disease may be partial, *i.e.*, the periodontal membrane on one side of the tooth only may be attacked. This condition is seen in the mandibular incisors on

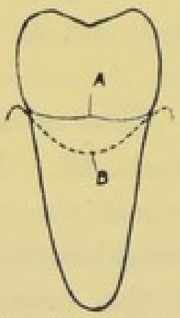


FIG. 657.—(A) neck of tooth and normal attachment of gum ; (B) margin of gum.

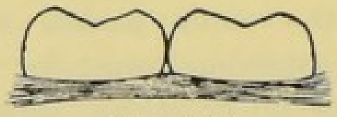


FIG. 658.

the labial aspects, where, owing to deposits of calculus, the membrane is occasionally destroyed to the apex of the root. The most important form from a clinical point of view is that met with in the region of the premolars and molars. A space may exist between the posterior teeth, and food, especially meat, become wedged between the teeth during mastication. The pressure thus exerted starts chronic periodontal inflammation, which, in time, leads to the destruction of the tissue, and the condition, if not treated, will gradually involve the membrane up to the apex of the root.

In other cases, the teeth may approximate at the occluding surfaces, but, owing to a slight recession of the gum, food works

its way between the approximal spaces during mastication. Unless great care is taken in removing these particles of food a progressive ulceration of the periodontal membrane is started. The membrane is destroyed in a cup-shaped manner, as seen in the diagram (fig. 657), forming pockets, the gum apparently filling up the approximal spaces (fig. 658).

The destruction of the membrane proceeds until the apical vessels are involved and pathological processes are then started in the pulp.

Signs and Symptoms.—Slight tenderness during mastication, with pulp pain from thermal changes (owing to exposure of the cementum), are the chief symptoms. *In cases due to ligatures or elastic bands,* the gum shows signs of inflammation and pus can usually be squeezed up round the neck of the tooth. There will be pain to thermal changes. *In cases due to pressure from mastication* there is extreme tenderness, the gum is swollen and congested, and the tooth tender to pressure.

When a pocket exists and the occluding surfaces are in contact, the tags of gum on the labial and palatal aspects of the approximal space appear slightly congested, but the recession from the space is, in many cases, only slightly marked. The patient complains of slight discomfort from food wedging between the teeth and, if there is pain to thermal changes, an examination with a suitable probe will show a considerable destruction of the periodontal membrane, the root of the tooth being frequently denuded to at least half its length.

The diagnosis presents little difficulty. An inflamed condition of the gum, slight tenderness on percussion and pain on touching the exposed cementum are sufficient evidence; care must, however, be taken to exclude pulp irritations from other causes.

Treatment.—*In the cases arising from ligatures, elastic bands, calculus, &c.*, the cause must necessarily be removed. The socket is then syringed out with a suitable antiseptic (hydrogen peroxide, 15 vols.) and the ulcerated surface treated with some mild escharotic, such as trichloracetic acid (25 per cent. solution).

In cases due to pressure from mastication, careful contour fillings must be made in the approximal surfaces of the teeth (see p. 431) and the exposed cementum treated with nitrate of

silver. When the periodontitis is *traceable to the lodgment of food simply*, and is not due to pressure from mastication, the approximal space should be syringed and the surface of the gum cauterized with nitrate of silver. This drug will serve a double purpose, namely, reduce the sensitiveness of the cementum and at the same time promote the formation of healthy granulations in the approximal space. The application by the patient of tincture of iodine every day for a week will result in the disappearance of the pocket and the formation of a space which can be easily kept free from the *débris* of food.

(3) General Periodontitis

Acute. — In this condition the morbid process involves several teeth as well as the contiguous periosteum of the bone. A general inflammation of the whole alveolar periosteum has therefore to be dealt with. The condition may have its origin in the periodontal membrane or in the muco-periosteum. The teeth become loose and sensitive to touch. The muco-periosteum is swollen, deeply congested and painful to pressure. The inflammation may resolve, but suppuration is very likely to occur unless prompt measures are taken to relieve the congestion. If suppuration occurs, the periosteum becomes separated from the bone, with the result that necrosis supervenes. The inflammation occasionally passes into a chronic form, particularly in gouty and rheumatic types.

Causes.—General periodontitis may arise in persons exposed to the fumes of phosphorus (see Necrosis of the Jaws). The prolonged administration of mercury and certain other drugs may be cited as a cause. It may arise from injury in patients the subjects of syphilis, gout, or rheumatism, or may follow on one of the exanthematous fevers.

Signs and Symptoms.—The local signs and symptoms are similar to those of the local form, except, of course, that several teeth are involved in the process. Pain of a dull, gnawing character is present, and is frequently intense when the patient is of a gouty or rheumatic diathesis. There will be general symptoms of pyrexia. Suppuration, if it occurs, is usually ushered in by a well-marked rigor, and the local pain becomes of a throbbing character.

Treatment.—*Local.*—The application of poppy-head fomentations with scarification. The mouth should be kept as aseptic as possible.

The *general* treatment will depend upon the cause. A smart saline purge should be administered in nearly all cases. If due to syphilis, iodide of potassium must be given, while cases of gouty and rheumatic origin call for the general treatment of those affections. If the inflammation shows a tendency to suppurate, free incisions must be made down to the bone, followed by the constant use of fomentations.

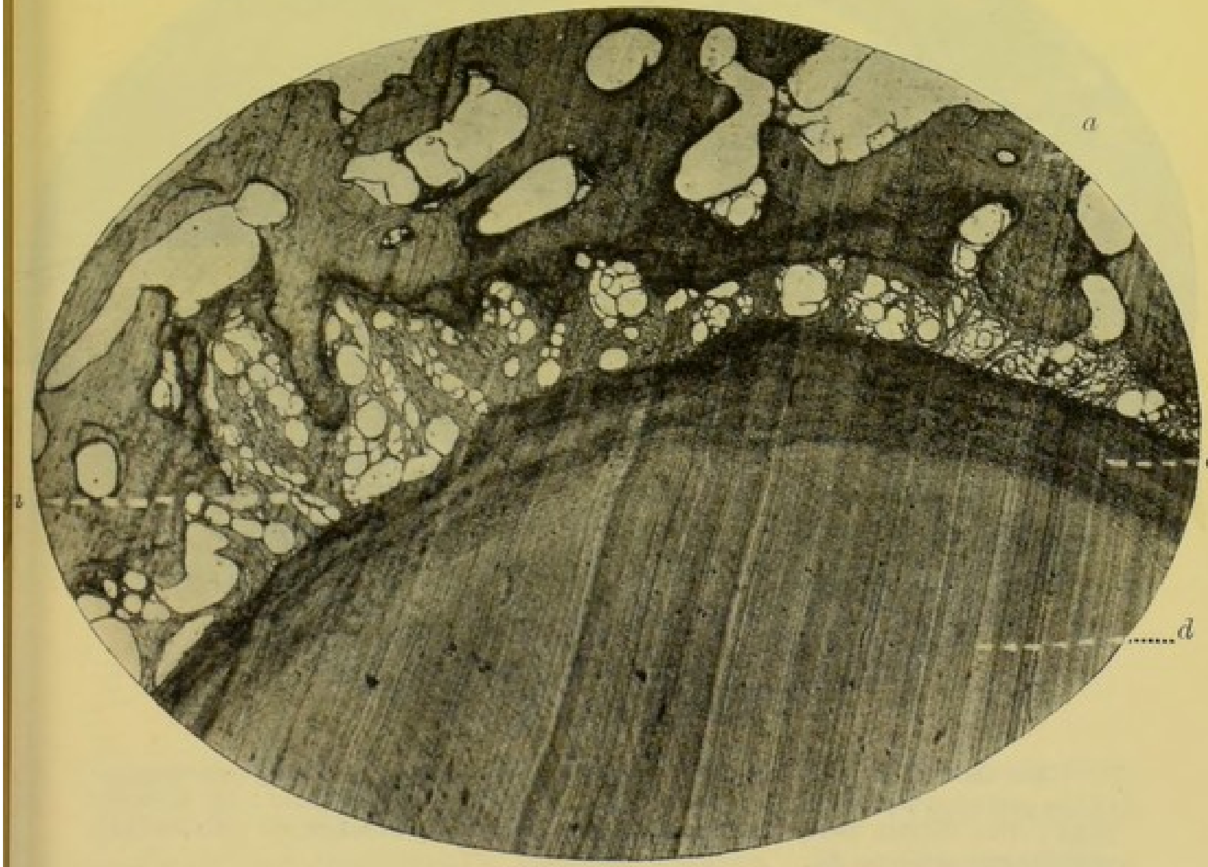


FIG. 659.[1]—(Hopewell-Smith.) Transverse section of fibroid degeneration of the periodontal membrane, cut *in situ*. × 50. (*d*) dentine; (*c*) cementum; (*a*) alveolar bone; (*m*) fibroid periodontal membrane, devoid of cellular elements and vascular and nervous systems.

(B) REGRESSIVE CHANGES

Regressive changes[2] of a fibroid character may occur in the periodontal membrane of elderly people, though not necessarily

[1] From *Dental Cosmos.*

[2] See paper by A. Hopewell-Smith, *Dental Cosmos*, vol. xlvi, p. 261.

confined to them. The normal elements of the parts are replaced by fibrous tissue which is grouped together in bundles enclosing areolar spaces (figs. 659 and 660). The adjacent bone shows signs of atrophy and the gingival tissue in the immediate neighbourhood also shares in the changes by becoming less vascular and more fibroid in character.

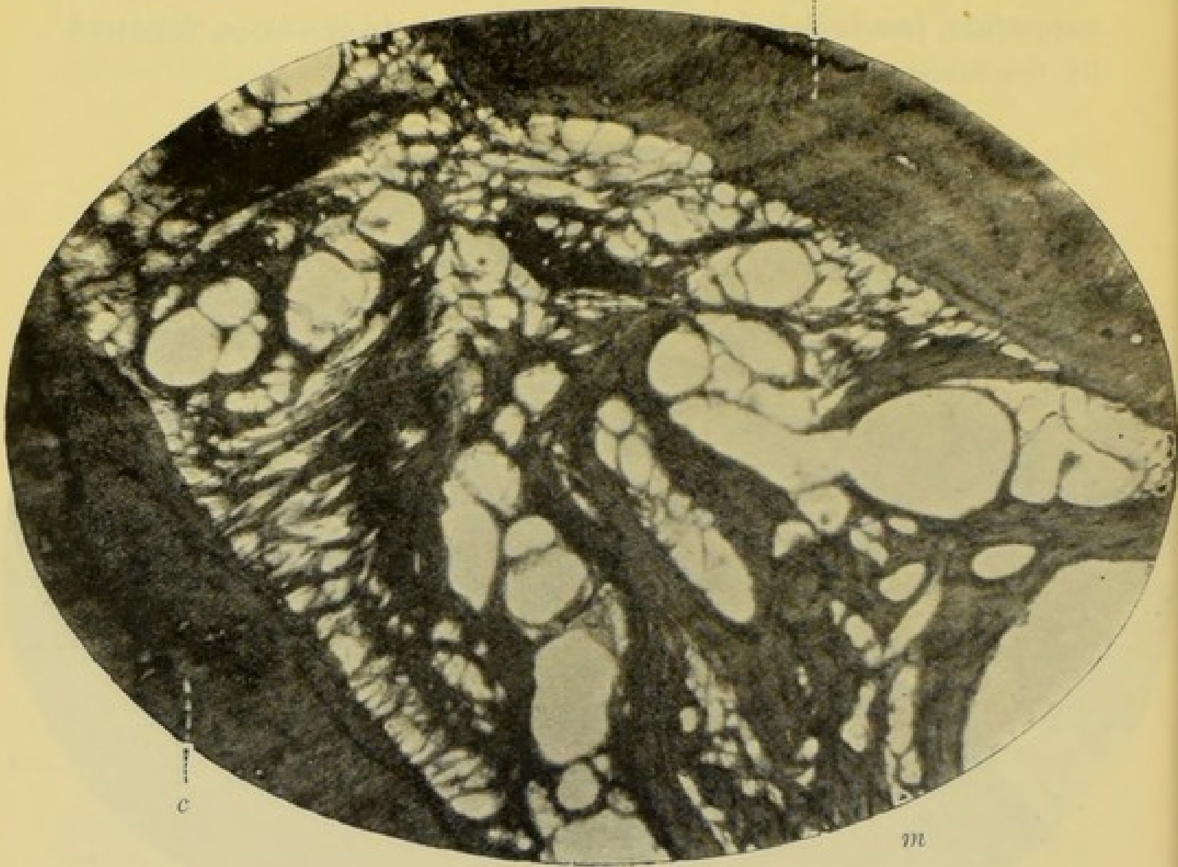


FIG. 660.[1]—(Hopewell-Smith.) Transverse section of fibroid degeneration of the periodontal membrane, cut *in situ*. × 260. (*c*) cementum; (*a*) alveolar bone; (*m*) fibroid periodontal membrane, showing absence of cells, blood-vessels, nerve fibres, &c.

(C) NECROSIS OF TEETH

A tooth derives its nutritional supply from two sources, namely, the pulp and the periosteum. When the death of the pulp alone occurs, a **partial necrosis of the dentine** takes place. From a clinical point of view, this is unimportant and does not give rise to any symptoms if the canal is properly treated. When,

[1] From *Dental Cosmos*.

in addition to death of the pulp, the periodontal membrane becomes separated from the cementum, partial or complete necrosis of the tooth takes place. **Partial necrosis of the cementum** is common, and is generally the result of suppurative periodontitis. A curious condition is at times seen where a single root of a molar is laid bare (more commonly the palatine); but such a condition does not, as a rule, give rise to any trouble, and therefore calls for no treatment. In cases of **complete necrosis of the cementum,** the tooth acts as a foreign body.

(D) GRANULOMES

This is a convenient term to describe those masses of tissue often seen in connection with teeth which have been the seat of chronic periodontitis. Examples are shown in fig. 661. In some

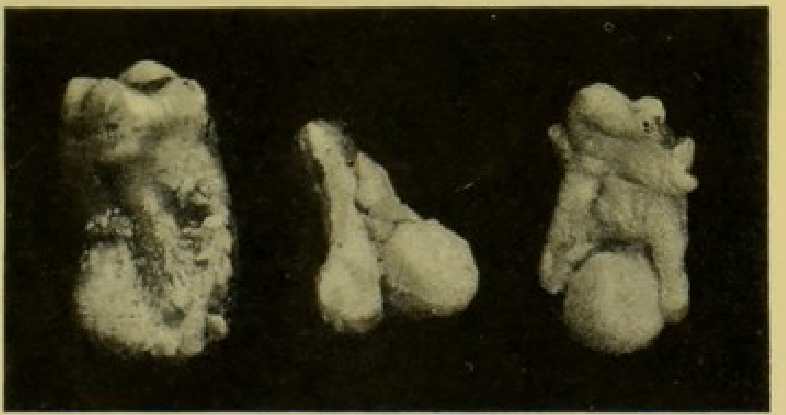
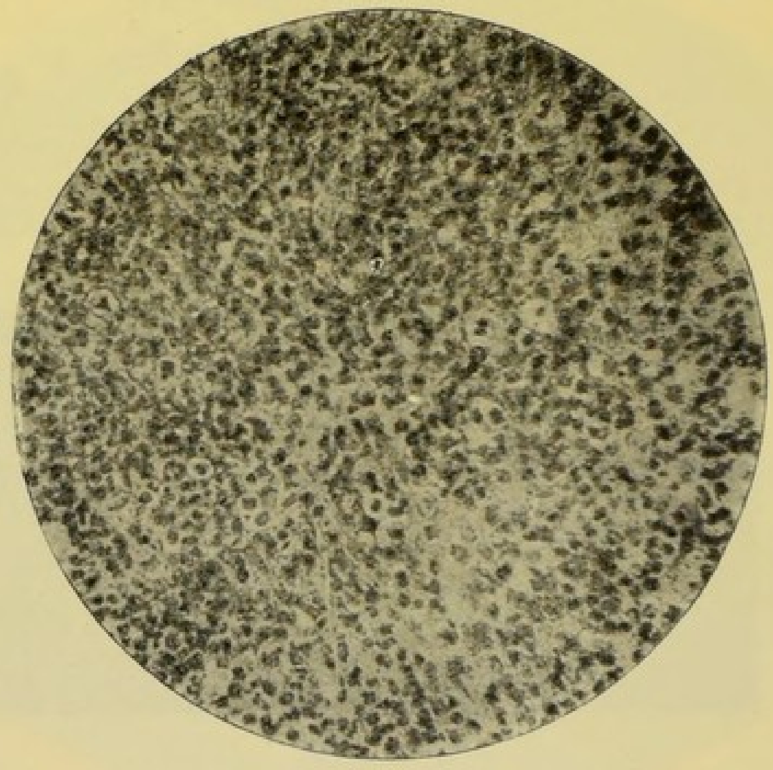


FIG. 661.

cases the mass is composed entirely of granulation tissue (fig. 662) while in others, in addition to the granulation tissue, epithelial cells or endothelial cells may be present. In a few examples a peculiar development of mucous tissue is seen.[1] The granulomes containing epithelium are stated by Romer to vary considerably in structure. In some of them there is a marked growth of epithelium, whilst, in others, granulation tissue prevails which would seem to indicate that there is a kind of struggle for existence between the epithelial and the granulation tissue. The

[1] See paper "On Granulomes and Tooth-root Cysts." Translated from the *Correspondenz-Blatt für Zahnärzte* (Ash's *Quarterly Circular*).

epithelium is not always easy to demonstrate. In the two specimens described by Dr. Romer the granulation tissue had worked its way into the root canals, and only in that situation was he able to demonstrate epithelial remnants. The epithelial remnants found in these granulomes are probably derived from the enamel organ. The formation and shape of the dentine of a root is determined by a prolongation of the enamel-forming organ known as the "epithelial sheath of Hertwig." On the formation of the



× 230.

FIG. 662.[1]—A granulome of the periodontal membrane.

dentine, the surrounding mesoblastic cells invade and partly destroy the sheath, and, applying themselves to the surface of the dentine, form the cementum and alveolar dental ligament (periodontal membrane). Portions of the sheath remain at times undestroyed and these form the periodontal epithelial remnants.

The epithelial granulome is the first stage in the development of a dental cyst.

It is quite possible that some of the varieties of sarcoma met

[1] From "The Histology and Patho-histology of the Teeth," by A. Hopewell-Smith.

with in the jaws have their origin in the root membrane. In a case recorded by Oakley Coles[1] of a second mandibular molar which had been the seat of chronic periodontitis, the structure of the small growth removed with the teeth was identical in character with a round-celled sarcoma. Mr. Hopewell-Smith[2] has also described cases of a similar nature.

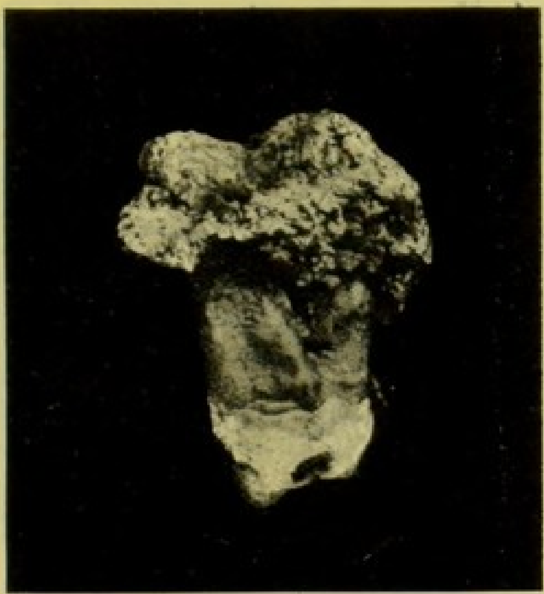


FIG. 663.[3]

(E) ANCHYLOSIS OF THE TEETH TO THE JAWS

Anchylosis of the teeth to the jaws may occur, but it is rare. The pathological changes which produce this condition between the teeth and the alveolar process are similar to those occurring in joints in other parts of the body. An interesting case came under the notice of Mr. E. Lloyd-Williams. The patient was a man suffering from suppuration, and a maxillary molar and premolar were removed with large masses of bone attached to them. Examination of the specimens showed them to be examples of anchylosis of the teeth to the bone. The molar is shown in fig. 663, while a decalcified section of the premolar is

[1] *Trans. Odonto. Soc.*, vol. xi, p. 115, "On a Tumour Arising from the Root Membrane."

[2] "On Malignant Diseases of the Periodontal Membrane," *Journ. Brit. Dent. Assoc.*, vol. xvi, p. 578.

[3] Copied from *Trans. Odonto. Soc.*

seen in fig. 664. It will be noticed that the tooth and bone are intimately connected. An interesting case of anchylosis to the jaw of a retained deciduous molar in a man, aged 40, is described by Dr. Amoedo.[1]

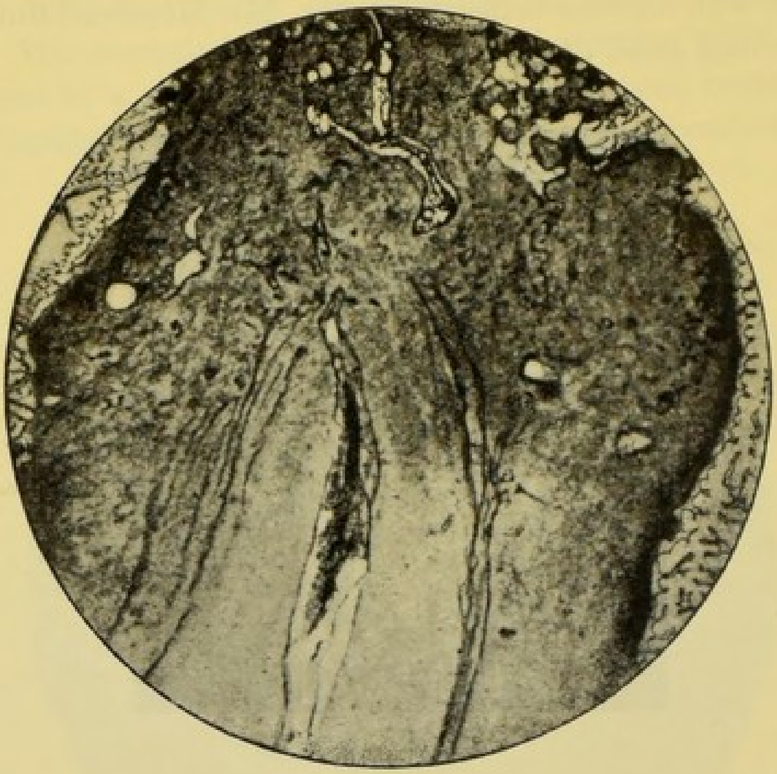


FIG. 664.[2]

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[1] *Journ. Brit. Dent. Assoc.*, vol. xvi, p. 249.

[2] Copied from *Trans. Odonto. Soc.*

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CHAPTER XVIII

Chronic General Periodontitis commencing at the Gingival Margin —Synon.: Periodontal Disease; Pyorrhœa Alveolaris; Alveolar Osteitis; Interstitial Gingivitis

The Anatomy of the Periodontal Membrane—Morbid Anatomy—Clinical Appearances—Condition of the Teeth—Sequelæ—Pathology — Bacteriology — Etiology — Treatment — Gouty Periodontitis

CHRONIC general periodontitis consists in a progressive destruction of the tooth socket, accompanied sometimes in the earlier and almost always in the later stages by a free discharge of pus from the gum margin. Descriptions of the disease will be found in the works of Ambrose Pare, Fauchard, Toire, John Hunter, and others. These authors, however, only described the disease in its advanced stages, the incipient stages not having been recognized until recent years. This disease is widely distributed throughout the human race, and is also met with in animals under domestication, and wild animals kept in captivity. It is said to have occurred in an epidemic form in Switzerland, and amongst the American troops in Cuba. During the South African War there was an outbreak amongst the Sanitary Corps stationed at Standerton, the condition being at first mistaken for scurvy. It is probable that the condition in these epidemics was the variety of "acute stomatitis" described on p. 652.

Various names have been given to the condition, *e.g.*, Rigg's disease, pyorrhœa alveolaris, alveolar osteitis, &c. The disease, as far as our present knowledge guides us, would seem to start in the gingival tissues, and thence spread to and gradually involve the whole of the tooth socket. It is this latter condition which is the characteristic feature of the disease, and it would therefore seem appropriate to describe the lesion as a chronic general periodontitis.

(A) THE ANATOMY OF THE PERIODONTAL MEMBRANE

There are a few points in the anatomy of the periodontal membrane to which reference may with advantage be made, as an appreciation of them will assist in making clear some of the theories that have been advanced to explain the etiology and pathology of periodontal disease.

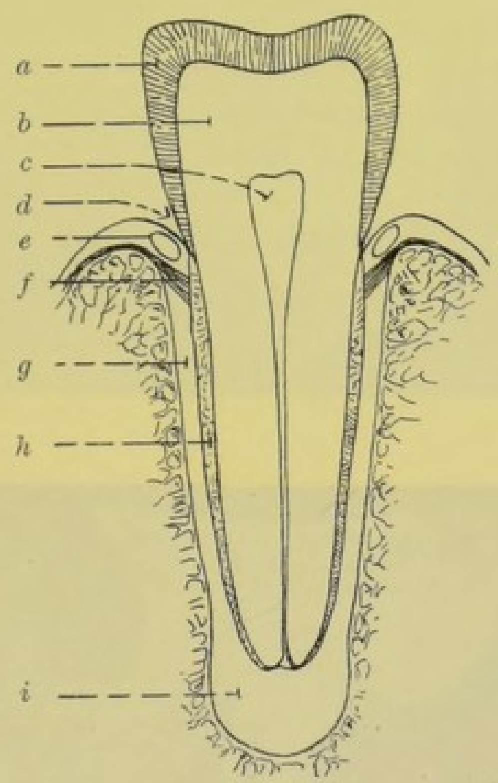


Fig. 665.—(*a*) enamel; (*b*) dentine; (*c*) pulp; (*d*) gingival space; (*e*) gland of Serres (gingival organ); (*f*) dental ligament; (*g*) periodontal membrane; (*h*) cementum; (*i*) apical space.

(1) The space between the tooth tissue and the bone is considerably greater around the apical portion of the root than in other places (fig. 665, *i*).

(2) The junction of the periodontal membrane with the muco-periosteum is marked by a density in the character of the fibrous tissue. This band of tissue has been termed by Dr. Black the *dental ligament* (fig. 665, *f*).

(3) The frequent presence in the periodontal membrane of masses of epithelium. In sheep these are arranged with apparent

regularity and, under high magnification, are suggestive of glandular epithelium.

(4) The gingival margin of the muco-periosteum is not attached flush to the tooth, but in such a way as to leave a slight valley around the tooth. The space between the gingival margin and the tooth is usually called the *gingival space* (fig. 665, *d*).

(5) In the substance of the gingival margin on the side bordering the space is a mass of cells, lymphoid in character. This mass of cells, which is called by Black the *gingival organ* (fig. 665, *e*), can readily be demonstrated in sheep, and in some sections there is an appearance of a duct leading from the gland and opening into the gingival space.

(B) MORBID ANATOMY

If specimens of human maxillæ which show this disease be examined, the first change noticed will be the disappearance of the bone between the teeth, leading to the formation of spaces (fig. 666).

Fig. 666.[1]

The next stage is marked by further destruction of the bone, the whole tooth socket being gradually involved. The bone immediately bordering the tooth disappears first, and so produces cup-like spaces around the teeth. The condition of the bone to the naked eye then presents the appearance of osteoporosis or rarefying osteitis (figs. 667 and 668).

[1] From *Trans. Odonto. Soc.*

The final stage of the disease is shown in fig. 670. In this specimen the premolars and molars have been lost, and the alveolar process has entirely disappeared.

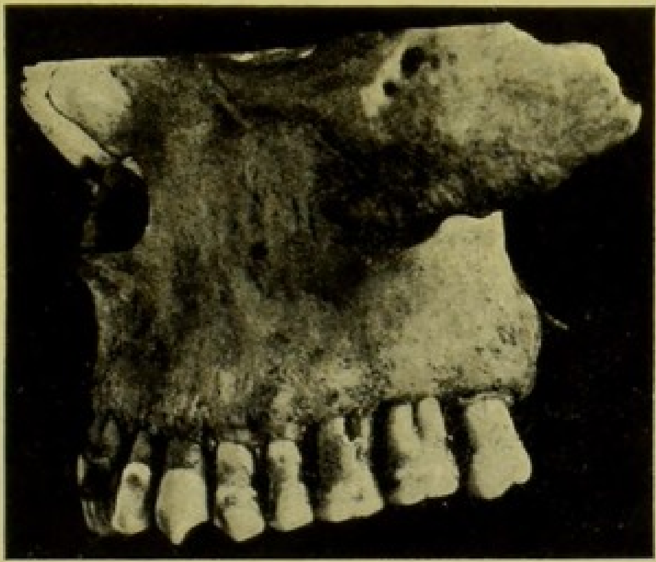


FIG. 667.[1]

FIG. 668.

In specimens showing more advanced stages the bone forming the teeth sockets will be found almost destroyed, affording but slight hold for the teeth (fig. 669).

[1] From *Trans. Odonto. Soc.*

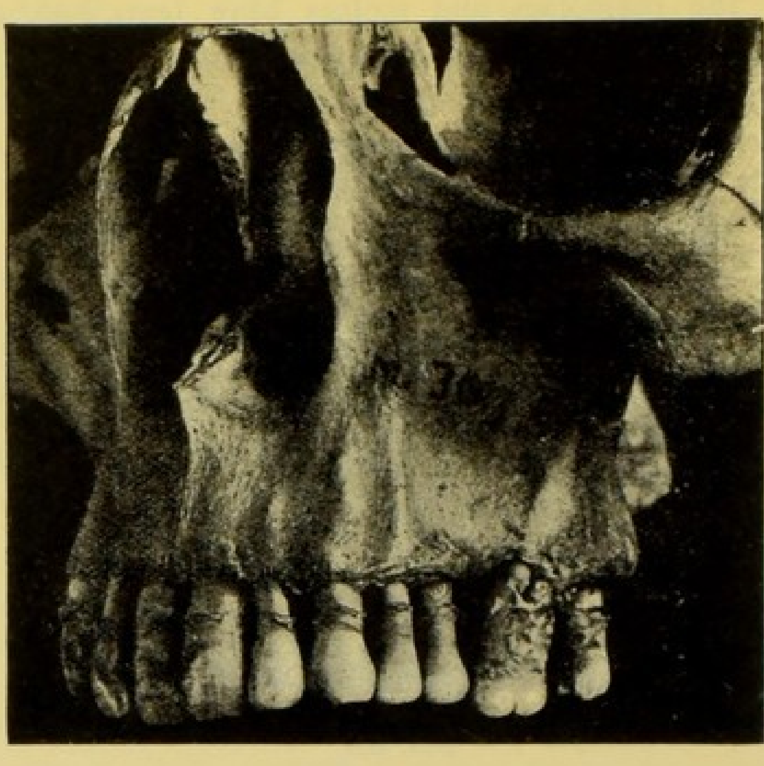


FIG. 669.[1]

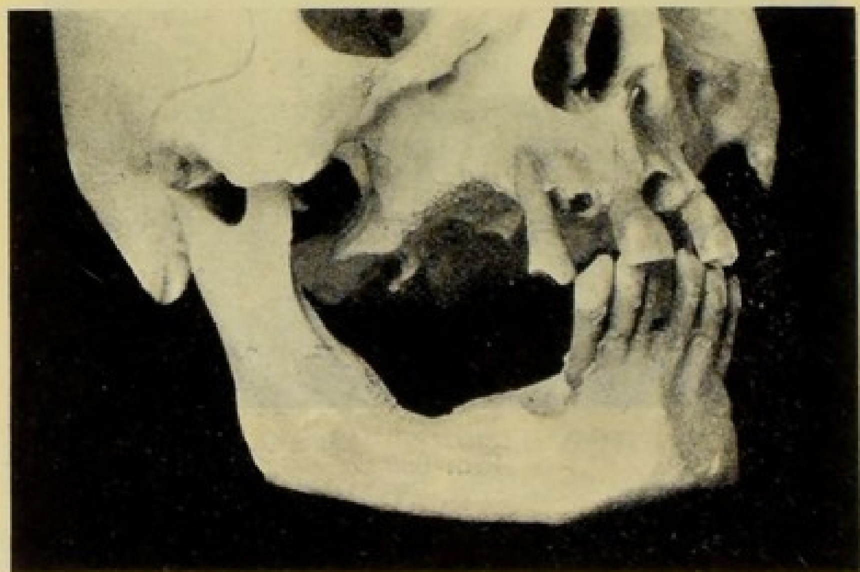


FIG. 670.

[1] From *Trans. Odonto. Soc.*

In the maxilla, especially in the region of the molars, **the bone is more involved in the disease than is the case in the mandible.** This is to be accounted for by the different nature of the osseous tissues in these two bones. Irregular patches of calculus will often be seen on the teeth near the necks, and at times the surfaces of the roots will be found completely covered with an irregular dark brown deposit. In some specimens the extent of the changes around the teeth appears to be slight, the margin of the alveolar process having receded, but the bone itself presenting a sclerosed rather than an osteoporotic condition. In these specimens, too, a considerable thickening of the outer alveolar plate will at times be noticed (fig. 671).

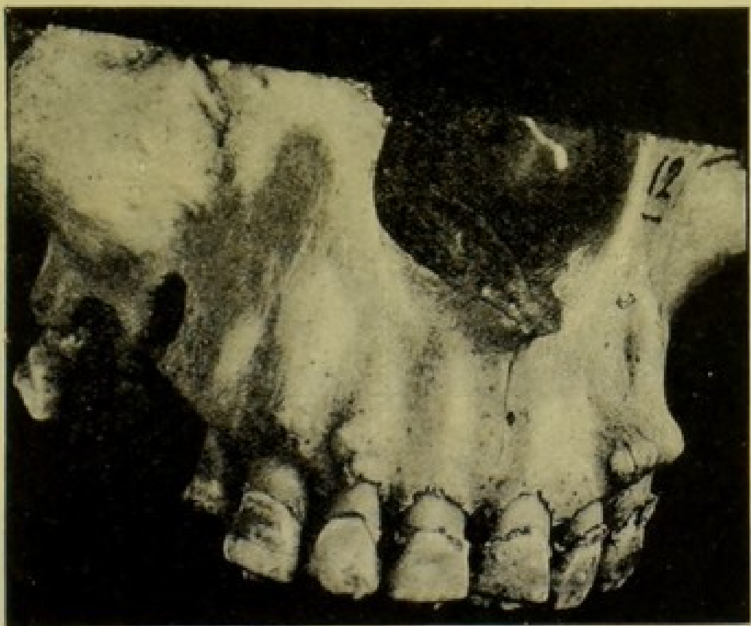


FIG. 671.[1]

In **animals** that have been the subjects of this disease exactly similar changes are to be found in the bones, but the teeth show greater deposits of calculus owing to the absence of the system of artificial cleaning adopted by human beings, and recent specimens will often show the spaces between the teeth choked up with food *débris*.

The following specimens show the different stages of the disease in animals :—

[1] From *Trans. Odonto. Soc.*

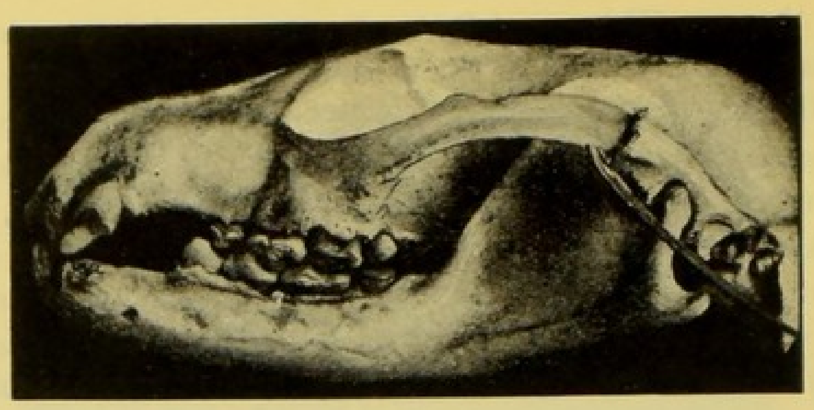


FIG. 672.

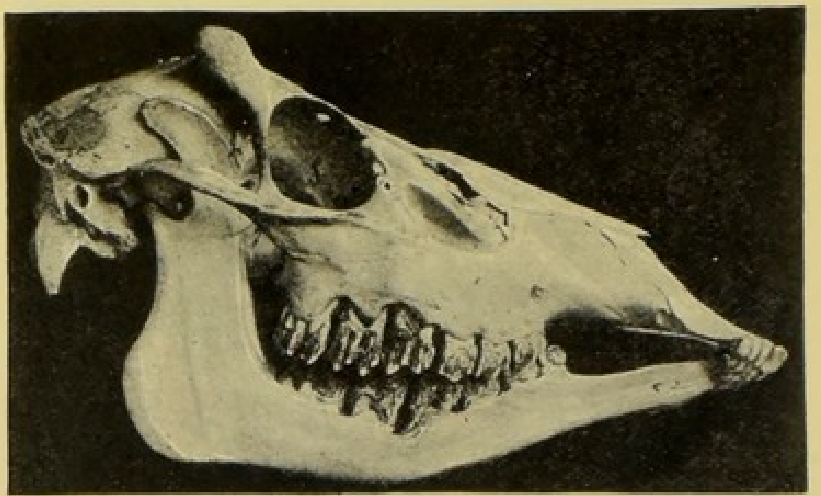


FIG. 673.[1]

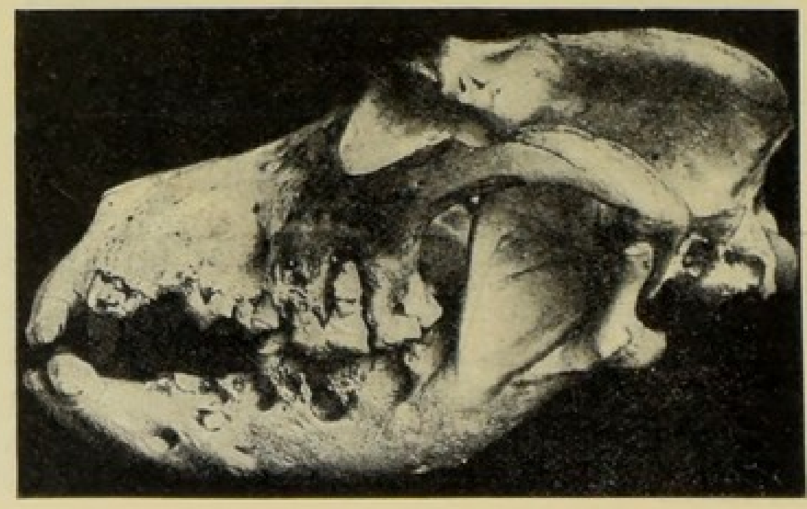


FIG. 674.[1]

[1] From *Trans. Odonto. Soc.*

Fig. 672 is the skull of a Chinese palm-civet (*Paradoxurus larvatus*), and shows the cupping of the sockets, the result of rarefying osteitis.

The next specimen (fig. 673) is one from a Panolia deer (*Cervus eldii*); the destruction of the bone is most marked in the region of the molars where the food is most liable to lodge.

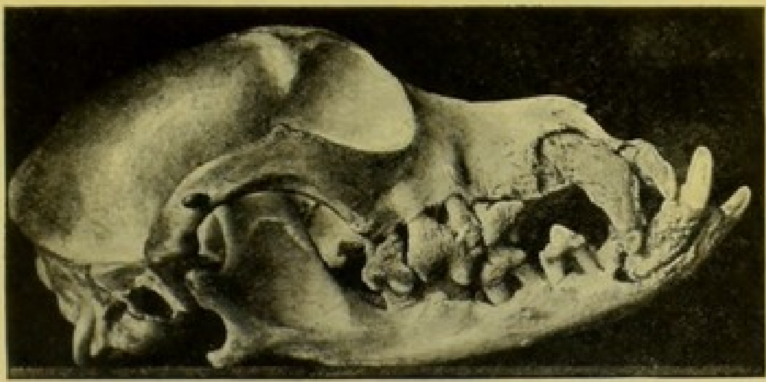


FIG. 675.[1]

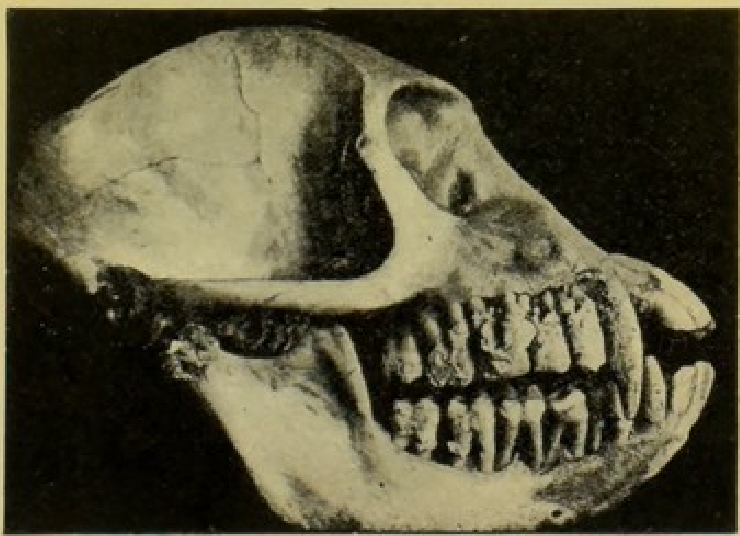
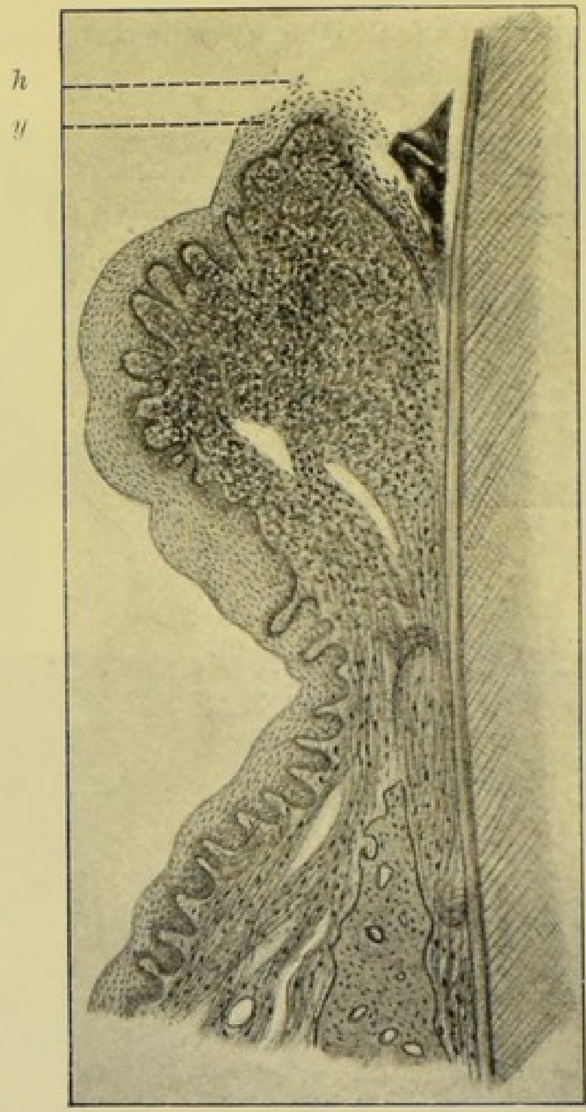


FIG. 676.[1]

Fig. 674 is a specimen of a spotted hyæna (*Hyæna crocuta*), and shows very clearly the marked destruction of the alveolar process from rarefying osteitis. This is the stage where the teeth are almost on the point of dropping out.

[1] From *Trans. Odonto. Soc.*

An example of this disease in a domestic dog (*Canis familiaris*), is shown in fig. 675, and is a fair sample of the mouths of many of these animals.



× 80.

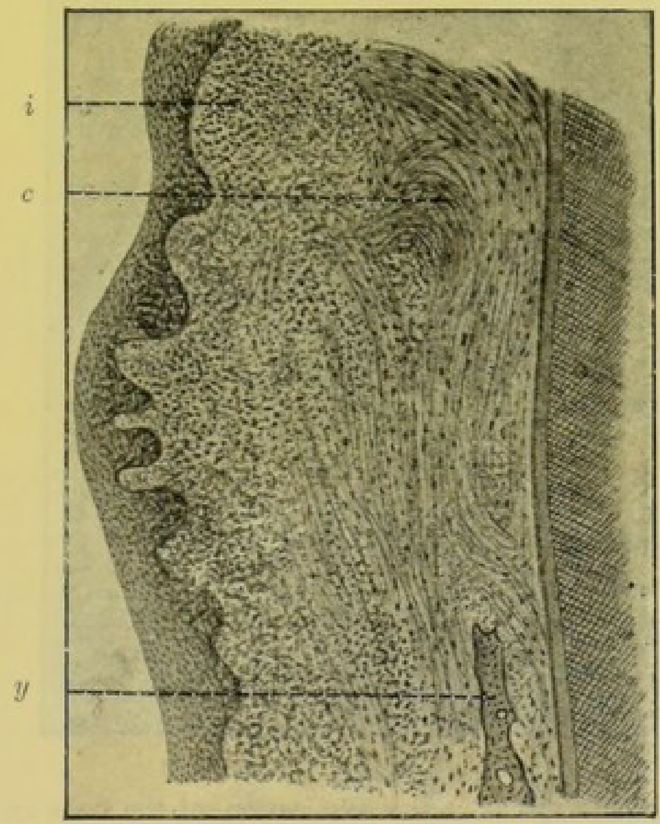
Fig. 677.[1]—In this section the infiltration of the gum margin with leucocytes is seen. At (*h*) the epithelium is destroyed. The bone is normal.

The specimen, fig. 676, shows an advanced state of the disease in a Vervet monkey (*Cercopithecus lalandii*).

Microscopical investigation of the tissues in the various stages of this disease has not been carried out to any consider-

[1] From *Journ. Brit. Dent. Assoc.*

able extent. A useful paper was published by Znamensky.[1] This author records the result of his examination of sections obtained from a female aged 39; she had suffered from pyorrhœa alveolaris. The patient died of acute anæmia, the result of hæmorrhage after parturition. The decalcification of the preparations was accomplished by means of a 3·5 per cent. solution of trichloracetic acid. Some of the sections were stained with eosin and



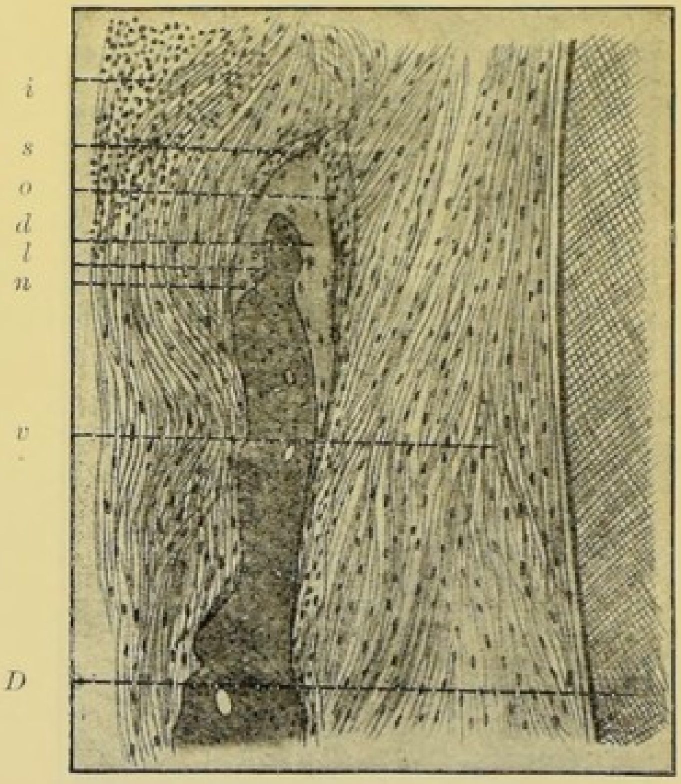
× 80.

FIG. 678.[1]—This section shows that the inflammatory process proceeds from the periphery, namely, from gum towards the bone. (*i*) gum infiltrated with leucocytes; (*c*) normal gum; (*y*) normal bone.

hæmatoxylin and others in Loeffler's blue, and the sections were afterwards mounted in Canada balsam. The series of sections showed the progressive development of the pathological process in this case. In all the sections a deposit of calculus was present under the gum margin. The sections showed that the pathological process was of an inflammatory character, originating in the gum, and then successively involving and leading to the

[1] *Journ. Brit. Dent. Assoc.*, vol. xxiii, p. 585.

destruction of the periodontal membrane and the adjacent bone. The destructive process in the bone near the margin of the socket consisted in decalcification of the bone and transformation first into an osteoid tissue and afterwards into a fibrous intervening tissue with the subsequent infiltration of the latter with leucocytes. In the part of the socket where the bone-marrow



× 180.

Fig. 679.[1]—In this specimen the implication of the bone in the disease is shown. (*i*) infiltration approaching from the gum towards the bone; (*s*) bone transformed into fibrous intervening tissue; (*o*) osteoid tissue; (*d*) bone partially decalcified; (*n*) bone corpuscles; (*l*) line dividing the healthy from the unhealthy bone; (*v*) periodontal membrane; (*D*) dentine.

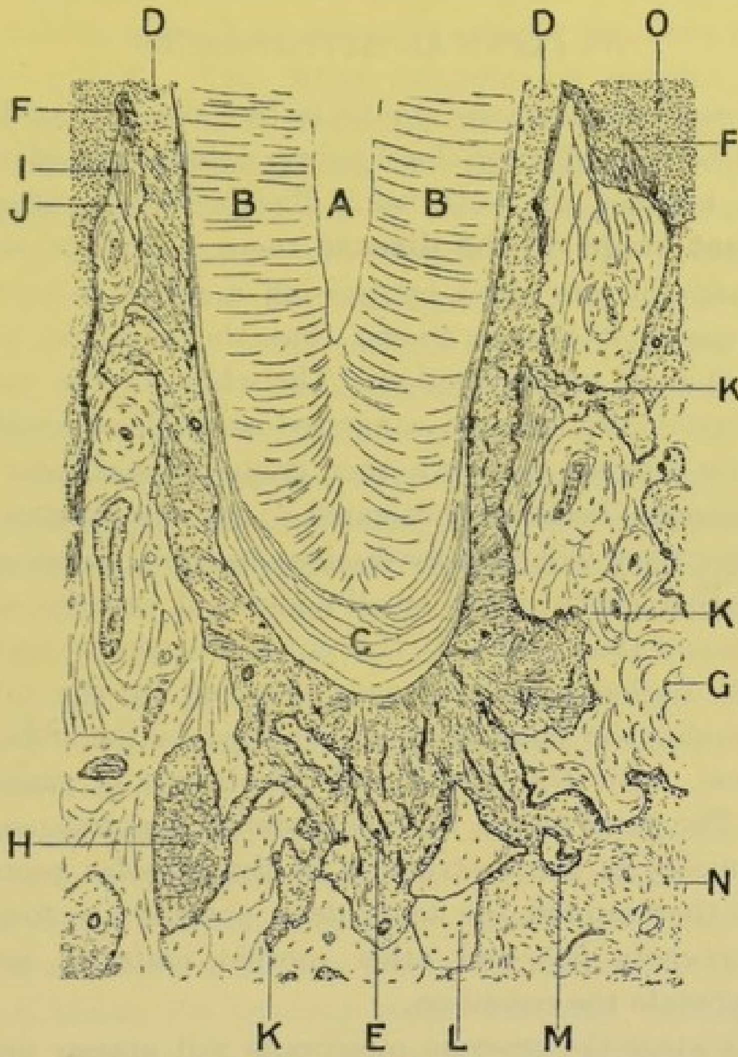
was present lacunar absorption of the bone was seen. The whole process was of the type of a rarefying inflammation (see figs. 677 and 679).

Dr. E. S. Talbot[2] has examined the patho-histology of the disease in a series of dogs and has shown that the earliest manifestation is in the gingival margin, and that with the progress of

[1] From *Journ. Brit. Dent. Assoc.*

[2] "Interstitial Gingivitis."

the disease both the periodontal membrane and the bone become involved. The absorption of the bone is at times quite rapid



(From a drawing by Mr. A. Hopewell-Smith.)

FIG. 680.[1]—(A) Pulp cavity; (B) dentine of tooth; (C) hyperplasic cementum around apex of root; (D) periodontal membrane, greatly thickened—hyperplasic; (E) indifferent tissue at apical region greatly increased in amount; (F) free edge of bone of socket becoming converted into fibrous intervening tissue; (G) bone of socket presenting earliest signs of osteoporosis; (H) large osteoporotic space in bone of jaw filled with bone-marrow; (I) bone of socket partially decalcified and converted into osteoid tissue; (J) junction of living with decalcified bone; (K) osteoclasts producing lacunar absorption; (L) bone of jaw only slightly altered by disease; (M) sequestrum undergoing peripheral absorption; (N) soft, cancellous tissue slightly changed from normal; (O) inflammation of gum at neck of tooth.

and takes place by (*a*) lacunar absorption; (*b*) the formation of perforating canals; and (*c*) halisteresis (disappearance after prior absorption of lime salts).

[1] From *Lancet*.

The main features of the condition of the bone are well shown in fig. 680, a section taken from the human subject.

(C) CLINICAL APPEARANCES

In a young adult whose mouth is in a normal condition the gums will be noticed to fit closely around the necks of the teeth, the spaces between the teeth being filled with tags of gum. In **the earliest stage of the disease** there is a slight congestion of these tags of gum, and by passing a probe into the inter-proximal spaces it can be shown that the gum has undergone a certain amount of destruction. The whole of the margins of the gums gradually become congested and bleed readily. The tags of gum between the teeth then gradually disappear and the normal festoons become obliterated. An examination of the teeth at this stage will usually disclose in the approximal spaces food and other *débris*, while small nodules of calculus are generally present on the teeth. If the gums are compressed a small quantity of discharge may be seen escaping by the side of the teeth. Finally, the bone becomes involved in the inflammatory process, and, with the periodontal membrane, is gradually destroyed. The gums recede, but the recession does not usually proceed as quickly as the destruction of the alveolar process, with the result that around the teeth deep pockets are formed, and in these pockets pus and other morbid material accumulate and so aggravate the condition.

At this stage the mucous membrane will appear deeply congested, the gums are swollen at their free margins and bleed readily on the slightest touch. The roots of the teeth are more or less exposed, and covered with a layer of hard greenish-brown calculus; there is a fœtid discharge and the breath has a repulsive odour due to indol-forming organisms. A sickly, sour odour of the breath is noticeable when yeasts and bacteria causing carbohydrate fermentation are present. The teeth are freely movable and may become so loose that they can be removed quite easily. If the disease is left untreated the teeth are lost one by one, and with the loss of the teeth the inflammatory process completely clears up.

In advanced cases superficial glossitis is often present, and

the tonsils and pharyngeal mucous membrane are also inflamed. An unpleasant taste is experienced in the morning. There is constant hæmorrhage from the gums, which is swallowed during the day, but at night it occasionally escapes from the mouth and stains the pillow. This latter symptom is worthy of special attention, as it may be mistaken for hæmorrhage from the lungs.

The **clinical appearances of the disease,** which **vary considerably,** are determined by the general condition of the patient, the resistance of the tissues, and the hygiene of the mouth. At one period the condition may be acute, with a free flow of pus from the teeth sockets and a rapid destruction of the tissue. This state of evanescence is, perhaps, followed by a period during which the inflammation may be only slightly marked. In some cases the teeth are comparatively free from calcareous deposits; in other cases they are completely coated. The disease, too, may be more active around the anterior than the posterior teeth, or *vice versa*. Again, the destruction of tissue may be more active in one region of the mouth than another. This is exemplified in the case of the incisors and canines, the destructive process being often more advanced on the palatal than on the labial aspect.

In severe cases the disease may spread in the maxilla to the antrum, or in the mandible to the body of the bone.

"The buccal mucous membrane in advanced cases shows a number of small white stellate points, somewhat hard and shotty, lying underneath the mucous membrane, and corresponding in position to the site of the disease of the gum margin. From these glands bacteria of various species, generally bacilli, may be obtained" (Goadby).

In some cases, where the hygiene of the mouth is carefully looked after, the gums appear fairly normal in colour, and abnormal looseness of the teeth is the only indication of the presence of the disease. In these cases the probe discloses deep pockets, and, on pressing the gum, a discharge can be expressed from the teeth sockets. In a few cases the disease is slow in its progress, and the surrounding bone actively reacts to the injuries caused by the toxic products in the sockets. This is well seen in the case shown in fig. 681.

In certain cases there seems to be a tendency to the formation

of granulation tissue, causing the condition to simulate sarcoma. In one case under observation, associated with myxœdema, the gums were friable and presented a translucent appearance.

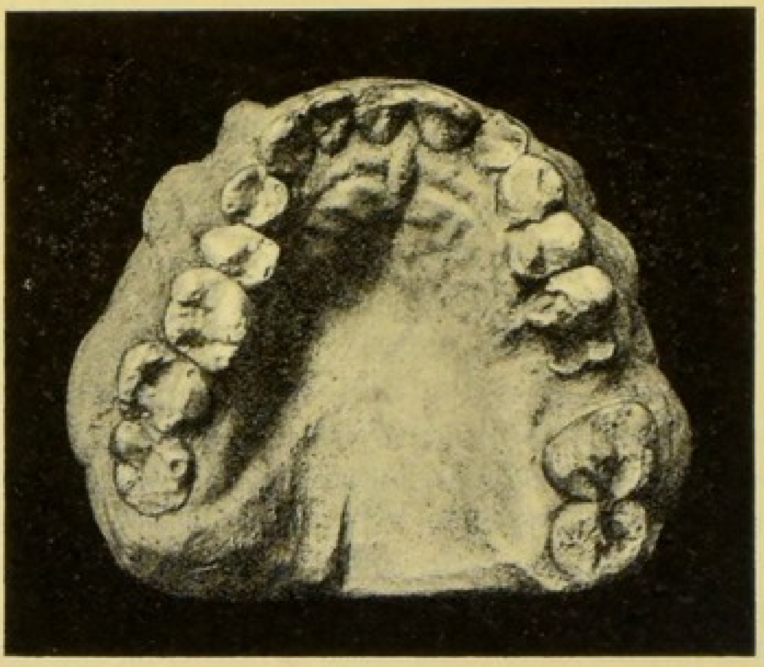


FIG. 681.—From a case under the care of Mr. J. G. Turner.

The disease may often be well advanced without the patient being conscious that anything is wrong, the only symptom being a tendency for the gums to bleed readily, and this is often unheeded by the patient. With the formation of spaces between the posterior teeth, neuralgia, arising from irritation of the exposed cemental tissue, may be present. In the later stages there is often persistent neuralgia owing to the main trunks of the nerves being involved in the diseased process. Where pus formation is active the patient will often complain of a general itching of the gums.

Whether the disease can be transmitted from one individual to another is an open question, but the balance of evidence is rather against it.

Clinical appearances alone are not altogether satisfactory guides as to the extent of the disease, and it is only by the aid of radiography that the amount of the bone destruction

can be estimated with any degree of accuracy. The following cases will serve to demonstrate the amount of bone destruction in relation to the clinical appearances.

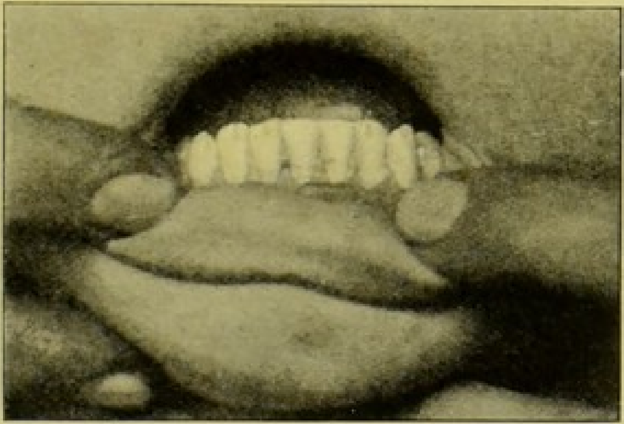


FIG. 682.

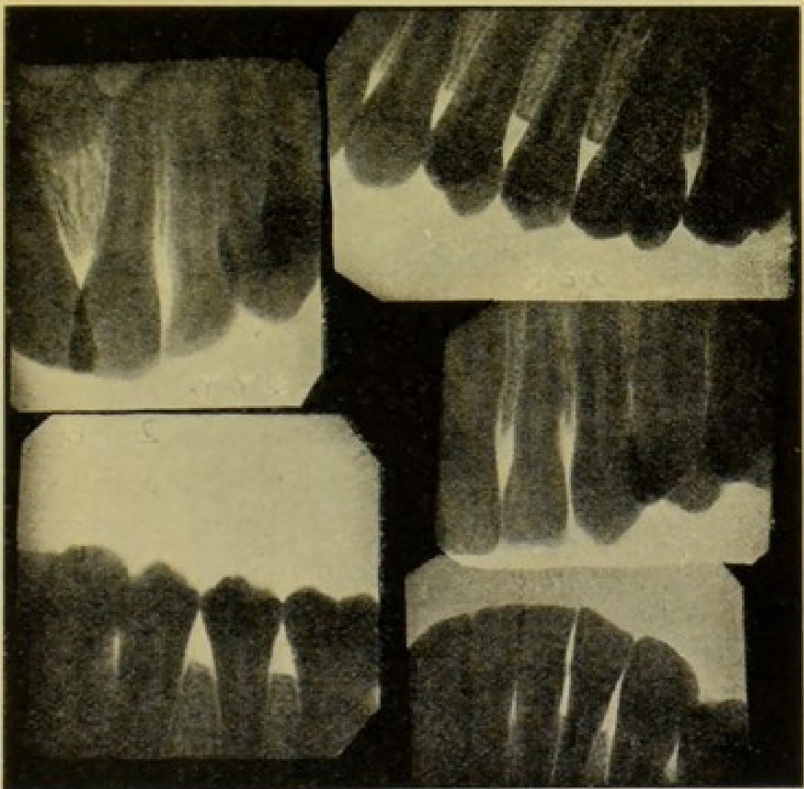


FIG. 683.

In fig. 682 is seen the mandibular incisor region of a girl aged 15. The gums were normal in appearance, with the exception of the gingival margins around the median incisors

and the left lateral and canine, where the gums were inflamed and the interdental papillæ slightly thickened. Examination with a probe at these points showed the presence of slight "pockets."

The radiographs show the alveolar process to be normal, with the exception of the lower incisor region where the septa between the teeth have been partially destroyed (fig. 683).

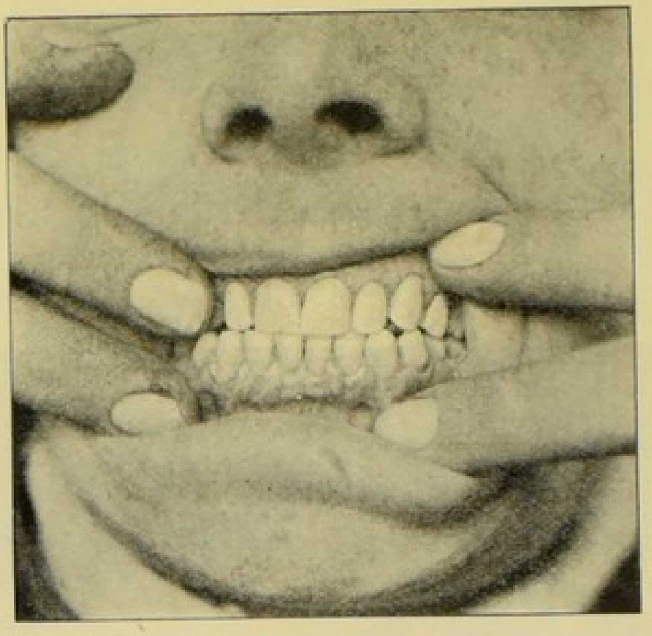


Fig. 684.

The case shown in fig. 684 depicts an early stage of the disease. Clinically there is no recession of the gums beyond a partial disappearance of the interdental papillæ between the lower incisors. There was a marked marginal gingivitis, together with a congestion of the whole of the gums. There was a free discharge from the pockets around the teeth. This patient had a well-developed arch and there was marked attrition. The radiographs show that the alveolar process is already involved, and that the destruction of bone has advanced to a considerable extent in the lower incisor region (fig. 685).

In the case shown in fig. 686 the clinical appearances suggest a more advanced condition of the disease than in the preceding case. The muco-periosteum was more swollen and congested.

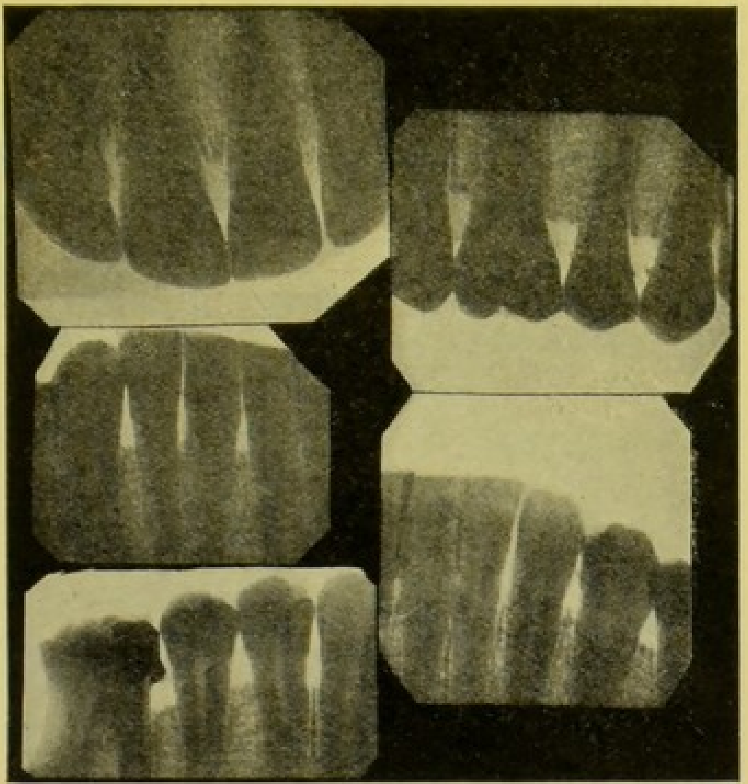


Fig. 685.

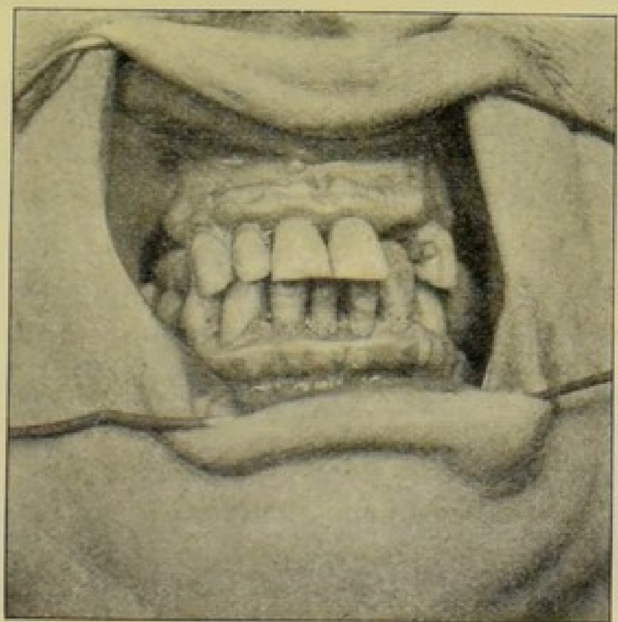


Fig. 686.

The interdental papillæ have quite disappeared, but the gum margin on the labial aspects of the teeth just fails to cover the necks of the teeth.

The radiographs show that the bone destruction is much more advanced than the gum recession. The level of the gum is well shown in the radiographs (fig. 687).

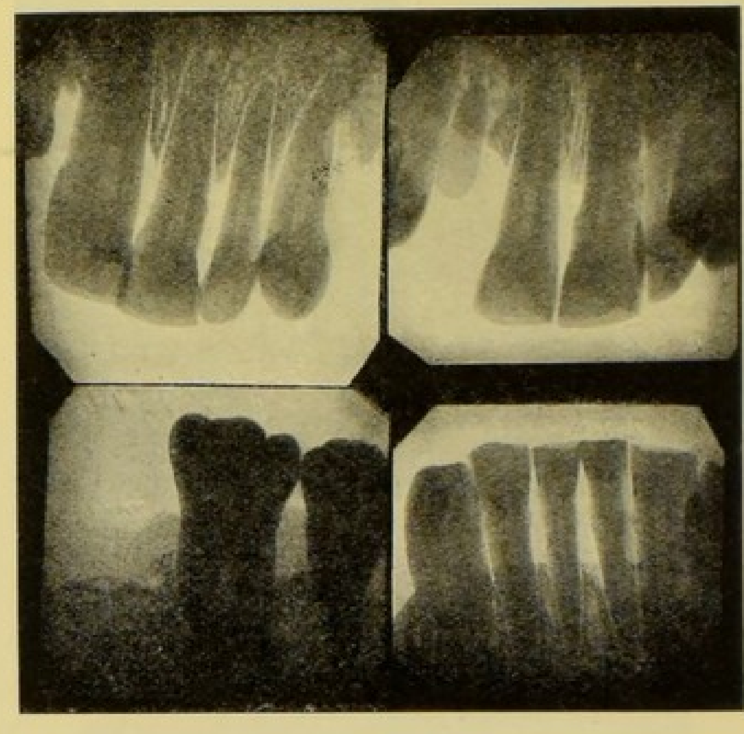


Fig. 687.

The case shown in fig. 688 illustrates an advanced condition. The radiographs show the extensive destruction of the teeth sockets. Those marked *a* and *b* also illustrate a point, namely, that the calculus only extends to just under cover of the gum margin. Rarefying osteitis around the roots of a maxillary molar is shown at *c* (fig. 689).

The case shown in fig. 690 illustrates some features which are of interest from the point of view of prognosis. The patient, a man, aged 34, was a compositor by trade, and was subject to dyspepsia. Beyond a well-defined marginal gingivitis the gums were normal in colour and firm in consistency. The teeth were smothered with calculus, the gum margin was above the necks of the teeth, and the interdental papillæ had disappeared.

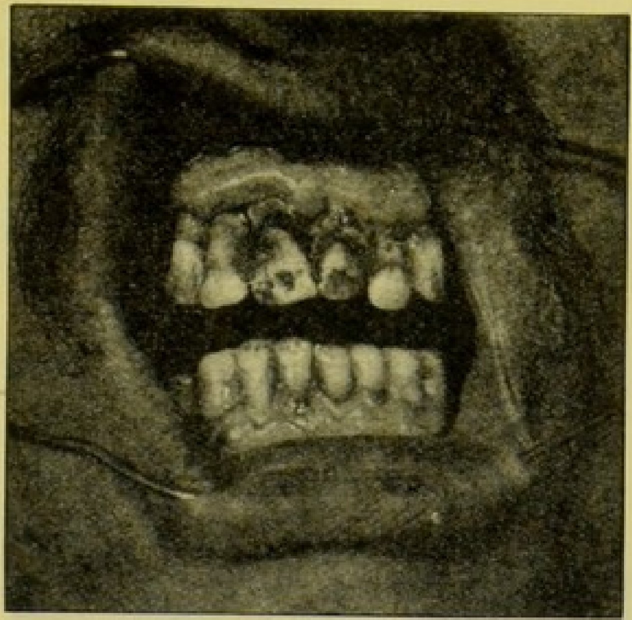
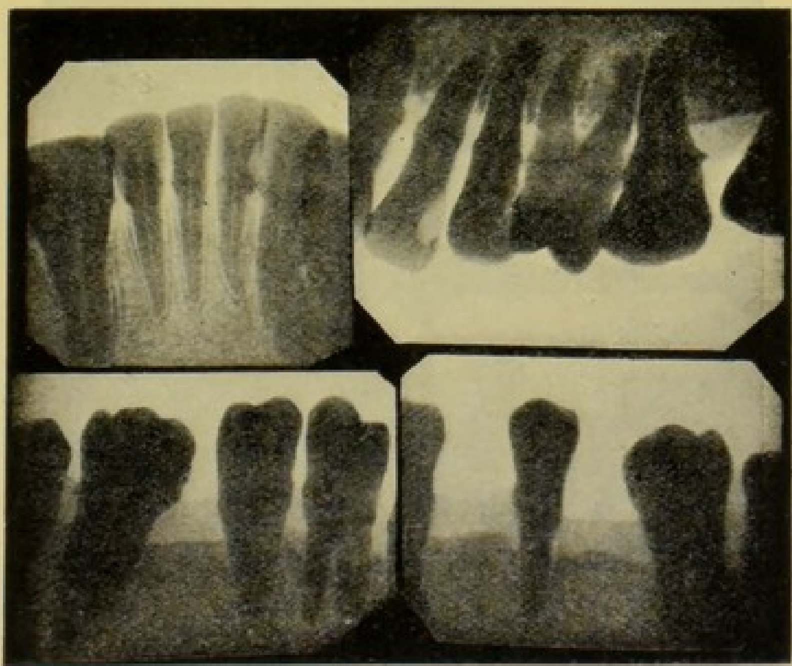


FIG. 688.

(c)



(a)

(b)

FIG. 689.

Examination with a probe showed slight pockets around the teeth. The clinical features suggested that the disease was of slow progression, and that there was comparatively little bone destruction.

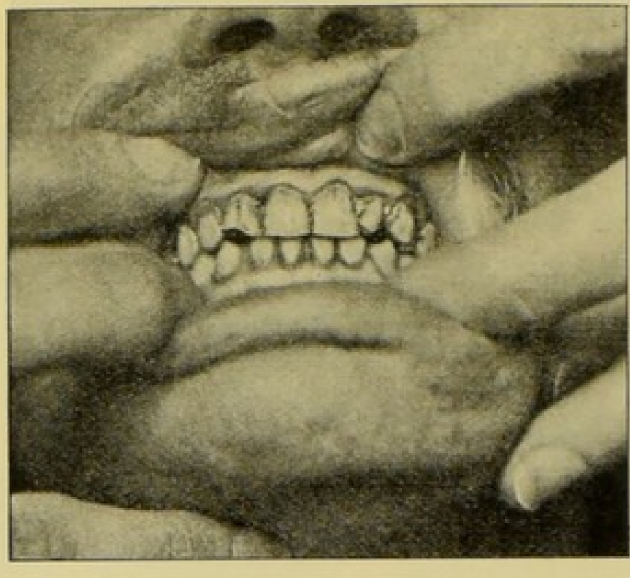


Fig. 690.

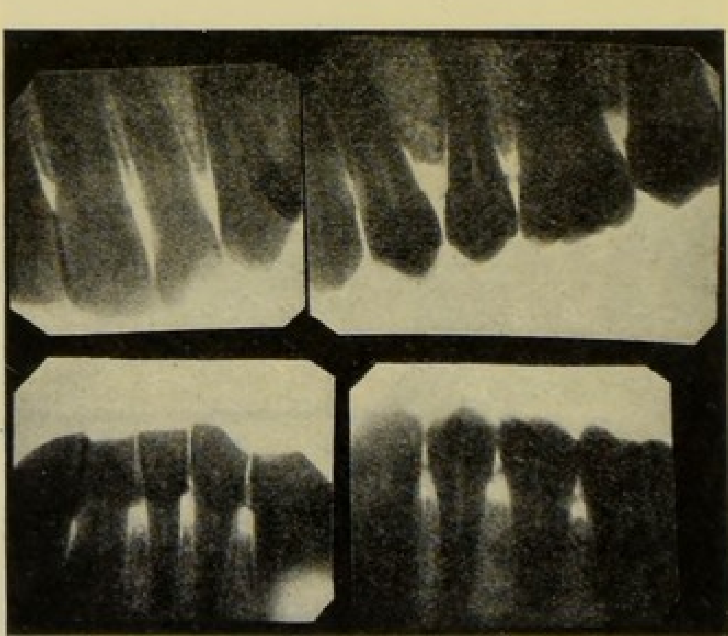


Fig. 691.

The radiographs show that the destruction is equal in all parts of the mouth, and that the inflammatory process extends only slightly beyond the margin of the bone (fig. 691).

In the case shown in fig. 692 the patient was a mouth-breather and complained of bleeding from the region of the mandibular

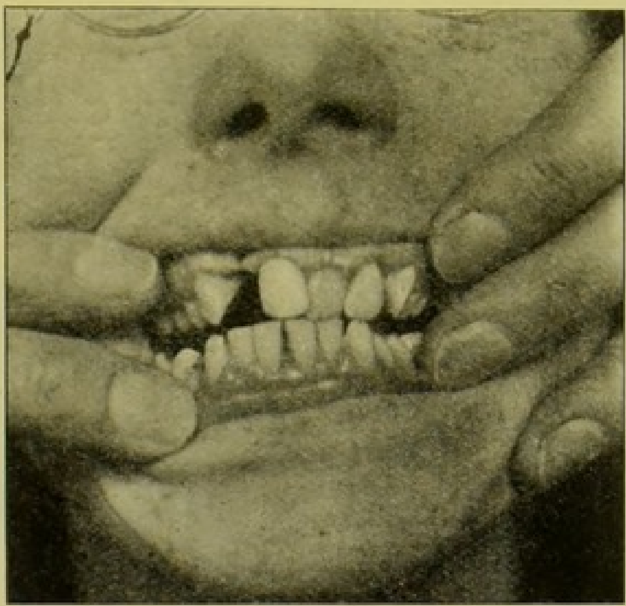


Fig. 692.

Mandibular incisors

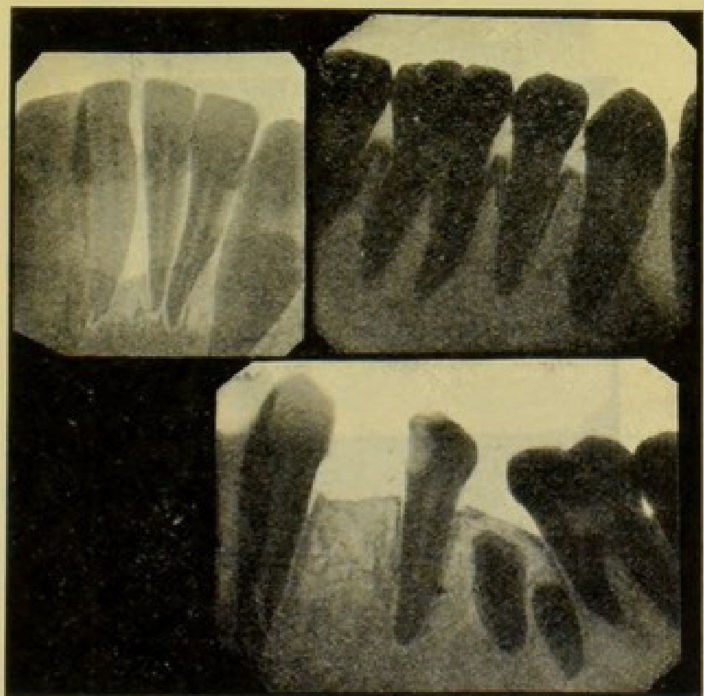


Fig. 693.

incisors. The teeth had been regularly cleaned. The gums were well up to the level of the necks of the teeth, and the interdental papillæ were not destroyed. There was marked gingivitis around

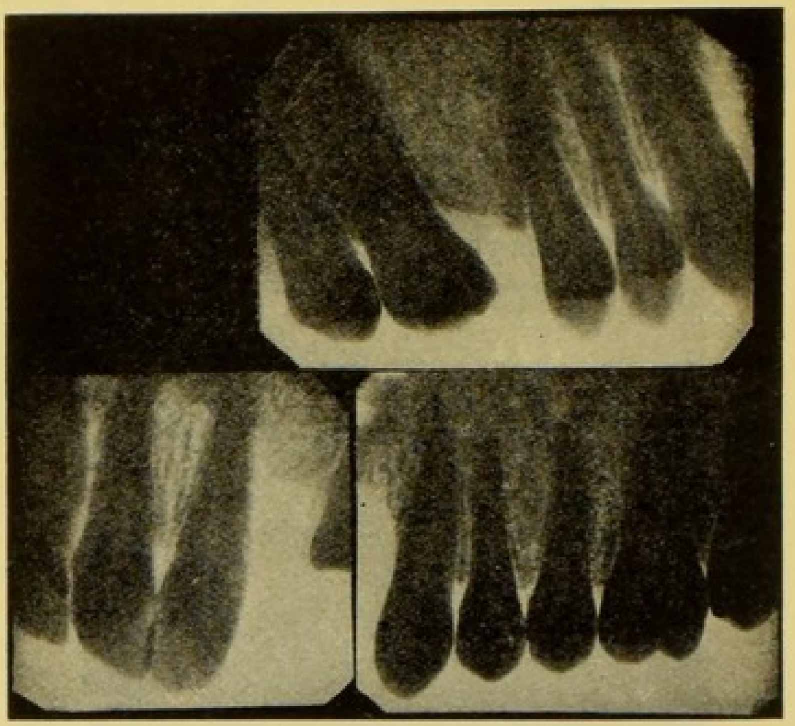


Fig. 694.

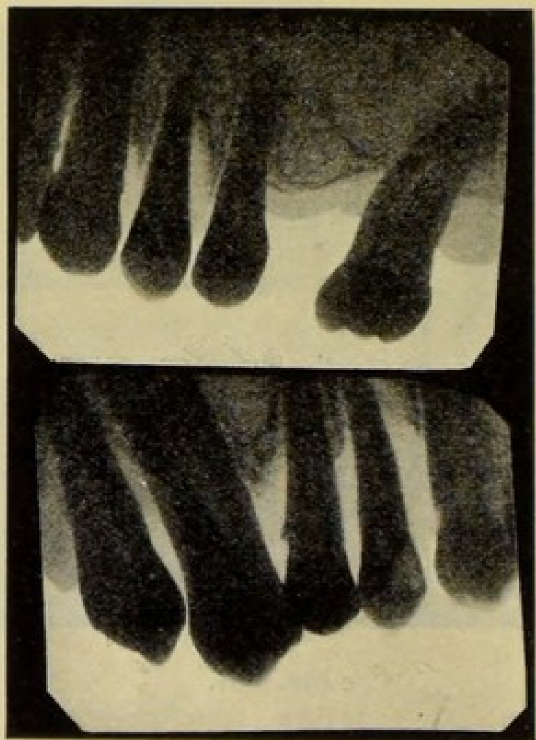


Fig. 695.

the mandibular incisors where pus was present. An examination with a probe showed that there was extensive destruction of the alveolar process in the region of the mandibular incisors, while in the rest of the mouth the bone was unaffected.

The radiographs shown in figs. 693 and 694 demonstrate these points.

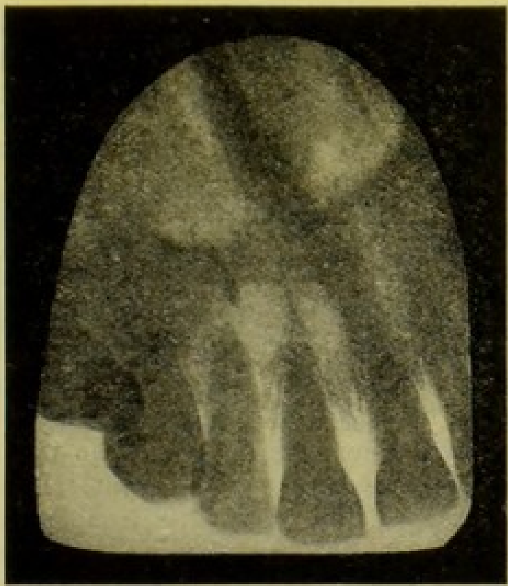


Fig. 696.

The radiographs seen in fig. 695 show an advanced stage of bone destruction and also serve to demonstrate the liability of the antra to become infected in these cases. Note the relation of the antra to the molar teeth.

In the case shown in fig. 696 the alveolar process on the mesial aspect of the lateral incisor has been completely destroyed, and infection of the bone around the apices of the lateral and central incisors has followed. This patient presented a well-defined dento-alveolar abscess, with the pulps of the teeth alive.

(D) CONDITION OF THE TEETH

Teeth removed in chronic periodontal disease often show in places adherent masses of periodontal membrane and absorption of the cemental tissue. Histological examination often shows small areas of semi-necrosed bone imbedded in these adherent

masses of tissue, rarefaction of the alveolar process having spread a considerable distance from the tooth socket.

(E) SEQUELÆ

The various local and general sequelæ that may arise from the presence of pus in the mouth are discussed in chapter xxv. But there is one point here upon which particular stress must be laid, and that is that the *absence of objective symptoms is no proof that damage—and possibly irreparable damage—is not in progress.* Patients will go on with pus in their mouths for years without apparent harm, but eventually general symptoms may appear. The following case is typical :—

A man, aged about 36, at the beginning of 1909 developed a swelling in the left maxilla, and examination of the mouth showed slight necrosis in this region with general suppurative periodontitis, necessitating the removal of all the teeth. This was the previous history of the patient : his normal weight was about 13 stone, he was an exceptionally fine type of man and had succeeded in carrying off many prizes in important athletic military contests. About the beginning of 1907 he discovered that he was losing weight, and in February, 1909, he weighed only about 9 stone. During this period his mouth had, he said, caused him very little trouble, except that he had neuralgia occasionally, and his teeth had from time to time become loose. All his teeth were eventually removed, and a rapid improvement in his general condition followed. On questioning this patient a very definite history of periodontal disease spreading over a dozen years was obtained.

This patient had, unknown to himself, been the subject of periodontal disease for years, and for a long period he had been able to combat the absorption of the toxic matter, probably by the production of antibodies, and so remain immune. After a time this immunity had broken down, and the toxic material became rapidly destructive to the tissues.

(F) PATHOLOGY

A study of this disease in animals will throw considerable light upon its pathology.

(1) **Horses.**—In the course of an examination of nearly 500 skulls of horses which had worked in London it was found that approximately one-third presented some degree of periodontal disease, ranging from a slight destruction of the gingival margin to the most aggravated form of the disease.

The first sign of mischief is a slight injury to the gingival margin, resulting in the destruction of the muco-periosteum filling up the intervals between the teeth. These spaces are usually seen in the maxilla on the buccal side and in the mandible on the lingual side. In the spaces formed, food, &c., collects and undergoes fermentation, leading to the destruction of the adjacent tissues, so that in time a marked space is formed between the teeth into which fodder or other material may become firmly wedged (figs. 697 and 698). As the disease progresses the periodontal membrane becomes more and more involved, leading to

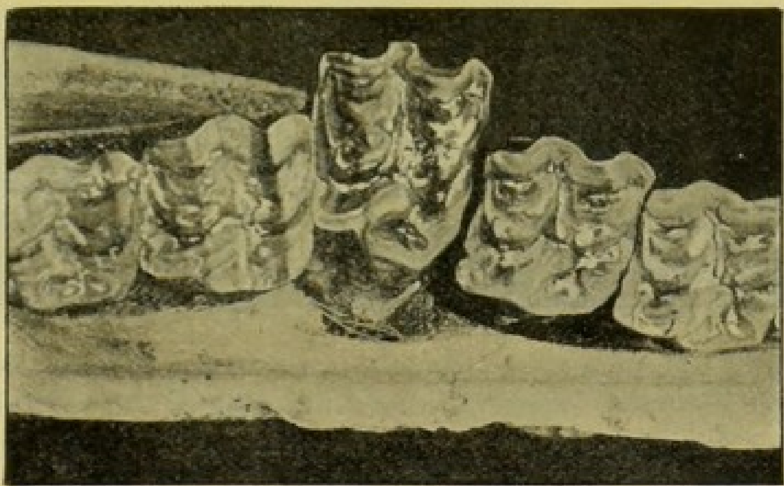


Fig. 697.[1]—Portion of maxilla of horse, showing destruction of the bone around the teeth. The disease is most marked in the neighbourhood of the first molars.

extensive destruction of the bone; the teeth loosen, and the infection spreads in the maxilla to the antrum, setting up suppuration, and in the mandible to the body of the bone, causing an abscess.

If a horse in which the disease is advanced be examined, the muco-periosteum is seen to be inflamed and thickened (see fig. 699) and a profuse muco-purulent discharge will be noticed around the teeth, the breath being extremely offensive. The mandible is much more liable to attack than the maxilla, and, as far as my own observations go, more spaces are met with between the anterior premolars than between the molars, but the spaces formed between the premolars do not apparently set up the same

[1] From *Trans. Odonto. Soc.*

amount of trouble as those found towards the back of the mouth. In the maxilla spaces seem to occur with the greater frequency towards the back of the series. As a result of the spaces the

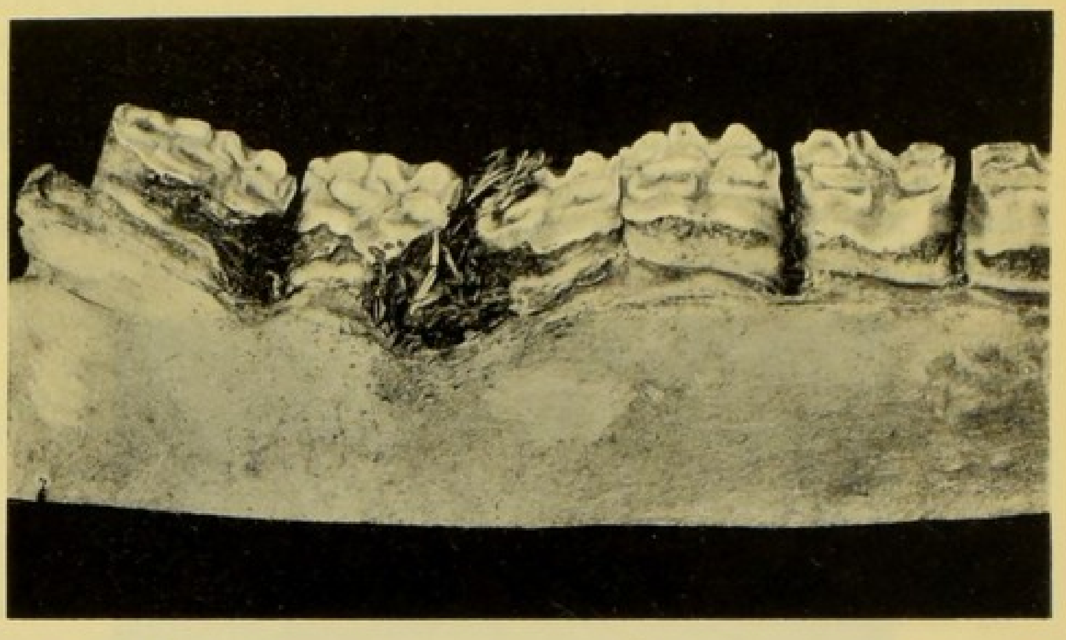


FIG. 698.[1]—Portion of the mandible of a horse showing food packed between the teeth.

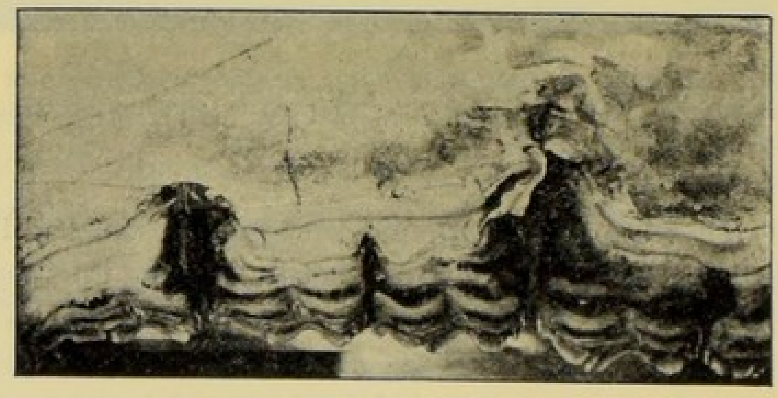


FIG. 699.[1]—Portion of the mandible of a horse with the muco-periosteum in position. The effect of the food packing in the soft tissues is well shown.

teeth become painful to pressure, and the function of mastication is interfered with, leading in many cases to marked irregular wear of the teeth. In some cases only one or two spaces are seen, in others huge gaps occur between nearly all the teeth.

[1] From *Trans. Odonto. Soc.*

The incisors may be attacked by periodontal disease. The effect on the incisors is very similar to that seen in the human subject; the alveolar process disappears, the teeth loosen, become forced out of place, and are finally lost.

The fact that the spaces start on the buccal sides of the upper teeth and on the lingual aspect of the lower teeth, and that the bone destruction is greatest in the region where the food is most liable to collect, would seem to suggest that food lodgment plays an important part in the causation of the disease.

In the horse the disease would seem to be mainly local in origin. The injury of the muco-periosteum is probably due to foreign bodies in the diet. In some cases possibly it may arise from the food prepared in the form of chaff, or it may arise from grains of corn becoming wedged in, on the one hand by the cheek, and on the other by the tongue. To the fermenting food in the spaces, infection, from organisms present in or introduced into the mouth, is added, and from the toxins so produced the tissue destruction proceeds. With the loss of the teeth a nidus no longer exists for the accumulation of *débris*, &c., and healing occurs.

(2) **Cats and Dogs.**—Amongst domestic cats and dogs periodontal disease is extremely prevalent. Mr. H. Gray, a veterinary surgeon, who has a considerable experience of the disease in these animals, is of the opinion that in cats it is most frequently seen in the highly bred pet animals that are fed on soft food, the ordinary domestic cat fed on a meat diet keeping comparatively free from the disease.

Amongst dogs the disease is seen most often in the pampered lap dogs, and in the short-muzzled breeds, such as the pugs and bull dogs, more especially in the teeth that are non-functional, namely, the incisors. Dogs living on a good flesh diet, which gives plenty of exercise to the jaws, are invariably free from the disease.

Amongst cats and dogs, therefore, the disease is closely connected with the soft pap diet which clings about the teeth, and ferments and injures the gingivæ.

(3) **Wild Animals.**—In animals kept in captivity periodontal disease is of frequent occurrence, and the Museum of the Royal College of Surgeons of England contains an excellent series

showing the disease in a wide range of animals, *i.e.*, herbivora, rodents, marsupials, monkeys, the small carnivora, &c. An examination of the skulls shows that the disease is not generalized, but in most instances is localized to the teeth which bear the main brunt of mastication. On the other hand, animals living in the wild state seldom show the disease, and the only two examples known to me are two skulls of gorillas; in one the molars have been lost, and in the other large spaces exist between the posterior molars in the left half of the mandible.

The frequency of the disease in the captive animals, and its absence in these animals when in the wild state, in conjunction with the localization of the disease to the masticating area, support the view that the disease is in some way associated with the character of the food given to animals in the captive state. This food we know is of a softer character than that obtained by the animal in the wild state, and it is more prone to collect in and between the teeth.

The study of the disease in animals would seem to show that it is purely local in origin, that is, it is due to food lodgment; the food undergoes fermentation and putrefaction and the tissues are damaged. This view is supported by the condition of the gums and teeth of cattle in parts of America, where owing to the penetration of the tissues by the barbed crowns of *Hordeum jubatum*[1] destruction of the teeth sockets occurs, and the teeth are lost. Mr. E. Thomson[2] also states that periodontal disease is common in horses running almost wild in countries liable to prolonged drought. The animals under these conditions dig up roots, and in chewing the grit and sand injure the gums and start periodontal disease.

(4) **Man.**—There are one or two important clinical facts in connection with the disease in man which may assist in the endeavour to trace the pathology of the disease. In *non-mouth-breathers* the disease commences in the molar region, and gradually spreads to the anterior teeth, while in *mouth-breathers* the disease commences at an earlier date, and often remains for some period limited to the anterior teeth. The commencement

[1] "Dental Surgery," by Tomes and Nowell, p. 648.
[2] *Trans. Odonto. Soc.*, vol. xxxviii, p. 76.

of the disease in the *non-mouth-breathers* occurs in the region where lodgment of food is liable to occur, and probably here the initial lesion is an injury to the gingivæ from food *débris*.

The fact that in *mouth-breathers* the disease commences in the incisor region is instructive. If the mouth of a child affected with mouth-breathing, but with functional molars, be examined, a gingivitis will be noticed limited to the incisor teeth, especially the mandibular ones. The absence of gingivitis in the molar region is due to the fact that the function of this part of the mouth is being properly performed; the friction of mastication and possibly the rubbing of the buccal mucous membrane against the gums removes the superficial layers of epithelium, and stimulates a healthy reaction in the tissues. In the front of the mouth the normal friction of the lips against the gums is absent, the surface epithelium accumulates together with the *débris* of food and micro-organisms, and injury results to the gingivæ. As long as mouth-breathing continues the gingivitis persists owing to the constant injury, and eventually the periodontal membrane becomes involved. There is little doubt, therefore, that, with mouth-breathers, the initial stage of the disease is a localized injury to the gingivæ of the anterior teeth.

In considering the pathology of this disease, *the degree of resistance of the osseous tissue* must be considered, as it is probable that this plays an important part in the rapidity with which the disease progresses. The examination of dried specimens certainly indicates that the more compact the osseous tissue the greater the barrier to the spread of the disease. The question arises; then, as to whether the tissues of the tooth socket are as resistant to disease as we might naturally expect them to be. Although no definite data bearing on this point exist, there are certain phenomena which tend to show that the tissues in many people lack normal resistance. It is an axiom that to maintain a part in health the function of that part must be maintained. There is little doubt that in modern times the teeth and surrounding tissues are not called upon to perform their normal functions, with the natural result that the tissues are deprived of a normal blood supply, and consequently must suffer in their vitality. The bone surrounding the teeth is, as we know,

a tissue of transient structure, depending for its very existence on the teeth themselves. It is therefore reasonable to assume that there is a very close relationship between functional activity and growth of the tissues. With our present diet, this function is not properly brought into play, as a very small amount of mastication is necessary with foods prepared as they are to-day. This loss of the function of the teeth must seriously affect the structure of the bone forming the alveolar process, and render it less resistant to attack. Clinical observation supports this view.

In mouths which show that the function of mastication is duly performed the alveolar process is well developed, and if such mouths are attacked by the disease under consideration the progress of the disease is not rapid. On the other hand, in individuals who masticate imperfectly, the bony coverings of the teeth are thin and sparse, and the disease when once started progresses rapidly. An examination of maxilla and mandible will confirm this statement, the roots being found in places quite bare of bone, and yet showing no sign of inflammatory changes. It seems probable, therefore, that imperfectly formed teeth sockets play an important part in the progress of the disease, inasmuch as their power of resistance is considerably diminished.

There is another point to be considered in connection with the resistance of the bone, viz., that *any inimical condition affecting the osseous system is likely to show itself in the alveolar process at an early age*, the reason being that, as pointed out above, the alveolar process is a transient structure. In support of this view one may instance the premature loss of teeth in animals affected with systemic disease involving the osseous system. Mr. Bland Sutton,[1] who drew attention to this point, gives three typical instances.

In fig. 700 is shown the mandible of an opossum (*Didelphys cancrivora*).

This animal was attacked by a condition simulating mollites ossium. The jaws were thin and soft, and could be easily bent, and on detaching the muco-periosteum the teeth came away with the membrane. To use Mr. Sutton's words, they "looked exactly as if they were rows of nails driven for half their length through a strip of leather."

[1] *Trans. Odonto. Soc.*, vol. xvii, p. 56.

In fig. 701 is shown the mandible of a lemur (*Perodicticus potto*). This animal died of atelectasis, resulting from the thorax yielding to atmospheric pressure, through having been softened by rickets. The jaws show considerable absorption of the bone, and the roots of the teeth are exposed, but the bone shows no sign of inflammatory reaction.

FIG. 700.

FIG. 701.[1]

FIG. 702.[1]

Fig. 702 is from a marmoset (*Hapale jacchus*). This animal was rickety; the teeth appeared as though set in soft putty. All that remained of the jaw is shown in the figure.

These examples are sufficient to demonstrate the fact that in animals certain constitutional diseases do markedly affect the bone, and therefore the alveolar process.

Mr. Bland Sutton also quotes a case of a snake (an anaconda 17 ft. in length), in which all the bones showed a condition similar to osteo-arthritis. The teeth were small and stunted,

[1] From *Trans. Odonto. Soc.*

and many of them came away with the muco-periosteum, leaving small carious sockets. A section through one of the teeth which remained attached to the jaw showed that the bone of attachment was undergoing absorption (fig. 703).

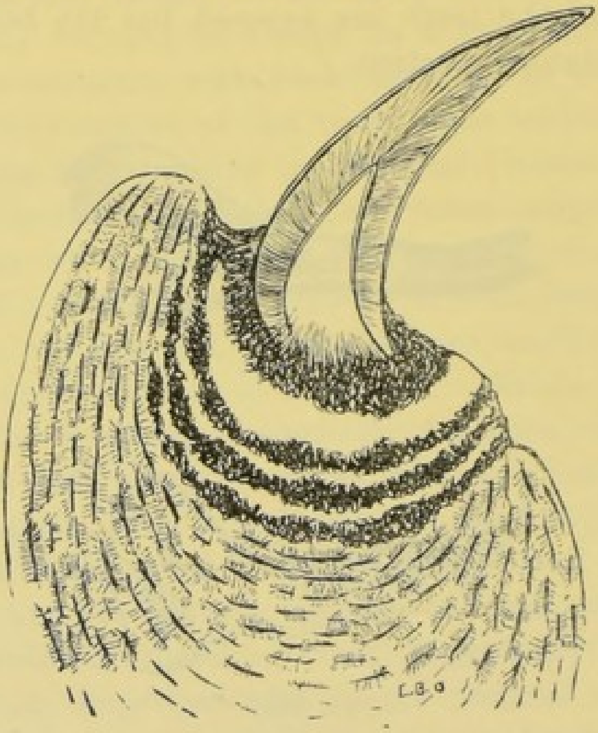


FIG. 703.[1]

(G) BACTERIOLOGY

The Relation of Micro-organisms to the Disease.[2]—In considering the results of researches already made on the subject, the fact must be remembered that the cases investigated by the majority of authors have only been those where the disease is far advanced. The only investigations dealing with the bacteriology of early cases are those of Goadby.[3] Seventy cases in which the disease was in an early stage were investigated by him bacteriologically, but even in some of these cases the disease was far enough advanced to cause destruction of the interdental bone and formation of pus. The bacteria found present in the pus in these cases did not differ in any marked degree from those found

[1] From *Trans. Odonto. Soc.*

[2] For the subject-matter of this section I am indebted to the kindness of Mr. Kenneth Goadby.

[3] *Proc. Royal Soc. Med.* (Odonto. Sec.), vol. iii, p. 55, 1910.

in the later stages of the disease on ordinary microscopical examination, but on cultural investigation the organisms most commonly occurring were those which have in recent years been regarded as the originators of catarrhal inflammation of the mucous membrane of the upper air passages, amongst these being chiefly :—

Micrococcus catarrhalis,

Bacillus coryza segmentosa, or *B. septus*,

M. pneumoniæ,

and, in addition, the *B. necrodentalis*, originally described by Goadby, and

M. citreus granulatus (Freund).

Where constitutional disturbances were present, which were associated with the mouth suppuration, the predominating organisms to which the general symptoms were attributed were either the staphylococci, streptococci, or the pneumococci.

MM. Malassez and Galippe found in the tubules of a tooth attacked by chronic suppurative periodontitis an organism which produced suppuration in guinea-pigs, and when injected into a rabbit showed a preference for the osseous tissue. Another organism was isolated, and when injected under the skin of a guinea-pig produced well-developed abscesses in the subcutaneous cellular tissue. Direct inoculation of these organisms between the teeth and the gums of animals gave negative results. Galippe considers that the disease is local, and that it " assumes a serious character, which is inversely proportionate to the physical power of resistance of the individual."

Miller examined twenty-seven teeth affected with pyorrhœa alveolaris, and obtained twenty-two different varieties of bacteria. In his cultural examination of these cases, one or other variety was obtained as a predominating species, and Miller on this account was inclined to regard the rest of the organisms present as unimportant. But it must not be forgotten that in making a bacteriological examination where such a large number of organisms is present, as are always to be obtained from periodontal pus, one or other of the species present may easily become predominant; further, the cultural picture obtained by making smears at the end of twenty-four hours' incubation invariably differs from the smears made from the pus direct. The

mycelium ascribed to the *Leptothrix racemosa*, but which is probably related to one or other of the Streptotricheæ, together with a mass of what seems to be fragmented mycelium, rarely occurs in the cultures. Preparations made direct, which show on microscopical examination a very small number of micrococci, on cultivation on blood agar, or even ordinary agar, show a large predominance of micrococcal forms; in fact, the special organism which is best suited to the given cultural media is the one which appears to be the predominating form.

A few experiments were made by inoculating the gums of healthy dogs with the pus from affected tooth sockets, but with negative results. Slight local reaction followed the inoculation, but the gums rapidly returned to a normal condition.

In culture experiments in agar-agar of 12 cases in human beings, 20 varieties were isolated. Among these *Staphylococcus pyogenes aureus* was found twice, *S. pyogenes albus* once, *S. pyogenes* once. Of the remaining 16, 9 subcutaneously injected gave no result, 4 a slight and 3 a severe suppuration in the subcutaneous connective tissue. Culture experiments in 6 cases of dogs yielded 9 species, the *S. pyogenes albus* occurring once; and of the remaining 8, 5 produced a slight and 1 a very profuse suppuration.

As has been pointed out above, the bacteria found on examining cover-slip preparations from the pus direct show a large variety of micro-organisms, all of which do not grow upon the usual laboratory media. In any established case of periodontal disease the *pus may be found in three different clinical conditions*: —

Thin, when it is generally found that bare bone is at the bottom of the sinus from which the pus is oozing,

Thick and yellow, small in quantity when chronic rarefaction is going on; and

Cheesy, where very slow tissue necrosis is in progress.

Microscopically, films of the pus are best stained by means of Leishman's stain, which stains not only the various bacteria present, but also the cells; if the pus be from active inflammation many well-formed pus cells are to be seen, some of them crowded with bacteria, others free. Eosinophile cells are often present in large numbers, particularly if the blood from the swollen gums be examined without a mixture of pus, but even in the pus itself

eosinophile cells are present. In addition to the ordinary pus cells a considerable number of large hyaline cells are frequently found. Epithelial *débris* is common, but generally the cells are disintegrated, except in the quite early stages of the disease. In the more chronic forms where the pus is small in amount, or where it is only to be discovered microscopically, pus cells show much granular degeneration, the nuclei staining badly, and few bacteria are found within the cells.

The bacteria seen in the cells are of many varieties; pointed threads may often be found to be almost the only bacteria englobed; whereas in other cases cocci alone can be seen, or short diplobacilli. Occasionally definite streptococci are seen, and where such definite streptococci exist in the pus the presumption may be made that the chief agent in such pus formation is streptococcal. *The bacteria found in the pus may be divided into groups :—*

(*a*) Cocci.

(*b*) Bacilli.

(*c*) Other morphological forms, of which yeasts, thread forms often staining irregularly by means of Leishman's stain, and occasionally mycelium, are present. Various fragments of a curious form known as *Leptothrix racemosa* are also frequently present.

(*d*) Spirochætes of at least two varieties.

(*e*) Streptothrix.

On staining by Gram's method the organisms for the most part decolorize, except the Gram-positive cocci, or *Bacillus septus*. In many instances preparations of fragmented mycelium are found which take the stain of Gram's method irregularly, the interior of the mycelium being filled with a number of minute dark violet points, whilst the sheath and general mass of protoplasm of the thread are decolorized. Gram-negative cocci are generally present, and belong either to the *Micrococcus catarrhalis* group, *M. citreus granulatus* of Freund, or to the *Staphylococcus viscosus*. Muhlens and Hartmann[1] described the spirochæte of the mouth as present in normal mouths, and they doubt whether these organisms possess any pathogenic action. They inoculated

[1] *Zeitschrift für Hygiene*, Bd. 1, p. 81, 1906.

a series of animals with the practically pure cultivations, but found that unless their cultures contained a large number of other organisms than the spirochætes, no abscess or pathogenic result was produced, and they are therefore inclined to regard the apparent pathogenicity found by some observers as due to the presence of other organisms than the mouth spirilla.

Cultivation of Bacteria from Periodontal Disease.—Cultivations made from the pus upon ordinary laboratory media show a considerable growth at the end of twenty-four hours in all cases where pus is present, and a very large number of different organisms have been isolated, as described by Goadby in the Erasmus Wilson lecture. On gelatine the number of organisms developing is not large, and is usually confined to the ordinary saprophytic varieties; the staphylococci may be obtained by these means when present. On broth, cocci, streptococci and long thread forms develop; if left for a short time, the thread forms develop considerably, and are to be found at the bottom of the tube. On shaking the tube a considerable quantity of evil-smelling gas is evolved, exactly resembling the smell from a septic mouth. On blood agar, or normal agar, to which an equal proportion of normal horse serum has been added without coagulation, certain bacteria are more or less frequently present, and occur in a sufficient number of cases to be regarded as associated definitely with the disease.

In the *earliest cases* where only microscopic pus is to be found, the chief organisms present are:—

Micrococcus catarrhalis.

Bacillus septus, or *B. coryza segmentosa.*

B. necrodentalis.

The *Streptococcus brevis* of the mouth is also invariably present.

In the *latter stages* the organisms most frequently present are:—

Streptococci of the *longus* group, known collectively as the *Streptococcus pyogenes.*

M. catarrhalis.

M. citreus granulatus (Freund).

Staphylococcus aureus, or the variety often found present in the mouth which gives a dull brownish colony on agar.

The pneumococcus.

The *Saccharomyces neoformans* (occasionally).

A number of other organisms of more or less pathogenic properties are to be seen from time to time. *The general bacteriology of the disease, as will be seen, is by no means confined to one group of bacteria, but is one which is generally associated with the organisms found in suppurative lesions in other parts of the body*, although a large number of bacteria, confined so far as is known to the oral cavity, are usually present in the pus.

Recent papers of Eyre and Payne[1] and Goadby[2] agree in most of the above bacteriological particulars. These observers have found the *M. catarrhalis* fairly frequently present, together with the streptococci and the staphylococci, although Eyre has confined his attention entirely to the cocci present. Goadby, on the other hand, has investigated the bacilli, amongst them the *Bacillus necrodentalis* and *B. coryza segmentosa*, and he considers that both of these organisms are essential ones in the early stages of the disease. The cases quoted by Eyre were thirty-three in number, and he gives the *M. catarrhalis* as occurring in twenty of these cases. Goadby quotes thirty-six cases in his Erasmus Wilson lecture, in which staphylococci were found in nineteen cases, and Gram-negative cocci in twenty; and in a recently published series of seventy early cases the *Streptococcus pyogenes* and *M. catarrhalis* were the most frequent organisms.

The consensus of opinion is, therefore, that, in established cases of alveolar suppuration, one or other of the pathogenic cocci, the Streptococcus, Pneumococcus, Staphylococcus, or Micrococcus catarrhalis is present; and, in addition, in the early stages other organisms of the bacillary type predominate. Goadby has also shown that in a number of cases lactose-fermenting organisms belonging to the type of bacteria associated with fæcal contamination are to be found in the alveolar discharge. These organisms are not common in air, and the only foodstuff by means of which they are likely to be conveyed to the mouth is milk. Staphylococci and Streptococci are also commonly present in unclean milk.

[1] *Proc. Roy. Soc. Med.* (Odonto. Sec.), December, 1909.

[2] *Ibid.*, January, 1910.

Occasionally general infection of the blood-stream supervenes, producing acute disease (septicæmia), the local disease in the mouth often being disproportionate to the severity of the general symptoms. Goadby has described two cases in which high temperature of many weeks' duration, associated with the usual symptoms of septicæmia, were directly due to infection from the gums.

In summing up the present knowledge of the bacteriology of pyorrhœa, one must admit that a very large number of bacteria, and of widely different species, are found in the pus; that, of these organisms, certain belong to the well-recognized pathogenic forms that are found associated with diseased conditions of a suppurative nature in other parts of the body; whilst a number of others are found associated with catarrhal inflammation of the mucous membrane of the upper air passages; and that a number of others, again, are not known to produce any pathological lesions, and are probably only living in the decomposing proteid *débris* along the gum margins. In addition to the three varieties cited, there are a number of organisms which are obligatory anaerobes so far as is at present known, and which are also serophile in their habit; in fact, the microscope picture of pus from pyorrhœa alveolaris shows an inordinate number of morphological forms of bacteria, a large proportion of which appear to be peculiar to the mouth, perhaps being involution forms of well-known species, taking on the special morphological character owing to their environment, or even marking different species not as yet adequately described. Perhaps the chief fact with which one is struck in examining films of pyorrhœa pus is the inordinate number of bacteria present, the quantity being, if anything, in excess of the bacteria to be found in the fæces. Any attempt to sort out the organisms which have causal relation to the disease is necessarily a matter of considerable difficulty, and for the present the *résumé* given of the knowledge of the subject is as definite as our present knowledge will allow.

The facts known regarding chronic general periodontitis would seem to indicate :—

(1) That the initial cause, in the majority of instances, is an injury of the tissues of the interdental spaces by fermenting food and other decomposing *débris*.

(2) That infection with pathogenic organisms rapidly follows, for the pus found even in the early stages contains organisms which are known to be associated with chronic forms of disease in other parts of the body.

(3) That the chronic character of the process is one of slow tissue necrosis rather than acute inflammation.

(4) That the disappearance of the tooth socket is due to the action of toxins which are formed in the pockets around the teeth.

(5) That pathogenic organisms and their toxins may gain access to the body *via* the blood-stream or gastro-intestinal tract, and, when this occurs they may cause various diseases often disproportionate in their gravity to the condition of the gums.

(6) That owing to inefficient mastication the tissues around the alveolar process are unduly liable to attack on account of the lack of functional activity.

(7) That the calculus on the teeth is the product of the discharges from the teeth sockets, and that it does not affect the disease beyond interfering with the cleansing of the pockets around the teeth.

(H) ETIOLOGY

There is great diversity of opinion as to the cause of chronic periodontitis. Although the disease was recognized by early writers, there can be no doubt that it has become much more prevalent during the last fifty years ; indeed, it is the rule rather than the exception to find patients with more or less chronic periodontitis.

A survey of the pathology of the disease inclines one to the opinion that the disease is essentially a local lesion, and that general conditions play only a secondary part. The *immediate cause of the disease* is the accumulation of irritant material in the pocket around the teeth, more especially in the interdental spaces. This morbid material may be the product of a gingivitis or of food *débris*. The accumulated material ferments, toxins are formed, and tissue destruction follows. The agencies which are instrumental in producing a marginal gingivitis (see p. 643) are therefore, also to be regarded as the causes of chronic periodontitis.

The *great prevalence of the disease* is probably due to the

altered character of the diet of the present day. Our foods are now prepared in such a manner that they readily accumulate around the teeth; still further, they more easily undergo fermentation. Efficient mastication is almost impossible, with the result that the tissues in and around the teeth are deprived of an adequate blood supply and are rendered less resistant to attack. When once the disease has started the formation of abnormal pockets favours the accumulation of *débris*, and so accelerates the action of the toxins. The deposition of calculus under the gingival margin, so often met with, is regarded by some observers as an exciting cause. This hard rim of calculus is almost always confined to the necks of the teeth. Its origin is not quite clear. It may be simply the product of the fermenting material lodged in the gingival spaces, or it may be the result of an altered secretion of the gingival gland.

A large number of observers consider that the cause of the disease is to be found in some general systemic condition. The rise and fall in the state of general health will be found to synchronize with an improvement or deterioration in the condition of the mouth, but it does not necessarily follow that the disease has a general cause. Persons of the gouty and rheumatic diathesis seem exceptionally liable to prolonged inflammation of bones and joints, after slight injuries the fibrous tissues being the parts attacked. It is therefore only to be expected that the periodontal membrane should share in this susceptibility to injury. The morbid conditions producing gout and rheumatism are to be regarded as predisposing rather than as exciting causes.

The view held that the disease is occasionally due to the actual deposition of urates, &c., in the periodontal membrane is not supported by conclusive evidence, and is referred to on p. 631.

Diabetics are especially prone to periodontal disease, but here again the morbid process producing diabetes acts by rendering the tissues more liable to attack. Similar conditions obtain in all chronic wasting diseases.

Periodontitis sometimes follows the severe fevers. In such cases the poison producing the fever probably causes cloudy swelling of fibrous tissue. Cloudy swelling is often followed by fatty degenerative changes, and the resistance of the tissues is thereby lowered.

Reference must be made to the view held by Dr. Black that the cause of the disease is to be found in an altered secretion of the "gingival organ," leading to the formation of calculus under the free margin of the gum; the calculus then acts as an irritant, setting up the periodontal disease. (See also p. 633.)

The infection seen in the disease is considered by Mr. Goadby to be traceable to milk. In many cases he has isolated lactose-fermenting bacilli, and presence of these organisms would seem to have suggested to him that the infection in pyorrhœa alveolaris may arise from contaminated milk. In referring to this point he says: "McConkey has shown that these lactose-fermenting bacteria are primarily of fæcal origin, and that they gained access to milk from which they had been isolated by him in a large number of instances. In attempting, therefore, to discover the original source of infection in alveolar pyorrhœa, the presence of these lactose-fermenters naturally requires consideration. Further, cocci of both the staphylococcal varieties are often present in milk, and may exhibit some degree of virulence. In the absence of any other obvious source of infection it would seem highly probable that the organisms to which at any rate the general symptoms attendant upon suppuration along the alveolar margin itself are due, may come from contaminated milk." Mr. Goadby also refers to the fact that periodontal disease is a frequent sequela of infectious disease, during the progress of which the patient has been upon a milk diet, and he further points out that the disease frequently occurs in several members of the same family. He seems to regard these facts as some evidence that milk may convey the original source of infection. The idea is certainly a novel one, but the data are hardly sufficient to justify a definite conclusion.

(I) TREATMENT

In treating the disease, all we can hope for, even in the most favourable cases, is an arrest of the process, and possibly a regeneration in the osseous tissue. This arrest can only be produced by promoting healthy reaction on the part of the tissues themselves, and to this end therapeutic measures may be adopted in four directions:—

(1) **Promotion of Asepsis as far as Practicable in the Pockets by Efficient Drainage.** — By efficient drainage the tissues are relieved of the constant injury arising from the toxic matter around the teeth.

(2) **By Hetero-inoculation** (vaccine-therapy). — By this means bodies are introduced into the system which assist the tissues in defending themselves against the action of the bacteria and their products.

(3) **By Auto-inoculation.**—Methods which assist the tissues to combat the toxic products of autolysis and other cell metabolism.

(4) **General treatment,** directed towards the removal of systemic intoxications, and a general improvement in health.

In mild cases the following line of treatment often gives good results : The teeth must be thoroughly freed of all calculus, care being taken to inflict as little injury to the periodontal membrane as possible. The pockets around the teeth should then be irrigated with hydrogen peroxide 15 vols., and this followed by the application of strong tincture of iodine to the sockets. Dr. T. Leary [1] states that he has obtained satisfactory results with the following solution: Iodine 1 part, potassium iodide 2 parts, water 100 parts.

The following routine treatment should be carried out by the patient for at least one month :—

The spaces between the teeth must be cleared with floss silk and the remaining surfaces of the teeth cleaned with a brush if possible after every meal, the mouth then being thoroughly rinsed with an antiseptic mouth-wash. The last thing before going to bed the pockets should be thoroughly irrigated with hydrogen peroxide 15 vols. ; for this purpose a small syringe is best. Frequent massage of the gums with the finger will be found useful, and instruction should be given to use the teeth thoroughly during mastication. At the end of a month the irrigation can be reduced to once or twice a week. Tooth powders should be avoided, as the insoluble particles tend to pass under the free margins of the gums and act as irritants.

In more advanced cases where there is much congestion of the gums and active pus formation, in addition to the above

[1] *Dental Cosmos*, 1909.

routine the gums should be rubbed every night with powdered tannic acid. An endeavour should also be made to eradicate the pockets by paring away the loose unattached gum and applying to the bare surfaces a mild escharotic, such as trichloracetic acid 25 per cent. The more thoroughly the pockets are kept free from discharge the less is the damage to the tissues, and naturally the greater the chance of the tissues reacting normally.

Vaccine-therapy has been advocated in treatment, and Mr. K. Goadby states that he has obtained good results. Vaccine-therapy aims at assisting the tissues to defend themselves against the action of bacteria and their products. It is essential for success in vaccine treatment that the causative organism of the disease should be known. With suppurative periodontitis the organism is not known, and as already explained the infection is probably of a mixed character.

The method suggested by Mr. Goadby is as follows: "A bacteriological examination is made of the material obtained from the gum pockets after syringing out with boiled water, the cultures being made in ordinary agar and maltose serum agar, and the bacteria planted out. The opsonic indices to the various organisms are then obtained, and a vaccine prepared of the one giving the lowest index. If more than one organism shows a low index, a mixed vaccine of the several species is indicated. If more than one organism is associated, as is commonly the case, subsequent observations of the index of each are recorded, and the vaccine is modified. If improvement is slow, further bacteriological analysis at a later date may be required, as further infection may have occurred. For further details of treatment the reader is referred to Mr. K. Goadby's paper.[1]

Clinical experience teaches us that careful and thorough treatment of the teeth will produce a rapid improvement, not only in the local, but usually in any general symptoms that may be present; and when, therefore, vaccine and local treatment are combined, it is difficult to discriminate between the effect of the local treatment and of the vaccine.

Up to the present, vaccine treatment has always been employed in addition to local treatment, and no observations on

[1] *Lancet*, vol. ii, p. 1875, 1909.

the treatment of pyorrhœa by vaccines alone have been recorded. Nor has it been shown by the comparison of a number of cases that the use of vaccines either hastens the cure of periodontal disease or renders it possible to cure cases which are not amenable to local treatment alone. It seems likely that in advanced cases of pyorrhœa accompanied by definite constitutional symptoms, the employment of vaccines may quickly raise the resistance of the patient to infection, and thereby enable him to respond more rapidly and more readily to local treatment; and the results yielded by vaccine treatment in such cases seem to support this view. With this exception there is no general consensus of opinion that the addition of vaccines to the local treatment of periodontal disease appreciably increases the likelihood of a cure; and until dental surgeons come into agreement upon this matter and also upon the pathology of periodontal disease and the meaning attached to the term "cure," the value of vaccines for the treatment of periodontal disease must remain *sub judice.*

Dr. E. C. Hort[1] has drawn attention to the fact that vaccine-therapy leaves out of consideration the damage to the tissues of the toxic products of autolysis and other cell metabolism. These toxic products are combated by the formation of corresponding antibodies. All conditions which produce hyperæmia in the part, whether it be by the use of poultices, blisters, or Bier's treatment, act by increasing the fluid exudate in the affected parts; in this way the irritant is diluted and the natural antibodies increased in the area; in other words, the treatment may be regarded as a process of auto-inoculation.

The ideal method of producing hyperæmia would seem to be that suggested by Dr. Bier, but there are practical difficulties in the way to contend with. This treatment has been tried in a few cases with apparently satisfactory result, and radiographic examination has shown that after six months' treatment the destruction of the bone has not progressed, and clinical appearances suggest marked improvement. To carry out the treatment a splint is made to grasp the gums as high above the teeth as possible (fig. 704.) The spring should be adjusted to cause sufficient pressure to congest the gums, but must stop

[1] *Proc. Roy. Soc. Med.* (Med. Sec.) vol. ii, No. 6.

short of causing pain. The splint should be applied for about fifteen minutes twice a day.

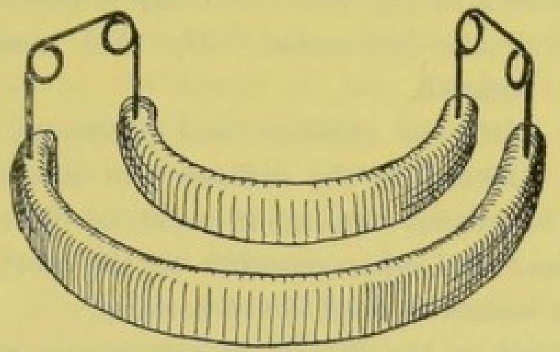


FIG. 704.—Semi-diagramatic view of splint.

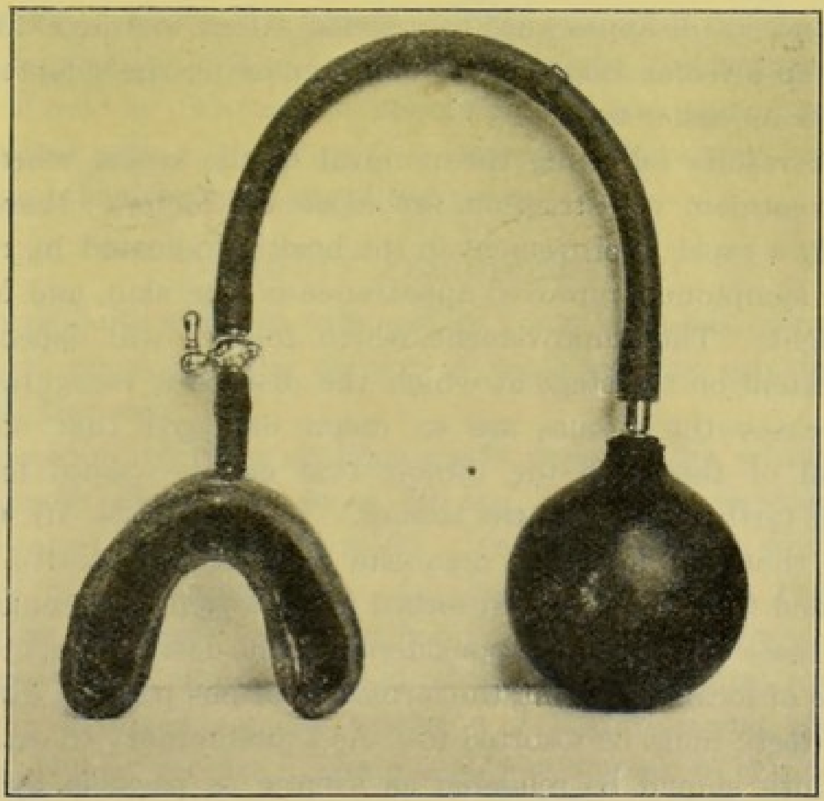


FIG. 705.

A useful apparatus for producing hyperæmia of the gums has been suggested by Mr. H. Woodruff. A vulcanite cap is made to grasp at its margin the gums as high above the tooth as

possible, the remaining portion being made so that a slight space exists between the gums and the splint. A tube is inserted into the splint, and this is connected with an exhaust bulb. The apparatus is shown in fig. 705. The cap is placed over the teeth and the air gradually exhausted. By this means an effective hyperæmia is obtained.

In dealing with the etiology and pathology of the disease, attention was directed to the influence of mouth-breathing. If this condition is present treatment must be directed towards its removal, as *local and other remedies* to the teeth will be *of little avail while the mouth is used for breathing.*

If, in cases *where the disease is progressing rapidly*, the teeth are removed before the whole of the alveolar process has disappeared, and dentures are inserted directly the tenderness following the operation has subsided, function will be restored to the bone, and its disappearance to a great extent arrested. By this means an alveolar ridge will remain, rendering the adaptation of dentures an easier task.

The results following the removal of the sepsis, whether by local treatment or extraction, are most satisfactory; there is invariably a rapid improvement in the health, indicated by relief of gastric symptoms, improved appearance of the skin, and increase in weight. The improvement which follows will depend to a great extent on the stage at which the disease is recognized. In some cases the tissues are so much damaged that with the removal of the teeth the utmost that can be hoped for is to prevent further injury to the tissues. In these cases Mr. Goadby thinks that the infecting organism still remains active in the bone, and their toxins are absorbed into the general circulation.

In cases where there is considerable bone destruction, or where, in spite of local treatment, the formation of pus persists, extraction of the teeth must be resorted to. As a preliminary to extraction, the mouth should be rendered as aseptic as possible by the use of efficient mouth-washes and irrigation. Opinions differ as to the number of teeth to remove at one sitting. This point must depend upon the condition of each individual case. Where the removal of the teeth will lead to but little laceration of the tissues, a large number can be removed at one sitting, and the wounds will be found to heal rapidly, and with very little

pain. The amount of pain following the removal of the teeth depends to a great extent on the care with which the extractions are performed and the after-treatment of the wounds.

Mr. Goadby and others think that it is inadvisable to remove more than two or three teeth at a sitting, "without previously raising the general resistance of the patient to the infecting organisms." The general experience, however, is that wounds following extractions are kept in a septic condition by the infection from the remaining septic teeth, and that, therefore, the sooner all the teeth are removed the more quickly will the wounds heal. It is, too, exceedingly uncommon to find either local or general disturbances following the extraction of many teeth in these cases. The after-condition of the mouth depends almost entirely upon the manner in which the operation is carried out.

In cases where the general condition of the patient suggests that the reaction of the tissues is but slight, the removal of the teeth should be delayed, and energetic local and general treatment persevered with in the hope of a general improvement, and therefore more healthy reaction of the tissues.

(J) GOUTY PERIODONTITIS

In patients with the uric acid or gouty diathesis, periodontitis seems to present, in the opinion of some authors, certain typical clinical features.

According to these authors, gouty periodontitis seldom manifests itself before the age of 30, and in most cases the patient has reached the age of 45 to 50. There is usually a well-marked history of hereditary gout. In the earliest stages there is a gingivitis, the teeth are often free from caries and show signs of well-marked attrition. Subsequently the periodontal membrane becomes involved, causing recession of the gums and absorption of the alveolar process. The mouth may remain in this condition for years.

The margin of the gums often presents a thickened appearance, which is probably due to a productive inflammation of the muco-periosteum. An examination of the sockets with a probe will not disclose any deep pockets or much calculus. At intervals synchronous with a lowering of the standard of general

health, the gums will appear congested, a catarrhal-like discharge or even pus may exude from the pockets, and the teeth will become sensitive to pressure, the inflammatory process appearing to involve the whole periodontal membrane; the teeth will be hypersensitive to thermal changes, and the patient will often complain of shooting pains in the region of the alveolar process. The oral condition improves with that of the general health, but the roots of the teeth will be left a little more exposed. The attacks tend to become more frequent as age advances, and one or two teeth during each attack appear to be singled out, as it were, for an extra dose of the specific poison. The inflammation in the tooth or teeth may stop short of suppuration, but even when a general improvement has taken place a distinct looseness of the tooth or teeth persists. During a subsequent attack the teeth become extremely loose, and the gum overlying the upper half of the root may become swollen, and a fluctuating swelling appear. An incision into the swelling will disclose a glairy, mucus-like fluid, or even pus.

If the swelling is not incised it may break externally, or the fluid may wend its way towards the gingival margin, and so discharge at the neck of the tooth. An examination of the tooth will disclose a living pulp. In such teeth a rapid destruction of the periodontal membrane and alveolar process takes place, and the tooth becomes quite loose and is lost. With the advance of years the attacks occur with increasing severity, the teeth becoming loose partly by the destruction of the membrane commencing at the gingival margin, and partly by acute exacerbations in one or two teeth as mentioned above.

Pathology.—The view has been advanced that this type of periodontitis is **due to deposit of urates** in the dental membrane. Dr. Pierce, who is the main advocate of this view, states that the salts are most frequently deposited near the region of the apex in the form of calcium and sodium urates with traces of uric acid and calcium phosphates. The deposit causes irritation, the tissues break down, an exit is formed from the pus around the neck of the tooth, and infection for the mouth ensues. This is diagrammatically shown in the above fig. 706.[1] This author con-

[1] From a paper by Dr. E. C. Kirk, *Dental Cosmos*, November, 1900, p. 1150.

siders that this type of periodontal abscess is the typical lesion of gouty periodontitis, and he states that he has seen between fifteen and twenty cases of this character. It is maintained by some observers that periodontal abscesses cannot arise in this manner, and that in all cases where suppuration occurs in connection with living teeth there is a primary breach of surface through which the pyogenic organisms gain entrance.

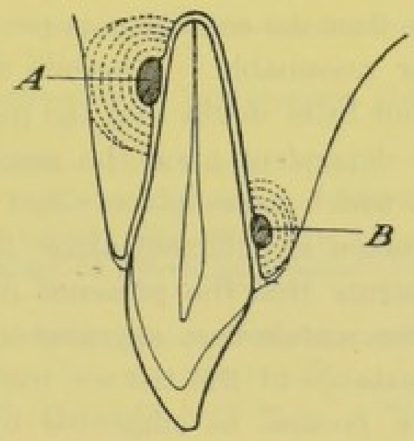


FIG. 706.—*A* and *B* show deposits of calcareous matter surrounded by zones of degeneration.

Dr. Pierce affirms that the presence of urates can be easily demonstrated by the murexide test, but that the reaction is at times masked by the presence of calcium phosphate deposits. Considerable doubt has been thrown upon the theory advanced by Pierce and supported by Kirk, and we may perhaps with advantage discuss the grounds on which these doubts are founded. First, then, as to the actual presence of urates. Dr. Talbot[1] reports that in 215 cases of teeth examined with calcic deposits, twelve gave a positive reaction with the murexide test. It is to be noted, however, that in this series of tests no apparent precautions were taken to confine the tests to teeth from gouty people suffering from periodontitis, and hence the value of these researches is somewhat discounted.

Dr. Galippe,[2] in an examination of forty teeth chosen from

[1] In a paper before the Academy of Stomatology of Philadelphia, January, 1896, *Dental Cosmos*, 1896.

[2] *Journal des Connaissances Medicales*, November, 1896.

patients with suppurative periodontitis, was unable to demonstrate the presence of urates, but here, again, no care seems to have been taken to exclude teeth from non-gouty subjects.

Dr. Black[1] carried out a series of tests of calculus, and found that traces of uric acid and urates were often present in patients with no history of gout.

The presence of urates in a gouty condition is still open to question. If their presence can be demonstrated in the majority of cases of periodontitis occurring in the gouty, the view advanced by Pierce that the condition is purely constitutional in origin would appear reasonable. Whether urates are present or not, there can be but little doubt that the mouth condition is to a very great extent dependent upon the general condition. The rapid improvement which takes place when a general course of treatment is undertaken is sufficient alone, from a clinical point of view, to demonstrate that the presence in the system of the products of defective metabolism aggravates the local condition by lowering the resistance of the tissues, but that the urates can start a suppurative process as suggested by Pierce is open to doubt. Gout is essentially a non-suppurative disease, and gouty deposits in the hands, ears, &c., do not promote suppuration. It seems therefore reasonable to assume that gout should not act otherwise if deposited in the periodontal membrane.

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[1] *Dental Review*, vol. viii, p. 449.

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CHAPTER XIX

Diseases of the Gums and Adjacent Mucous Membrane

Hypertrophy of the Gums—Gingivitis—Stomatitis—Leucoplakia—Pemphigus — Purpura — Scurvy — Perforating Ulcers — Tubercle—Syphilitic Lesions—Aneurism

(A) HYPERTROPHY OF THE GUMS

True hypertrophy of the gums consists in a general overgrowth of that portion of the gums covering the alveolar process. Figs. 707 to 710 delineate the mouths of two brothers, aged 7 and 9 respectively, which came under observation in 1892. In a younger brother seen five years later at the age of 6, a similar condition existed, the thickening, according to the father's statement, having begun as the teeth erupted. The hypertrophied gum in all three cases was normal in colour, of a dense fibrous character, and was more marked in the front of the mouth. The mouths were clean, and there was no tendency to bleed and no discharge. The boys were intelligent and there were no lesions elsewhere. No abnormality of the gums was present in the parents or the two sisters.

The hypertrophy of the gums would seem to commence with the eruption of the teeth. In a case quoted by Mr. Erichsen, the affection showed itself at the age of 7 months, during the eruption of the incisors, and in another case, quoted by Mr. Heath, the swelling of the gums commenced at 2 years of age with the eruption of deciduous molars. If left alone, the hypertrophy increases, and in time the teeth become completely hidden.

The hypertrophy in some cases is limited to a particular region; for example, in a case recorded by A. Evans,[1] the trouble was confined to the molar region.

[1] *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. i, p. 125.

A **microscopical examination** made by Mr. C. S. Tomes, of one of Mr. Heath's cases, showed that "the growth closely resembled that of the small polypi which are sometimes found occupying the cavity of the carious teeth; it was a true hyper-

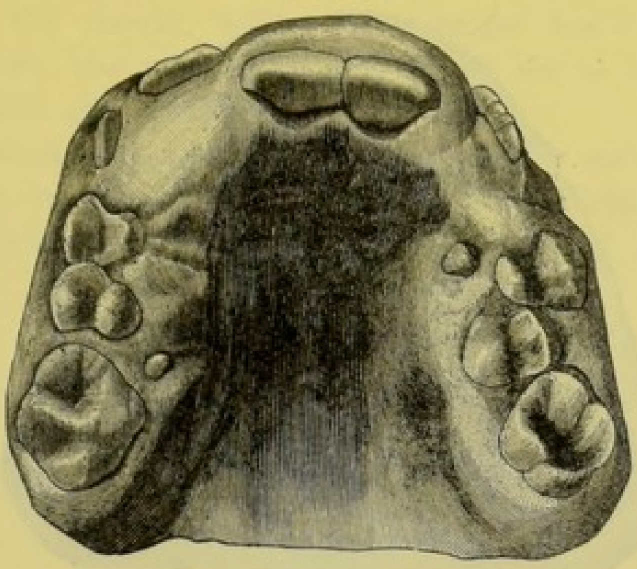

Fig. 707.—F. S., aged 9 (maxilla).

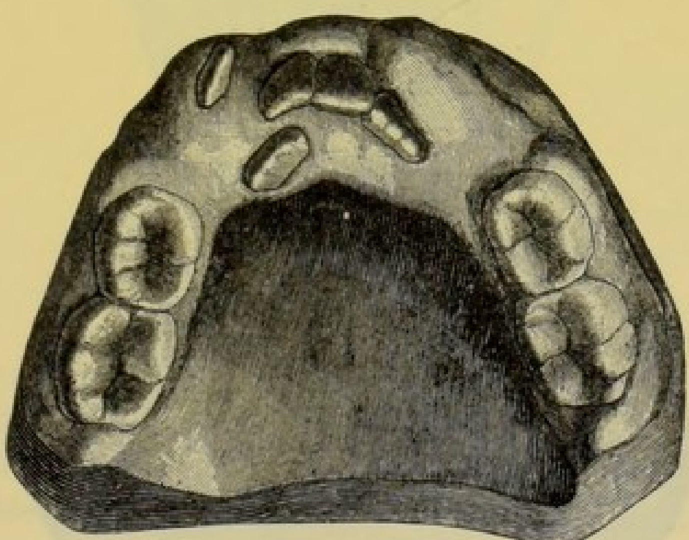

Fig. 708.—F. S., aged 9 (mandible).

trophy of the gum, and chiefly of the fibrous portion. It sprang from the periosteum round the neck of the tooth just within the margin of the alveoli. From this point emanated a dense stroma of interlacing fibres, covered by a thin mucous and epithelial layer."

In many of the accounts given of this disease, the gums are described as being darker than the normal, and bleeding freely on the slightest touch. This condition is due to inflammatory reaction in the hypertrophied tissue from sepsis in the spaces

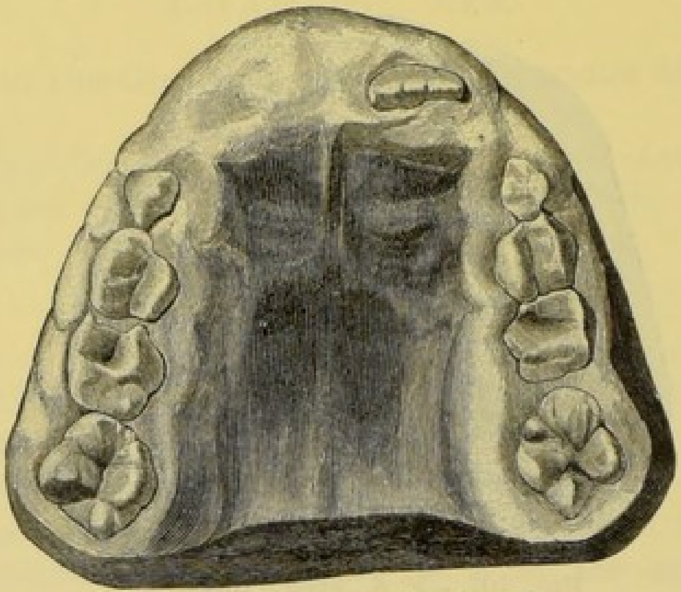

FIG. 709.—T. S., aged 7 (maxilla).

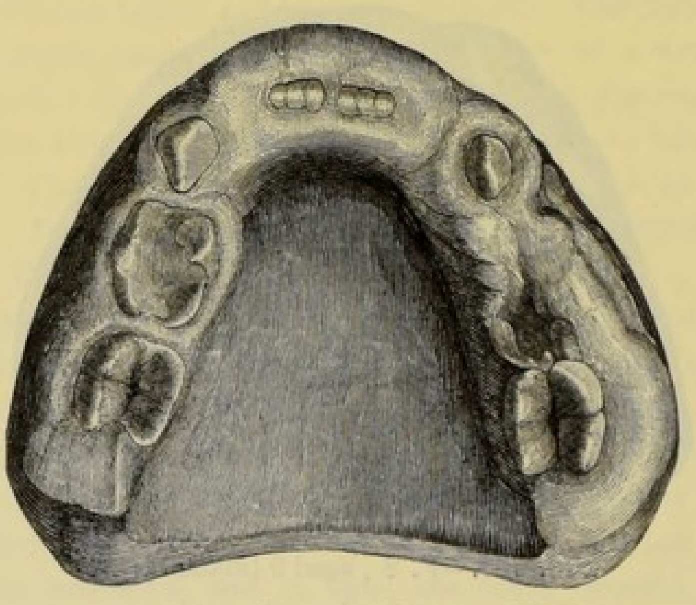

FIG. 710.—F. S., aged 7 (mandible).

between the teeth and the gums, and was well demonstrated in the cases shown in figs. 707 and 710. In these patients, the gum was trimmed away down to the margin of the bone, and when seen five years afterwards the condition was as follows: In the

elder boy there was practically no recurrence, the mouth being clean and the gums a normal colour; in the younger boy there was recurrence, the gums were congested, bled readily, and inflammatory tissue was present in several of the pockets around the teeth. The elder boy was extremely careful about the hygiene of the mouth, while the younger boy's mouth was neglected, with the result that sepsis had led to inflammatory reaction in the gum tissue.

The combination of hypertrophy of the gums with superadded inflammatory reaction may give rise to a most distressing condition, of which the following case, recorded by Mr. Heath,[1]

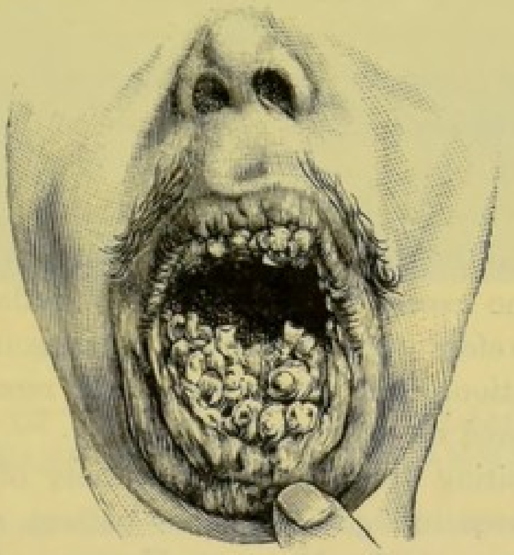

Fig. 711.

is a good example. The patient was a man, aged 26, and four years previous to being seen had consulted Mr. Hulke, who cut away the hypertrophied gums of both jaws, with much relief to the patient. Three months afterwards, the patient noticed that the growth had recommenced, and, although it had made steady progress for three years, he had sought no further advice. On admission to University College Hospital, the external deformity was well marked, and, on opening the mouth, the gums of both jaws were seen to be enormously hypertrophied, and most of the teeth to be loose and displaced (fig. 711). The

[1] *Lancet*, 1897.

palate at a cursory glance had the appearance of a cleft palate, but this was due to the fact that the hypertrophied gum on either side covered the palate almost to the median line.

A microscopical examination of this hypertrophied tissue showed that the mucous membrane covering the growth was healthy, the bulk of it being composed of delicate bundles of wavy fibrous tissue, which interlaced. Between the bundles were numerous cells, in some places forming large clusters. Numerous vessels were scattered through the growth.

The case of Mr. Evans already referred to is interesting as showing the degenerative changes that may take place in the redundant tissue. In this case, the tissue removed at the first operation consisted of "translucent strands of fibrous tissue," while that removed four years later was "composed of adult fibrous tissue arranged in strands, between which was some badly staining homogeneous material denoting some myxomatous degeneration; in places were some thickened arterioles, and around these some round-celled infiltration; the overlying mucosa was slightly thickened, and beneath the thickened papillæ was some excess of round cells of inflammatory origin. The growth therefore was a fibroma undergoing early myxomatous degeneration, while the growth first removed was a pure fibroma and showed no degeneration."

A case exhibiting another clinical variety of hypertrophy of the gums is shown in fig. 712. This patient, a man aged 43, was under the care of Mr. Montagu Hopson. He subsequently developed a sarcoma in connection with the orbital plate of the maxilla. Two of his children also showed slight hypertrophy of the gums.

Hypertrophy of the gums is at times correlated with abnormalities of other tissues. In three cases recorded by Murray[1] occurring in three children (two girls and one boy), the condition was associated with molluscum fibrosum and defective mental condition.

In the well-known case of Julia Pastrana, hypertrophy of the alveolar process and overlying soft tissues was accompanied by excessive development of the hair. A similar condition existed

[1] *Med. Chir. Trans.*, vol. lvi.

in a case mentioned by Parreidt,[1] in an Indian girl, Kras, aged 7. The hypertrophied gums were accompanied by a well-developed growth of hair on the body.

Treatment.—Microscopical sections demonstrate that the hypertrophied gum springs from the alveolar margin. In treatment, the affected alveolus must therefore be removed with the excess of gum, the trouble being liable to recur if the gum only is removed.

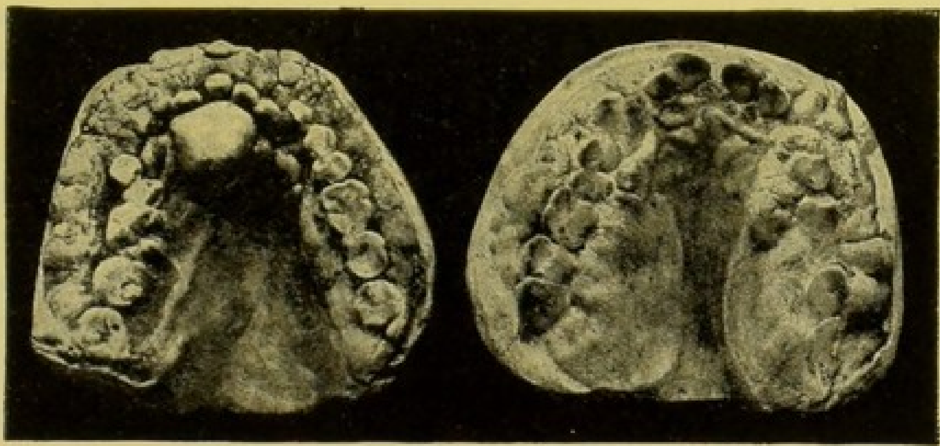

FIG. 712.[2]

(B) REACTION OF THE GUMS AND ADJACENT MUCOUS MEMBRANE TO INJURY—INFLAMMATION

Inflammation of the mucous tissue of the mouth is called stomatitis; when affecting the gums it is termed gingivitis. Some little confusion has arisen from the use of these terms. It is therefore proposed to **limit the term "gingivitis"** to inflammations which arise in the gums and do not extend beyond them, and to **adopt the term "stomatitis"** for inflammations in which the gums, buccal mucous membrane and other mucous surfaces of the mouth may be involved.

(1) GINGIVITIS

This condition may be general, or may be limited to the gum margin—"marginal gingivitis."

[1] *Deutsche Monatsschrift für Zahnheilkunde*, 1886, Jahrgang iv, H. 2.
[2] From *Trans. Odonto. Soc.*

(a) **Marginal gingivitis** is a common affection, and leads, if not treated, to chronic periodontitis.

Pathology.—In a mouth that is functional, the constant friction of efficient mastication and the friction of the mucous membrane of the cheeks and lips against the gum margins, assisted no doubt by the free flow of "currents of saliva," remove all *débris* and keep the gingival margins in a healthy condition. Abnormal conditions, such as mouth-breathing, and functionless teeth, lead to the accumulation of food *débris*, &c., at the gingival margin; the material thus lodged undergoes fermentative and putrefactive changes, the soft tissue is injured, and inflammatory reaction follows. In mouth-breathers this is well marked. If the mouth of a child suffering from nasal obstruction be examined, a marginal gingivitis will be found present around the anterior maxillary and mandibular teeth, while the gingival margin at the posterior part of the mouth will be found quite healthy, providing the function of mastication is properly performed. In a mouth-breather, the natural friction of the lips against the gums is, to a great extent, in abeyance, with the result that the *débris* around the teeth is not removed and the gingival margin is thereby injured. The gingivitis so often associated with many fevers arises, partly at least, from a similar cause. The fevers frequently bring about a condition which induces mouth-breathing and, a "slop" diet being necessary, the ordinary functions of the mouth are not performed, and food naturally collects at the gingival margins.

Although gingivitis is in the majority of cases the direct result of lodgment of food *débris*, &c., it is possible that it may also arise from toxic material circulating in the blood. In reference to this point Dr. Black points out that the gingival organ, in common with other glandular structures, seems to possess the function of selection and eliminating from the blood certain poisons, as evinced in mercurial gingivitis. The elimination of the poisons or toxins leads to hyperæmia or inflammation. As a result of hyperæmia or chronic inflammation a dark-coloured calculus forms under the free margin of the gums (fig. 713). The exact manner in which this calculus is formed is not clear. It may be a product solely of the inflammatory condition of the gingival tissues, or a union between the calcium salts of the

saliva and the inflammatory exudation. The calculus when formed acts as a local irritant and increases the morbid condition. In certain conditions the calculus does not form.

Varieties. — **The inflammation is usually catarrhal** in character. It **may become purulent,** while in certain patients there is a tendency to hypertrophy, so that large tags of tissue are formed between the interspaces of the teeth, the gum encroaching upon the surface of the teeth and causing a large portion of them to be hidden. This form is usually designated "**chronic hypertrophic marginal gingivitis.**" The so-called "polypus of the gum" is a localized "chronic hypertrophic gingivitis."

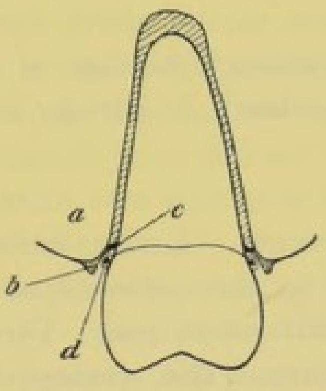

FIG. 713.—(*a*) alveolar process; (*b*) free margin of gum; (*c*) dental ligament; (*d*) calculus.

Causes.—(i.) *Local.*—Mechanical irritants, such as the accumulation of calculus and food *débris* at the necks of the teeth. Overhanging edges of fillings and badly adjusted crowns; these act mainly by favouring lodgment of food. The injudicious use of clamps, ligatures, &c., and chemical irritants; for example, escape of escharotic drugs on the gums.

(ii.) *General.*—The prolonged administration of mercury, lead and iodides. Marginal gingivitis is a frequent accompaniment of certain general diseases, such as gout, diabetes, nephritis.

Signs and Symptoms.—The free margins of the gums are red and painful, and bleed freely with the slightest touch. Slight pressure will cause a thick creamy discharge to exude around the necks of the teeth.

Treatment.—The treatment of gingivitis is to remove the

cause if possible. When mouth-breathing is the cause, prompt attention must be directed to relief of the nasal obstruction, while if the disease is due to a general cause general treatment must be adopted. Locally, attention must be paid to the hygiene of the mouth and special care taken to free the spaces between the teeth of all foreign matter. The pockets around the teeth may be syringed with hydrogen peroxide and an astringent mouth-wash prescribed. In marked cases, the application of powdered tannic acid to the gums twice a day will also prove a useful remedy. In cases where there is considerable discomfort amounting at times to pain, the application of a lotion composed of equal parts of tincture of iodine and spirits of camphor will be found beneficial. In cases where the inflammation is of a proliferative character, it is advisable, in addition to the above treatment, to cut off with a small pair of curved scissors the tags of gum which are present in the interstices of the teeth, and freely scarify the other portion of the gum.

An acute attack of gingivitis may arise from direct infection, for example, the gonococcus. Under these conditions, the infection rapidly spreads to the periodontal membrane, the teeth becoming loose and bathed in pus. There is marked salivation and a rise of temperature. The treatment that answers well is thorough irrigation of the tooth sockets with hydrogen peroxide and the application of nitrate of silver, 10 gr. to the ounce, twice daily.

Lead Poisoning in Relation to the Gum Margins.—In chronic lead poisoning a blue or slate-coloured line often appears on the gums. The manner in which the line is formed is not quite clear. It is supposed that the lead brought by the blood to the gingival margin is converted into a sulphide. The line is more frequently seen on the lower gums than on the upper, and in the incisor region more than in the molar. In addition to the blue line, lead poisoning usually presents other symptoms, such as colic and wrist-drop, the latter being due to paralysis of the extensor muscles of the wrist. In rare cases the blue line is present, but no other symptoms; in such cases great care must be taken to eliminate all other possible causes. In individuals taking diachylon to produce abortion the characteristic blue line on the gum is frequently present.

The blue line must be diagnosed from (i.) a delicate line of blue at the margin of the gums and teeth, but not involving the gums, which occurs in persons exposed to white lead dust for a few hours. This line is merely lead sulphide deposited upon the gums and disappears on rinsing the mouth.

(ii.) A deposit under the margin of the gums, which is found in persons who clean their teeth with charcoal.

(iii.) A deposit similar to (ii.), occurring in miners and others exposed to carbon dust.

(iv.) The line caused by copper and bismuth poisoning.

It must be noted that the blue line does not appear if the teeth are missing, and that it is most prominent when a source of irritation, as, for instance, "tartar," exists around the necks of the teeth.

Treatment consists in removing the patients from the unhealthy surroundings, when the line will generally disappear in three or four weeks, although in severe cases the line may persist for a much longer period.

(**b**) **Chronic gingivitis** is usually the result of local irritation. It is frequently seen in patients wearing artificial dentures, and is often due to want of cleanliness. The gums are slightly swollen and are red, congested and painful. A temporary relinquishment of the denture and the use of astringent mouth-washes is sufficient to effect a cure. Any general condition will need treatment.

Artificial dentures in certain subjects, more especially those of a gouty or rheumatic diathesis, produce a peculiar tenderness of the gums, accompanied by an itching sensation, the patients stating that they can only get relief by removal of the dentures. Local applications are of little value, and the removal of the denture, except, of course, at meals, seems to be the only means of obtaining relief.

A form of **chronic gingivitis atrophic in character** is described by Mr. Tomes.[1]

The gums "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

[1] "Dental Surgery." Third Edition, p. 726.

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 trouble seems to occur in females about the period of "menopause."

A rare form of chronic inflammation of the gums has been described by Arkovy[1] under the name of **"gingivitis nudata,"** The disease usually has its seat in the roof of the mouth, and spreads until it involves the interdental papillæ, or it may be limited to the latter. It appears at all stages of life and may continue for one or two years. With the naked eye it is difficult to locate the junction of the affected with the non-affected part, as the edges are not pronounced and the colour of the gums unaltered. *The pathology of the condition* is an entire absence of the epithelial covering of the sub-mucous tissue, leaving the papillæ exposed.

The etiology is obscure : occasionally it may be traced to scalding. Dentures with rough surfaces, or which do not fit accurately, may contribute to the production of the disease. The symptoms are a feeling of "continual burning with sensitiveness of touch, especially during meal-times."

Treatment should aim at restoring a layer of epithelium over the denuded sub-mucous tissue. All irritants, whether in the form of foods or otherwise, should be avoided. The foods taken must be of a mucilaginous and slippery character, and all medicaments must be administered in a similar condition.

(c) Polypus of the Gum.—Polypus of the gum is the name given to local hypertrophies of that tissue caused by irritation.

Causes.—This condition is generally found in connection with the ragged edge of a cavity or root, or may be brought about by the presence of calculus, or even irritation from a clasp or some other portion of an artificial denture.

Appearances.—In character and microscopical appearance a polypus resembles the gum tissue. The growth really starts as a simple hypertrophy of the gum ; this increases and becomes pedunculated, and, if the cause is not removed, may become so enlarged as to simulate a fibrous tumour.

A polypus of the gum may, as it grows, encroach upon the

[1] *Dental Cosmos*, October, 1893.

cavity and eventually completely fill it. Should the hypertrophied tissue come in contact with the opposing teeth, ulceration will ensue and give rise to considerable pain.

Diagnosis.—When the polypus occupies the cavity, care must be taken to diagnose it from a polypus of the pulp. The diagnosis is not difficult, as in one case the pedicle of the growth will be in connection with the pulp chamber, while in the other it can be traced to the gum between the teeth. The polypus of the pulp is not painful to the touch, whereas polypus of the gum is extremely painful to pressure.

The treatment consists in removing the source of irritation, but it is in addition generally advisable to snip off the growth, or, if the growth is in connection with a cavity, it is better to remove the growth with some potassa cum calce, or with the actual or electrical cautery. The cervical margin of the cavity must be carefully trimmed, so as to avoid any overlapping edges which might favour the accumulation of food *débris*, &c., and so provide a source of irritation.

(2) STOMATITIS

(a) Catarrhal Stomatitis.—This form is generally associated with inflammation of the throat or nose, and probably arises from the same cause as catarrh of those parts. It is frequently seen in the course of the exanthematous fevers and gastro-intestinal disturbances. The excessive use of tobacco, or too hot or too highly seasoned foods, may be cited as causes.

Signs and Symptoms.—The serum from the congested mucous membrane filters into the sub-epithelial space. There is an increased production of surface epithelium and also of mucus. This mucus continues and, with the serum, forms the peculiar sticky discharge seen in these cases. In more severe cases the epithelium may be detached in large masses, the sub-mucous tissue becomes greatly infiltrated with leucocytes and the whole mucosa swollen, giving rise to a purulent or muco-purulent condition. The margins of the gums become acutely inflamed and painful to the slightest touch. In the early stages the gums are dry, but this is soon followed by an excessive secretion. The portion of gum attached to the margin of the alveolar process is

pale, while the reflection of the gum from this point on to the cheek will show the vessels to be congested. The gums appear whitish and mottled, and pus is generally seen welling up from the sulci around the teeth.

The mottled appearance of the gums is due to the fact that in inflammation the epithelium proliferates and appears whitish, but through the friction which occurs between the gums and the cheeks the epithelium covering the papillæ of the gum is rubbed off and leaves reddish patches here and there. The breath is fœtid, the patient has a sensation of heat and pain, and the taste is impaired. The tongue is furred, there is loss of appetite, derangement of the bowels, and a feeling of malaise.

Treatment.—The cause should, if possible, be removed, antiseptic and astringent mouth-washes should be used and the general condition of the patient treated by appropriate remedies.

(**b**) **Mercurial Stomatitis.**—Prolonged use of mercury is likely to lead to gingivitis which rapidly spreads to contiguous parts. The ptyalism, so often seen in cases of mercurial stomatitis, is due to the spread of inflammation to the salivary glands. The early symptoms are soreness and discomfort in the mouth, accompanied by a metallic taste and fœtid breath. The gums become inflamed, and present a deeply congested appearance at the free edge; the portion attached to the margin of the alveolar process remains whitish, and the portion beneath presents the whitish mottled appearance referred to above. The teeth become loose, sloughing and ulceration occur near the margin of the gum, the slough separates, and the teeth fall out. The inflammation spreads rapidly to the cheeks, tongue, floor of the mouth, and to the salivary glands, leading to a profuse flow of saliva. There is much pain in swallowing, speaking, and on moving the jaws. In severe cases, if not quickly treated, extensive sloughing and necrosis may supervene.

With regard to the pathogenesis of mercurial stomatitis, Alonkvist,[1] who examined specimens from subjects who had died in the course of mercurial treatment, concludes: "That the deposition of mercurial granules takes place in the vessel walls, and in preference in the capillary loops nearest to the epithelium.

[1] See "Mercurial Stomatitis: Present Status of the Question," Raymond Lulle, *Le Progrès Dentaire*, September, 1907.

During the evolution of the disease the following phenomena occur in the gum and mucous membrane. Deposition of granules of mercuric sulphide, vascular dilatation, diapedesis of leucocytes laden with the mercury granules, degeneration and death of the histological elements of the tissue. The mercury is deposited through the action of hydrogen sulphide formed during the decomposition of proteid matter in the mouth or intestinal tract. The latter compound precipitates the mercury which circulates through the blood-vessels and that which is eliminated through the oral mucous membrane in the form of mercuric sulphide. Hence the necessity of keeping the mouth and teeth in a perfect state of cleanliness during mercurial treatment, and of paying as much attention as possible to the digestive functions, in order to avoid the formation of excessive amounts of hydrogen sulphide. Inflamed gums caused by carious teeth do not hug the teeth tightly at the neck, and in the interstices thus produced food *débris* accumulates, and, in undergoing decomposition, hydrogen sulphide is formed, which causes the precipitation of the mercury eliminated through the mucous membrane."

"In animals mercurial intoxication is not as a rule accompanied by stomatitis, which, however, may be induced by detaching the gums around the teeth and irrigating the pockets for some time with solutions of hydrogen sulphide."

Treatment.—Local.—In mild cases, the use of an antiseptic mouth-wash is sufficient. In severe cases, local depletion will be found advantageous.

General.—The administration of the drug must be stopped, and the bowels made to act freely by means of saline purgatives. A plentiful use of alkaline mineral water should be enjoined. The diet should be in a liquid form, and, if there is much pain, opium in the form of pulv. opii co. may be given at night. The general anæmic and debilitated condition which follows severe "ptyalism" requires a supporting form of treatment.

(c) Ulcerative Stomatitis.—This condition is most frequently met with in children. It may prevail in an epidemic form in institutions where insanitary conditions exist. Want of cleanliness, faulty hygienic surroundings, and general ill-health favour the development of the disease.

The inflammation commences at the free margin of the gums,

and is said to be more frequent in the maxilla. In the early stages the gums are swollen and congested, the congested veins leading to the part being distinctly visible. The ulceration, commencing at the free margin, gradually spreads, denuding in its course the alveolar process, and leading to necrosis of the teeth. The adjacent mucous surface of the cheek usually becomes attacked from contact, and, if the case is left alone, the ulceration may extend, leading to extensive necrosis, sloughing, and, ultimately, death of the patient. In well-developed cases, an ulcer with sharp irregular edges is seen, the margin displaying a bluish ring, the ulcer being covered with a greyish or yellowish slough, the neighbouring lymphatic glands being enlarged.

Bacteriology.—In this disease, the *Bacillus fusiformis* and *Spirochæta dentium* are always present in large numbers; and observers who have examined such cases have generally come to the conclusion that the fusiform bacillus and the spirochæte are the causative organisms.

No satisfactory evidence of the pathogenicity of either of these two organisms is, however, forthcoming, as Ellermann, and Mühlens, and Hartmann, who isolated respectively the fusiform bacillus and the *Spirochæta dentium*, were unable to obtain pathological lesions by injections of pure cultures. By epidemiologists the disease is often thought to be related to the foot-and-mouth disease of cattle (see p. 660), and in this disease no definite micro-organism has been isolated; but whatever the organism may be, it is apparently somewhat smaller than any organism we are acquainted with as yet, as the living virus will readily pass through the pores of a Pasteur and Chamberland filter.

Guezette[1] considers that ulcerative stomatitis is closely related to noma. The most constant feature in three cases he examined was the presence of a spirillum and a bacillus. He injected the discharge from a case upon his own lip, and found that the spirillum speedily disappeared whilst the associated streptococcus flourished freely.

In addition to the spirochæte and *Bacillus fusiformis*, in three cases of ulcerative stomatitis which Mr. Goadby has examined

[1] *Archiv. de la Sci. Méd.*, vol. xxiii, No. 1.

he found the *Saccharomyces albicans* present in large numbers, both on the films direct and upon cultivation. The organism takes some little time to develop, and may easily be missed. It is quite possible that this organism may be only a concomitant to the inflammatory condition, but it is not common in ulcerative lesions of the mouth, whereas the *Bacillus fusiformis* and the spirillum occur whenever any diseased condition of an inflammatory nature is present in the mouth.

Signs and Symptoms.—In the early stages there is little pain, and the disease may be far advanced before it is discovered by the parents, and then the odour of the breath is the first symptom noticed. Constitutional symptoms are marked in severe cases, and death sometimes results.

Treatment.—Treatment consists in administering internally chlorate of potash, a drug which seems to be a specific for this disease. Children should be given 5 to 10 gr. according to age, adults 15 to 20 gr. It is well to give at the same time some iron or such-like tonic in the following form :—

℞ Liquoris ferri perchloridi .. .. .. ♏ii.
Potassæ chloratis .. .. gr. v. to x.
Aquam aurantii .. .. .. ad ʒi.
Misce. Mitte ℥ii.
(One teaspoonful to be taken three times a day after meals.)

A mild purgative should be given, and an endeavour made to improve the surroundings of the patient, should these be at fault. Plenty of exercise in the fresh air should be recommended.

Locally, all unhealthy teeth should be removed, and the ulcer should be painted with a strong solution of nitrate of silver, the mouth being kept clean by frequent irrigation with hydrogen peroxide. Should the cheek be involved as well as the gums, a strip of lint moistened with carbolized oil should be placed between the two surfaces. A gargle of chlorate of potash should be prescribed,[1] and its frequent use recommended. Under this treatment most cases speedily improve.

A curious form of ulcerative stomatitis intimately connected with menstruation is recorded by Davis[2] under the name of

[1] ℞ Potassæ chloratis .. .. ʒi.
Acidi hydrochlor. dil. .. .. .. ʒss.
Aquam .. .. ad. Oi.
Misce. To be used as a gargle.

[2] *Medical Times*, May, 1898.

cyclical stomatitis. The patient, who was a married woman, aged 35, had had four children. "Several times before the birth of the last child, attacks of stomatitis coincided with menstruation. For three years after this she suffered from severe ulcerative stomatitis, involving the tongue and the whole of the buccal mucous membrane. The first sign of the molimen was soreness of the mouth, appearing five days before the menstrual flow. The attack was at its height at the end of menstruation, at which time the mouth was full of small, dirty ulcers. During the stomatitis no solid food could be taken, and liquids only with caution. All medical treatment had failed, and as the patient was losing ground the tubes were removed. Both ovaries contained cysts about the size of a duck's egg, and the right Fallopian tube contained a mass of blood-clot which was not a tubal gestation. The patient completely recovered. As to the explanation of the cyclical character of the stomatitis, the authors suggests that it may have been a feeble attempt at vicarious menstruation."

In women who are nursing, ulcers of the mouth are common. They usually occur on the lips and cheeks, arise from the mucous follicles, and vary from 3 to 5 mm. in diameter. As a rule, they cause no inconvenience, and heal speedily with the application of nitrate of silver and attention to the general health.

There is **a type of stomatitis which seems to possess distinctive clinical features.** The condition usually starts around a septic tooth, and at first differs but little from a simple ulcerative stomatitis. Within from twenty-four to forty-eight hours the infection spreads rapidly along the gingival margin, involving both jaws, and often extends backwards to the pillars of the fauces, to the hard palate, and the floor of the mouth. The gums bleed readily and present a ragged margin of necrotic tissue; the periodontal membrane is rapidly involved, and the margin of the bone becomes exposed (fig. 715). With the gum condition are usually associated lesions of the mucous surfaces of the fauces, tonsils, soft palate and pharynx, which become covered with patches of exudation forming a yellowish to greenish-yellow membrane, which may remain superficial or tend to spread into the deep layers of the tissues. The breath has a most offensive odour, and pus and blood wells up around

the teeth. If left untreated, the teeth rapidly loosen and are lost, and the adjacent tissues are deeply ulcerated and the lymphatic glands enlarged. The local condition is attended by a rise in temperature varying from 100° to 103° F., which usually falls to normal about the fourth or fifth day.

In one case under observation, the disease started around a loosely fitting crown, and in three other cases the focus of infection was around a misplaced third mandibular molar, whence it spread rapidly forwards along the gingival margin and backwards on to the pillars of the fauces and soft palate. In a series of seven cases recorded by Messrs. Harwood-Yarred and P. N. Panton[1] carious teeth were present, and it was apparently

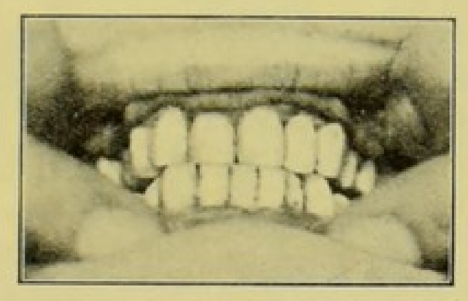

FIG. 714.—From photograph of gums of patient suffering from the type of stomatitis described in the text.

around these teeth that the disease arose. In five of the seven cases, a greyish-white necrotic patch appeared in the mucous membrane of the cheek and opposite the carious teeth. In every case the authors were able to demonstrate one or both of the organisms described by Vincent.

The symptoms and general course of the disease are similar to those characterizing the condition usually known as Vincent's angina; "indeed, it is probable that they are one and the same affection, the main focus of the disease lying in the gingivæ." Two varieties of Vincent's angina are recognized. A mild or diphtheroid type, in which the process is limited in extent of surface and does not penetrate to any depth, and a severe or ulcero-membranous type, in which the process extends rapidly over the surface and involves the mucous membrane deeply.

[1] *Lancet*, February 17, 1906.

Bacteriological examination of cases shows that, in addition to pyogenic cocci, a characteristic bacillus is present in the exudation frequently associated with a spirillum. In the mild type, the bacillus predominates; in the severe type, the spirillum is "much more frequent and may even be present in greater numbers than the bacillus." The bacillus described by Vincent is called the "fusiform bacillus." (See p. 422).

Treatment consists in thorough irrigation of the pockets around the teeth, and also of the affected mucous membrane, with hydrogen peroxide, followed by the application of strong tincture of iodine. The acute symptoms rapidly improve under this course of treatment, but a chronic condition often remains which requires careful hygienic treatment on the part of the patient. Teeth which are obviously the source of chronic sepsis should be removed, and, in cases where the stomatitis spreads from the misplaced third molars, these teeth should be removed.[1]

(d) **Gangrenous Stomatitis; Noma; Cancrum Oris.**—This very serious disease is a rapidly spreading gangrenous inflammation, which usually attacks the cheeks, and occurs in children from 2 to 6 years old. The disease may, however, occur in adults.[2] It is more common in girls than in boys. It is frequently seen in those just recovering from one of the exanthematous fevers. Unhygienic surroundings and weakening of the system by long-continued administration of mercury also act as predisposing causes. The disease may start either in the substance of the cheek, or in the mucous membrane, the latter being the more usual common situation. The cheek becomes hard, brawny, and very swollen, a dark red colour showing in the centre, the surrounding parts being œdematous. At this stage, if the mouth be examined, an ulcer will be seen on the mucous surface of the cheek corresponding to the dark spot on the cheek. The ulceration, or rather sloughing, leads to perforation of the cheek, and, if the disease still pursues its course,

[1] In connection with this question, the following papers will be found worthy of perusal: On Vincent's angina. H. W. Bruce. *Lancet*, July 16, 1904, p. 135. Cases of stomatitis and tonsilitis in which Vincent's spirochæte and bacillus were present. W. H. Harwood-Yarred and P. N. Panton. *Lancet*, February, 1906, p. 438.

[2] See *Lancet*, December 21, 1901, p. 1730.

the soft parts rapidly become gangrenous. The child becomes exhausted, delirious, and eventually dies of exhaustion, blood poisoning, or some septic affection of the lungs.

The facts that the whole cheek becomes gangrenous, and that the disease is not amenable to the action of chlorate of potash, help to distinguish it from ulcerative stomatitis, but most

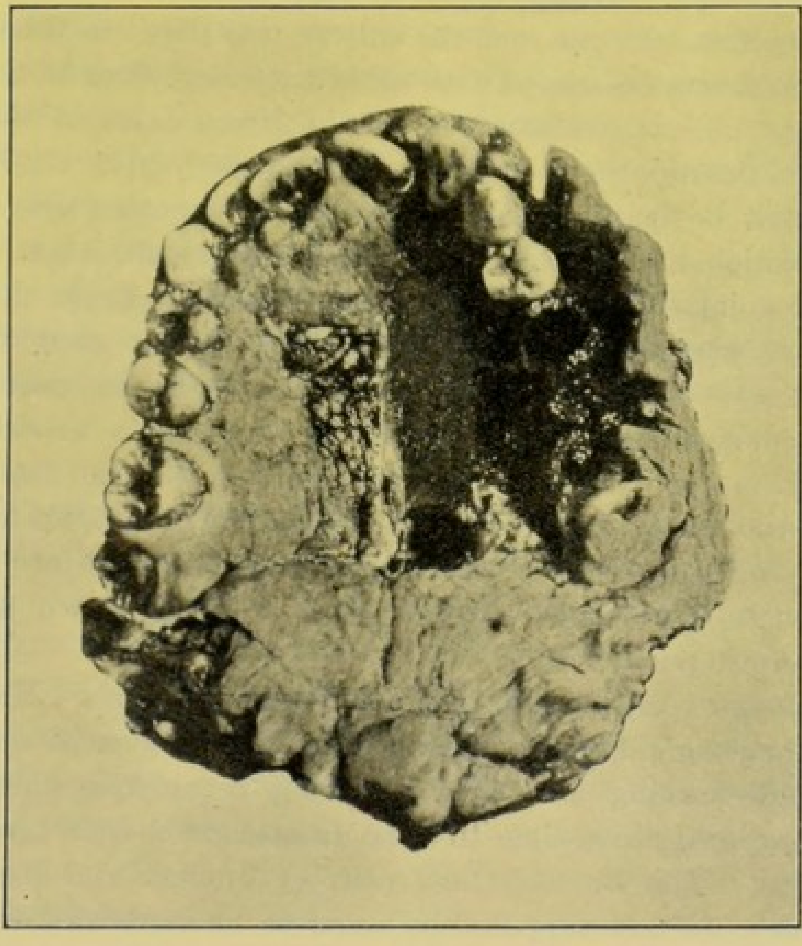

FIG. 715.—A case of gangrenous stomatitis. Museum of Charing Cross Hospital.

authors think that the difference between cancrum oris and ulcerative stomatitis is only one of degree. The disease is said to be caused by thrombosis of the capillaries, induced by the presence of a specific micro-organism, and is similar to the gangrenous inflammation known as noma, which occurs upon the female genitals.

The disease in rare instances may commence at the gingival margin. A case illustrating this point is recorded by C. Lockyer.[1] The patient, a youth aged 18, removed three roots of teeth by means of a wooden penholder sharpened and used as an elevator. Four days subsequently the face began to swell, gangrene ensued and spread rapidly over the palate and the alveolar process, the patient eventually succumbing to general septic infection (fig. 716.)

Bacteriology.—Walsk[2] found in eight cases of noma the diphtheria bacillus. In one case the culture was pure; in the remaining seven it was associated with other bacteria. Four of the cases started as ulcerative stomatitis, but in fifteen cases of the latter condition the diphtheria bacillus could not be found. Dr. Hellsen[3] states that he has isolated from a case of cancrum oris a diplococcus which he was able to cultivate, and which, when injected into an animal, caused the identical disease. From the latter source it was obtained in pure culture. Four generations of bacteria were obtained from the original growth, and each caused a well-defined case of necrosis in the specimens experimented upon. It is worthy of note in this connection that the *Diplococcus pneumoniæ*, an organism frequently present in suppurative conditions and infections of the mouth, when injected into guinea-pigs causes a fibrinous exudate, later breaking down at times into necrotic pus.

Professor von Babes, in Kollé and Wassermann's "Handbuch der pathogenen Micro-organismen," gives a number of references to spindle-forming and thread-forming organisms which have been described from time to time as associated with gangrenous stomatitis. The *Bacillus fusiformis* of Vincent and the *Spirochæta dentium* are supposed by some to be associated with this disease, and some time since Bernheim considered that the spirochæte was the cause of the disease, as it was usually present in large numbers. Other observers have thought that the *Bacillus necrosis* or a streptobacillus of Zohr, was an organism which played a part in the production of gangrenous stomatitis. In one or two instances the bacillus of malignant

[1] "A Case of Gangrenous Stomatitis," *Brit. Dent. Journ.*, vol. xxix, p. 605.

[2] *Proc. Path. Soc. Philadelphia*, June, 1901.

[3] *Münchener med. Wochenschrift*, 1907, No. 5.

œdema has been described, but as yet there is no settled bacteriology with regard to the disease. The disease is fortunately uncommon, at any rate in England; and there is little opportunity for making bacteriological examinations.

The *prognosis* of cancrum oris is bad. The *treatment* consists in carefully drying the soft parts, removing all gangrenous portions, and cauterizing the remaining surface with nitric acid, or the actual cautery. The general treatment should consist in supporting the patient's strength with a plentiful supply of beef-tea and other nutritious remedies. It has been suggested that free excision of the gangrenous surfaces would be an effective treatment, and in cases recorded it has proved beneficial. Corrosive sublimate locally applied has been used; it has proved successful in three cases recorded by Kingsford in the *Lancet* of May 4, 1889. Disinfectant mouth-washes must be prescribed, and the raw surfaces carefully dressed with antiseptics. The disease may spread until the whole side of the face disappears, the cavity extending from the nose to the ear, and from the lips to the upper eyelid.

(e) **Follicular Stomatitis.**—This inflammation is similar to an ordinary herpetic eruption. A cluster of vesicles first appears, which on breaking down coalesce and form a small circular and well-defined ulcer. This ulcer is surrounded by a zone of redness, and is extremely painful. The ulcers are said to occur more frequently near the frænum of the lip, on the under surface of the tongue, and in the sulcus between the gums and the lip. The little round punched-out ulcers met with in the cheeks are probably a variety of this form. Follicular stomatitis occurs in adults less frequently than in children. It is often associated with some gastro-intestinal disturbance.

The *treatment* consists in the application of an astringent solution, and, in intractable cases, the ulcers may be touched with a crystal of sulphate of copper or nitrate of silver. The general condition of the patient must also be treated.

(f) **Parasitic Stomatitis.**

(1) **Due to Saccharomyces albicans (Thrush).**—Thrush is a parasitic inflammation of the mucous membrane of the mouth, dependent upon a fungus, the *Saccharomyces albicans*. It is common in infants, but may occur in adults, and, in the latter,

is generally associated either with some of the acute specific fevers, or with chronic wasting diseases, such as phthisis. When associated with phthisis it generally proves fatal. The fungus develops in the upper layers of the mucosa, the filaments forming a dense network among the epithelial cells. In this manner the mucous membrane becomes covered with numerous white spots, which are firmly adherent, and, when removed, a deep red colour is revealed. These spots appear mostly near the angles of the mouth and on the tongue, but may occur elsewhere in the oral cavity, the affection spreading at times to the pharynx and œsophagus. The spots are about the size of a pin's head, are circular in form, and they gradually coalesce and form larger patches, giving rise to the appearance of a false membrane with a slightly yellowish aspect. These patches come away of their own accord leaving a reddish surface beneath. The patches are found to consist of epithelium and fat, together with sporules of the *Oïdium albicans,* the vegetable parasite which causes the disease. (See also p. 307).

When thrush occurs in children they are generally found to be out of health, the bowels relaxed, the evacuations green and sour. The motions are generally acrid, and irritate the margins of the anus, giving rise to an erythematous blush over the buttock, the appearance of the edges of the anus being similar to that seen in the mouth. Sucking and deglutition are impaired by the condition of the mouth, and the child will usually be in a state of drowsiness and torpor. Many cases of thrush in infants are distinctly traceable to the use of dirty feeding-bottles.

The treatment of thrush may be divided into local and general. The *local* treatment consists in carefully wiping the mouth with soft lint after each meal, care being taken to burn the lint after use. The exposed surfaces thus left are touched with a solution of 3 drachms of borax to 1 oz. of water. In severer cases, it will be advisable to use nitrate of silver, 5 gr. to the ounce, or dilute carbolic acid in glycerine. It is needless to say that attention should be given to the condition of the feeding-bottle. The *general* treatment should consist in careful attention to the diet, with the administration of a mild aperient.

(2) **Due to the Aspergillus nigrescens.**—An inflammatory

condition due to the presence of the *Aspergillus nigrescens* has been reported.[1]

The following is a brief account of the case: "A small ulcer first appeared on the middle line of the roof of the mouth, about half-way between the incisors and the soft palate. The patch increased slowly in size, and others formed in the neighbourhood, the condition appearing like a lumpy patch extending from just behind the incisors to within one-fourth of an inch of the soft palate. Cup-shaped elevations on the soft palate appeared on either side of the middle line. A firmly attached membrane, giving rise to hæmorrhage when forcibly removed, covered the areas. The colour of the recent deposit suggested the sulphur-coloured scutula of favus; where it had remained undisturbed it was darker. With low power the growth was recognized under the microscope as a fungus differing from the achorion. The mycelium network was composed of delicate fibres, bearing perpendicular fructifying hyphæ. Scattered over the field were a number of fruit receptacles and a few spores. The manner of fructifying showed that the fungus did not belong to the oïdium, but to the ascomycetous genus. Cultures showed it to be *Aspergillus nigrescens* which had caused the inflammation. Upon applying 25 per cent. ethereal solution of pyrozone, improvement was immediately noticed. The pseudo-membrane disappeared and new patches ceased forming. After seven weeks' treatment the patient was well."

"The spores were supposed to have been implanted in the mouth through the medium of cheese, strong and mouldy varieties of which the patient was very fond of eating."

(g) Aphthous Stomatitis.—This form rarely occurs in adults. It is characterized by the formation of fibrous deposits on and under the epithelium, and is considered by some authors to be contagious. It is frequently met with in rachitic and weakly children and is most common during the periods of dentition. In adults it occurs in those debilitated by illness, or may be associated with general inflammatory conditions. In women, it occurs during menstruation, pregnancy, and during the puerperal period.

[1] *Medical Record*, October, 1896 (*The Dental Digest*, p. 641, 1896).

Bacteriology.—In ten cases of aphthous stomatitis examined by Mr. Goadby a streptococcus was present in six having the characters of the *Streptococcus fæcalis*, and not of the ordinary *Streptococcus brevis* of the mouth.

Signs and Symptoms.—Small yellowish-white patches, slightly elevated and extensively sensitive, are present on the mucous membrane. The patches are surrounded by a zone of inflammation. They have a tendency to spread and coalesce, forming large patches. When not associated with any active general disease, constitutional symptoms may be present, namely, slight elevation of temperature, thirst and loss of appetite.

Treatment.—Locally, a mouth-wash of chlorate of potash should be used, and the mouth thoroughly cleansed after each meal. If the aphthæ persist, they may be treated with nitrate of silver. The constitutional condition also requires attention.

In cattle **aphthous stomatitis appears in an epidemic form** and is commonly known as **"foot-and-mouth disease."** It is communicable to man. In man it is an eruptive fever running a fixed and definite course, usually in eight to ten days, and is characterized by a vesicular eruption in the mouth, on the lips, gums and tongue, as well as on the hands and feet. In the early stages of the disease there is headache and loss of appetite, with a quickly rising fever. Pustules appear in the mucous membranes of the mouth, more frequently in the lips and the tongue, than on the hard palate and the throat. After a few days the pustules burst, leaving eroded spaces with greyish-yellow surface, which during the second week commence to heal. In the acute stage, the patient suffers from a sensation of heat and burning in the mouth, the cervical and salivary glands swell, producing severe dysphagia.

(h) Chronic Neurotic Stomatitis.—This condition appears usually in patients suffering from mental worry. It is an uncommon condition. Knowsley Sibley[1] considers that it is not of the nature of pemphigus, as sometimes described, but is a distinct affection.

"It generally commences as a crack or streak, or from the beginning as a small superficial bright red ulcer. Occasionally in

[1] *Brit. Med. Journ.*, April 1, 1899, p. 900.

the tongue it begins in an inflammatory localized thickening just beneath the mucous membrane, which rapidly breaks down and forms an ulcer, usually with a slough in the centre and considerable inflammatory redness around. It sometimes happens that the ulceration is preceded for a day or two by a heaping up of the epithelium, often forming a pale, gelatinous-looking ridge fitting in the spaces between the teeth. At other times, the ulcers are preceded by small gelatinous-looking bodies about the size of millet seeds, and, occasionally, by small vesicles; accompanying the ulcers is usually a considerable desquamating catarrh of the surface of the tongue. There is usually a good deal of burning sensation and great distress, accompanied by profuse salivation, and, if the ulcer is very indolent, with œdema of the parts around. If the lesion is situated in the mucous membrane of the lips, these may become so swollen as hardly to permit of the mouth being opened and the tongue protruded. The ulcers are produced by a distinct tropho-neurosis, and they are quite different from the common catarrhal or dyspeptic ulcer."

In one case recorded by Sibley the ulcers had appeared intermittently for twenty-three years.

Treatment.—Complete rest from worries is needful. Locally, the healing of the ulcers may be expedited by the application of tincture of iodine. The pain and distress may be mitigated by the use of cocaine, or, in severe cases, opium.

(3) LEUCOPLAKIA

Leucoplakia of the cheeks and the palate is of frequent occurrence in syphilitics and those addicted to heavy smoking. It is more usually seen in the muco-periosteum covering the back of the hard palate, and in marked cases presents the appearance of "ichthyosis." At times the condition may be limited, and give rise to a definite swelling of a white, cauliflower-like growth. H. S. Pickerill [1] has recorded a case of this character. On the tissue being removed and examined microscopically, the growth was found to consist of epithelial cells, which, instead of becoming squamous and then desquamating, had become swollen and hardened and remained

[1] "A Note on a Case of Ichthyosis Gingivæ," *Brit. Dent. Journ.*, vol. xxx, p. 733.

in situ (fig. 716). The sub-mucous tissue was normal. This author considers the condition similar to the "pre-cancerous" conditions of the tongue described by H. T. Bullin.[1]

(C) PEMPHIGUS

The eruption of pemphigus may occur in the mouth, and one rare form, **pemphigus vegetans,** may remain localized to the mouth and adjacent cavities. The following case[2] will illustrate this condition.

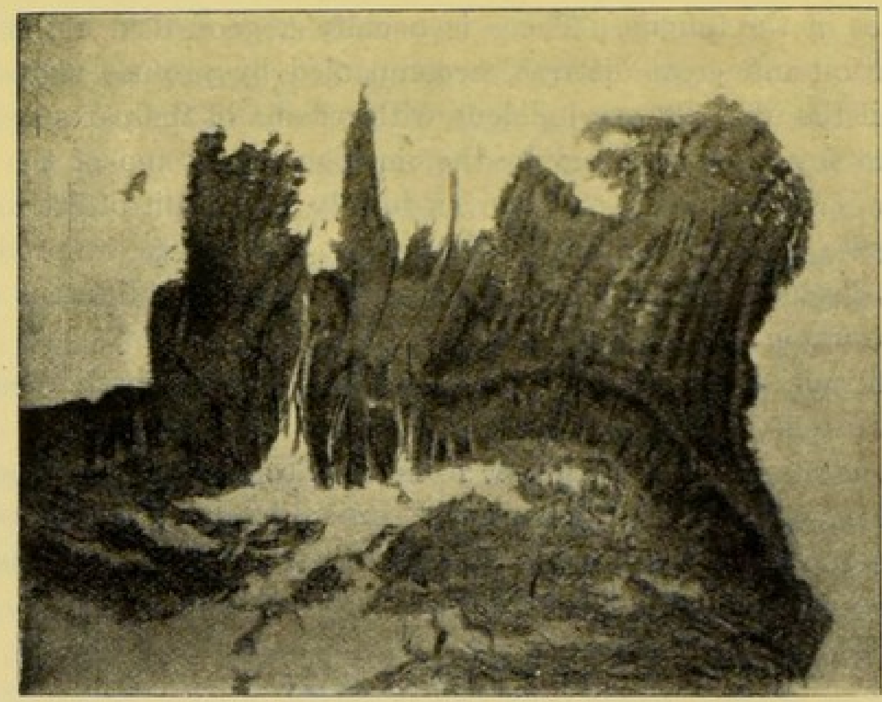

FIG. 716.[3]

The patient was a man, aged 72, who complained of soreness in his mouth and inability to take solid food. On the roof of the mouth and on the epiglottis were patches of false membrane of considerable thickness, which, when removed, left a raw, bleeding surface. Some decayed teeth were extracted and antiseptics used, but blebs formed on the roof of the mouth, the soft palate, the cheeks, under the tongue, and on the posterior wall of the pharynx. Bacteriological examination of the membranes gave

[1] *Brit. Med. Journ.*, January 9, 1909.
[2] Dr. Lewis Maller, *New York Med. Journ.*, July 3, 1898.
[3] From *Brit. Dent. Journ.*

negative results. There was neither fœtor nor salivation. Whenever the patient attempted to masticate solid food a fresh crop of blebs appeared.

(D) PURPURA

In the severe form of purpura known as "purpura hæmorrhagica" the gums and mucous membranes may be the seat of the hæmorrhage. A very similar condition to this is occasionally seen in patients the subjects of hæmophilia, spontaneous hæmorrhage occurring at the margin of the gums.

The treatment of purpura belongs to the domain of general medicine. The hæmorrhage from the gums can be treated by the use of astringents such as tannic acid, the application being combined with a certain amount of pressure.

(E) SCURVY

The effect of scurvy on the gums is that they become dark, turgid, spongy, and swollen, so as to hide a considerable portion of the surfaces of the teeth. At first the gums bleed readily; this is followed later on by a constant oozing. Ulceration and sloughing of the edges of the gums take place, leading to loosening and loss of the teeth and necrosis of portions of the jaws. In scurvy, the mucous membranes are anæmic, and there will be a strong contrast between the reddened gum and the pale mucous membrane covering the lips. The local symptoms are always associated with marked general symptoms indicative of the disease. In infantile scurvy changes in the gums are absent if no teeth have erupted, and in scorbutic adults the gums show no change if patients are edentulous.

The treatment of scurvy cannot be dealt with here. Suffice it to say that the mouth must be kept quite clean and aseptic by the constant use of antiseptic lotions.

(F) PERFORATING ULCERS OF THE MOUTH

due to trophic changes are occasionally seen in patients who are the subjects of *tabes dorsalis*.

As to the explanation of the lesion, there are two views: (1) that of Galippe, that it is the result of alveolar pyorrhœa

aggravated by tabes; and (2) that of Baudet, that it is an atrophic tabetic lesion due to the fifth nerve being affected, which begins by loss of the teeth and atrophy of the jaws, and sometimes terminates by ulceration and perforation into the antrum.

(G) TUBERCLE

Tuberculosis of the mucous membrane of the mouth is a rare condition, and seldom arises as a primary lesion.

(H) SYPHILITIC INFLAMMATION AND ULCERATION

Syphilis may affect the gums and oral mucous membrane in all stages.

The primary lesion may occur on the gums, tongue, or other parts, and often assumes an unusual appearance. Ulcers of peculiar appearance and uncertain origin should always be regarded with suspicion, and the possibility of their being of syphilitic origin carefully inquired into.

Secondary lesions may appear in the form of mucous tubercles and in almost any part of the mouth; the favourite situations are the inner surfaces of the cheeks, the edges of the tongue and the lips. In weak and debilitated patients, the tubercle may break down, leaving an ulcer with a sinuous outline. The ulceration may extend and lead to extensive destruction of the tissue, followed, on healing, by adhesion of contiguous parts and extensive contraction.

In the tertiary stages, the ulcerations are generally of a deep, excavated character, and are preceded by gummata, which, undergoing degeneration, produce the ulceration.

(I) ANEURISM

A case is recorded by J. H. Edward[1] in which the anterior palatine artery entered the mouth through an aperture in the centre of the suture between the palatine bones. The pressure of a denture at this part led to an aneurysmal dilatation of the vessel.

The various tumours arising in connection with the gums are described in chapter xxvii.

[1] *Journ. Brit. Dent. Assoc.*, vol. xvi, p. 272.

CHAPTER XX.

Saliva

Physical Characters — Composition — Mixed Saliva — Characters of the Different Secretions — Quantity Secreted — Adaptation to Diet — The Saliva in Disease — Bactericidal Properties — Salivary Calculi — Degeneration of the Salivary Glands — Secondary Parotitis

THE glands which pour their secretions into the mouth are the parotid, sublingual and submaxillary salivary glands, and the buccal mucous glands, the combined secretions being known as mixed saliva.

(A) PHYSICAL CHARACTERS

Mixed saliva when freshly collected is a transparent, slightly opalescent and viscid fluid. On standing, it comes slightly turbid, owing to the precipitation of calcium carbonate. This salt is held in solution by carbonic acid, and, with the escape of acid, the calcium carbonate is deposited. The specific gravity of mixed saliva is 1002 to 1006. The reaction in health is alkaline.

(B) COMPOSITION

(1) Mixed Saliva

According to Halliburton, mixed human saliva contains water 994·10, solids 5·90.

(a) **Soluble organic matter.**

Mucin—precipitable by acetic acid.
Ptyalin—an amylolytic ferment.
Proteid—of the nature of a globulin.

(b) **Epithelium.**

(c) **Soluble inorganic matter.**

Sodium chloride—most abundant.
Carbonates of sodium and calcium.
Potassium chloride.
Phosphates of calcium, magnesium and sodium.
Potassium sulphocyanide (0·10).

(2) Characters of the Different Secretions

(*a*) **The parotid** is clear and watery. On standing, a deposit appears, consisting principally of carbonate of lime. The total amount of solids is 0·3 to 0·5 per cent. There is no mucin.

(*b*) **The submaxillary** is of a thick, viscid character, contains mucin, and, on standing, deposits chloride of potassium and sodium.

The solids amount to 2·1 to 2·5 per cent., and consist of mucin and ptyalin, with potassium and sodium chlorides, and calcium and magnesium phosphates and carbonates.

(*c*) **The sublingual** is the richest in solids, which amount to about 2·75 per cent. It is the principal source of ptyalin. The salt in greatest abundance is phosphate of lime.

(*d*) **Mucous Glands**.—According to Bidder and Schmidt, the secretion contains water, mucin, and inorganic salts, of which the chief is sodium phosphate.

(C) QUANTITY SECRETED

From one to three pints are said to be secreted during the day, of which about two-thirds are secreted by the parotid, and one-twentieth by the submaxillary gland.

In rare instances there may be a *complete absence* of saliva. In infants, the salivary glands do not become functionally active until the child is from four to six months old.

(D) ADAPTATION OF THE SALIVARY SECRETION TO DIET

This subject has been investigated by C. H. Neilson and O. P. Terry.[1] As a result of experiments carried out on dogs, it was shown that sugar appears in the saliva of bread-fed dogs much sooner than in meat-fed dogs. In one experiment a dog was fed for fourteen days on a meat diet, and the glands on one side then removed. After operation the dog was placed on a bread diet for fourteen days, and the glands on the opposite side then removed. The extract of the glands removed after the meat

[1] *Amer. Journ. of Physiol.* vol. xv, p. 406.

feeding showed only a small amylolytic power, while the extract from the glands after the dog had been fed on bread showed a much greater amylolytic power.

(E) THE SALIVA IN DISEASE

Within recent years more attention has been given to the study of the saliva from a pathological standpoint, and Michaels, Kirk and LeRoy have published some interesting and valuable observations on the subject. The following details relating to pathological saliva are taken from a paper by B. R. LeRoy.[1] In cases of jaundice, the colouring matter and salts of the bile can be traced in the saliva, and the sulphocyanides disappear from the saliva when the bile is diverted from the alimentary tract.

In normal saliva, the sulphocyanides and ammonia are nearly in equal proportions, and when the sulphocyanides disappear and the ammonia appears in increased quantity, a hypo-acid condition is produced. This condition exists in all diseases of the nervous system. When ammonia is present in excess, there is a diminished amount of both oxygen and carbonic acid in the saliva, with a rapid tendency to decompose. This state of affairs is present in all septic conditions, and, with acetone present, there is a condition of auto-infection of the system, with indican in the urine.

The sulphocyanides are absent in conditions where there are exhaustive discharges from the body. The presence of an excess of sulphocyanides indicates a condition characterized by incomplete oxidation, such as gout, rheumatism, diabetes.

When the saliva is exceedingly acid, the presence of free lactic and oxalic acid may be suspected. In these cases, the saliva, upon standing, turns a dark yellowish-brown, and the enzyme ptyalin is always absent. When urea is present, or combined with sodium phosphate, it forms the acid sodium phosphate, and this is clinically shown by an irritated condition of the oral mucous membrane.

Xerostoma, or "dry mouth," is a condition in which the secretion of saliva is arrested, and is very rare. It generally occurs in the female sex, and in persons of advanced age, and is probably of nervous origin, but its pathology is not clear.

[1] *New York Med. Journ.*, March 7, 1908.

(F) BACTERICIDAL PROPERTIES

Sanarelli[1] states that human saliva possesses the power of destroying micro-organisms when their number is not considerable, and even when it fails to destroy them, as in the case of the germ of pneumonia, it seems capable of modifying their normal characteristics by weakening them, and then rendering them completely inactive. M. Sanarelli experimented chiefly with the more common of the micro-organisms which are found in the mouths both of healthy and unhealthy individuals, namely, the *Staphylococcus pyogenes aureus*, *Streptococcus pyogenes*, the bacillus of diphtheria, the *Micrococcus tetragenus*, the diplococcus of pneumonia, the typhoid bacillus, and the cholera spirillum. The saliva was filtered with a Chamberland filter and experiments were practised by the plate method.

Dr. Hugenschmidt[2] records numerous experiments with filtered saliva, and he has come to the conclusion that "the bactericidal action of the saliva appears to be very problematical." He was only able to detect it on the torula and *Staphylococcus aureus*. The saliva, Hugenschmidt considers, has an important mechanical action, as it dilutes the bacteria, glueing them together so that they are swallowed and destroyed in the stomach by the action of the gastric juices. In connection with these experiments it has been pointed out by Miller that the result of filtering the saliva is to deprive it of the greater part of its nutrient matter, so that it contains but a small fraction of the organic matter usually added to the culture media. The refusal, therefore, of bacteria to grow in such a fluid cannot be regarded as a proof of antiseptic action.

In a series of experiments carried out by Miller[3] this source of error was excluded. Bouillon of double strength made from beef extract, peptone and sugar was prepared, and 5 c.c. placed in three tubes. To tube A, 5 c.c. of the saliva of a person immune to caries; to tube B, 5 c.c. of the saliva of a person not immune; and to tube C, the control, 5 c.c. of water. By this means the strength of the bouillon was reduced to the normal. The saliva was filtered

[1] *Centralblatt für Bakteriologie*, vol. x, p. 817.

[2] *Dental Cosmos*, October, 1896.

[3] "Introduction to the Study of Immunity in its Relation to the Diseases of the Mouth and Teeth," *Dental Cosmos*, vol. xlv, p. 1, January, 1903.

through a Chamberland filter. The three tubes were inoculated with a bacterium obtained from carious dentine and incubated. As a result of this experiment he found that the saliva exerted no retarding influence on the growth of the organism.

Experiments were then undertaken to test the rate of acid production. Bouillon of fivefold strength was taken, and to one part of bouillon four parts of saliva were added. The tubes were then inoculated and the rate of acid production determined by the amount of a 5 per cent. solution of bicarbonate of soda required to neutralize the amount of acid formed. One experiment gave the following results:—

RELATIVE AMOUNT OF ACID FORMED.

	In 42 hours	In 62 hours	Total
Saliva of A	9·5	5·5	15·0
,, B.	9·0	7·0	16·0
,, C	10·0	7·5	17·5
Control water	9·0	7·0	16·0

The amount of acid produced in the control tube containing water and the three tubes containing saliva showed no appreciable variation. Further experiments were undertaken on the undiluted saliva, non-altered saliva, &c., with similar results, and the conclusion Miller came to was "That 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 or putrefaction."

Considerable importance is attached by some authors[1] to the natural protective action of the potassium sulpho-cyanide of the saliva. Dr. Michaels, of Paris, claims that in patients highly susceptible to caries there is a superabundance of ammonium salts and an absence of sulpho-cyanates, whilst in those immune to caries there is a diminution of ammonium salts, and the presence of sulpho-cyanates. The concentration of potassium sulphocyanide in the saliva does not exceed 1 : 8,000. Miller added to saliva quantities of the salt to produce varying strengths from 1 : 5,000 to 1 : 250, and to the different tubes 0·1 gm. of peptone and 0·1 gm. of grape sugar or pulverized bread were added,

[1] Michel, *Deutsche Monatsschrift für Zahnheilkunde*, 1901, p. 257.

the tubes being incubated and tested after twenty-four and forty-eight hours. Control tubes to which no sulphocyanide had been added were also incubated. The result of these experiments showed that the acid formed in the control tubes was as great as in those containing the sulphocyanide in strength 1 : 2,000. In the tubes containing a stronger concentration of sulphocyanide the amount of acid was less, as shown by the following figures :—

Amount of Acid Formed.

	At end of 24 hours	At end of 48 hours	Total
Control tube	7	10	17
,, ...	7	10	17
Sulphocyanide 1 : 2,000 ..	7	10	17
,, ,, ..	7	10	17
,, 1 : 1,000 ..	7	8	15
,, ,, ..	7	8	15
,, 1 : 500 ..	5	7	13
,, ,, ..	6	6	12
,, 1 : 250 ..	5	2	7
,, ,, ..	4	6	10

In a further series of experiments in which the saliva of a person immune to caries and containing sulphocyanide (1 : 8,000) was added to peptone and sugar, and inoculated with *Bacillus prodigiosus*, the organism increased with enormous rapidity. Hugenschmidt,[1] in experiments with staphylococcus and typhoid fever bacillus, found that potassium sulphocyanide in strengths from 0·06 per 1,000 to ·20 per 1,000 possessed no bactericidal properties.

Protective properties have been accredited to the buccal mucus. Miller, however, came to the conclusion that "growths of bacteria and fermentation and putrefaction processes take place in oral mucus quite as readily, if not more so, than in the mixed saliva of the same person." He says that "it seems hardly probable that the buccal mucus can contain any bactericidal property in view of the fact that the mucous membrane of the mouth is invariably found to be covered with large masses of bacteria." On the other hand, the action of mucus in other cavities of the body must not be lost sight of. Wurtz and

[1] "Experimental Study of the Different Modes of Protection of the Oral Cavity against Pathogenic Bacteria," *Dental Cosmos*, vol. xxxviii, p. 797, October, 1896.

Lermoyez have shown that "after three hours' contact with the nasal mucus at 38° the spores of the *Bacillus anthracis* are killed, while the *Staphylococcus aureus*, the streptococcus and the *B. coli* are greatly attenuated." Thomson and Hewlett[1] also found the nasal mucus possessed a retarding influence, but no bactericidal property.

The mucus secreted normally by the cervix uteri destroys and attenuates the germs of the vagina and prevents them from penetrating into the uterine os; still further, in connection with the bronchi, Widal considers that "the innumerable glands which exist on the surface of the respiratory mucous membrane secrete constantly a mucus which has a bactericidal action." Arguing by analogy, it would certainly seem probable that the mucus in the mouth when healthy does exert a protective influence against infection.

The possibility of fresh saliva containing protective substances (alexins) is shown in the case of East Indian snake-charmers. These individuals treat snake-bites by applying saliva to the wounds, they themselves having acquired immunity by being bitten first by very small snakes and gradually by larger ones, the antibodies thus formed in the blood passing into the saliva. Alexins (complement of Ehrlich-cytase of Metchnikoff), are of the nature of ferments, and are destroyed by heating to a temperature of 60° C. for half an hour. The following experiment was carried out: Three tubes of saliva filtered through paper were taken; tube 1 was left unchanged, in tube 2 the saliva was heated to 60° C. to destroy any alexins present, and in tube 3 the saliva was heated to 60° C. to destroy any alexins present, and then fresh saliva was added, that is, saliva not deprived of alexins.

The tubes were then infected with *Bacillus prodigiosus* and the number of bacteria tested at different periods.

The following results were obtained :—

	Tube 1. Non-heated saliva	Tube 2. Heated saliva	Tube 3. Reactivated saliva
At commencement of experiment	8	16	11
After 1 hour	13	28	15
After 2½ hours	21	12	16
After 23 hours	690	159	488

[1] *Lancet*, 1897, p. 860.

These figures show that the saliva experimented with did not contain an antibody to the *B. prodigiosus*. Indeed, in the tubes heated to destroy any antibody present, the growth of the bacillus at the end of twenty-three hours was considerably less than in tubes 1 and 3. The subject, however, requires further investigation before it can be definitely stated that such antibodies do not exist in saliva. There is reason to think that the saliva may contain definite antitoxin properties, and that this is so is borne out by the experiments of Wehrmann[1] who showed that the ptyalin of human saliva mixed with a quantity of snake poison, which would otherwise prove fatal in a very short time, rendered the poison completely harmless.

It seems more than probable that the **protection of the oral cavity against pathogenic bacteria is due to phagocytosis.** Hugenschmidt refers to the chemiotactile properties of saliva, and shows that non-filtered human saliva possesses positive chemiotactile properties. This he demonstrates by the following experiments: Human saliva ejected in the morning was left for some time in an experiment glass; the upper part of the liquid, which had become clear, was then introduced in small quantities into capillary tubes which were each closed at one extremity; the tubes were then inserted into the peritoneal cavity of a guinea-pig and left for eight hours, after which they were removed, and, on being examined, leucocytes were found to have formed a dense plug 2 mm. long. In another experiment, in which the saliva was kept for twenty-four hours in an oven at 37° C., and in which the number of microbes had greatly increased, the plug formed by the leucocytes in the capillary tube was visibly larger, thus showing that the attraction exerted by the leucocytes is in relation to the intensity of the culture, and consequently with the quantity of the microbian products present in the liquid. From these experiments it may be inferred that when there exists in the interior of the alveolar process after an extraction, or in any other part of the buccal parietes, a cavity where the saliva can remain and become the medium of an abundant culture, the saliva presents chemiotactile properties in relation to the quantity of microbes which have developed in it.

[1] *Annales de l'Institut Pasteur*, 1897, vol. xii, p. 510.

The leucocytes of the neighbourhood will be energetically attracted towards the diseased part, and will, in a very marked way, accomplish their protective action.

Experiments in which the saliva of a guinea-pig was introduced into the same animal's peritoneal cavity produced the same results as human saliva, thus demonstrating the fact that the saliva of one animal attracts the leucocytes of the same animal. Having shown that saliva possesses positive chemiotactile properties, experiments were made with the view of ascertaining whether the phagocytes of an animal are capable of englobing and digesting the microbes which are cultivated in the salivary secretions. That the phagocytes of an animal are capable of englobing and digesting the microbes which are present in the salivary secretions is shown by the following experiment:—

Human saliva which had been left quiet—so as to clear it—was mixed with leucocytes from guinea-pigs. The mixture was then placed in an oven at 37° C. for an hour; the liquid was then placed on slides, fixed, and coloured by Ehrlich's process. Microscopical examination of the slides showed that the leucocytes had taken up the microbes with great avidity. Similar experiments with the saliva of guinea-pigs, and leucocytes from the peritoneal cavity of the same animal, gave similar results. In another experiment recorded, the activity of the destruction of the microbes by the phagocytes is clearly demonstrated. "A trace of saliva was taken from a guinea-pig, and from this preparations were made and stained, some with methyl blue and others by the Gram method. This done, a wound was made in the gum and in the median line of the mandible, the mucous membrane being removed and the bone scraped. Twenty-four hours later the wounds presented a white coating consisting of leucocytes, almost all polynuclear, some mononuclear. These leucocytes, by proper stainings, were found to contain an abundance of microbes similar in form and character of stain to those seen in the preparation of the saliva. A considerable number of the englobed microbes were less energetically stained than those from the surrounding liquid, thus demonstrating their degeneration."

In the experiments above recorded the saliva was used unfiltered and therefore mixed with microbes. To test whether

filtered saliva possessed these chemiotactile properties, the following experiment was carried out: Saliva, filtered through a Chamberland filter, was introduced into six capillary tubes, each of which had one end closed. In six other tubes, cholera culture was introduced, and into another six physiological serum. These three bunches, separately attached, were placed in the peritoneal cavity of a guinea-pig and left for ten hours. Examination at the end of that period showed dense plugs of leucocytes in the tubes containing cholera culture, but few leucocytes in the tubes containing filtered saliva, and no trace of any in the tubes containing physiological serum. "It would thus seem that the positive chemiotactile properties of saliva depend upon the presence of micro-organisms."

But phagocytosis is probably not the only means by which the oral cavity is rendered immune to pathogenic organisms, for it is probable that the epithelial cells and also the vital antagonism of the microbes lend their aid. The epithelial cells of the oral cavity are constantly being replaced, this desquamation being especially active during the act of mastication. Although the epithelial cells do not possess phagocytic properties, neverthelsss they are lined on the surface and also, to a certain extent, penetrated by scattered bacteria; the result is that the cells are dislodged by the saliva, and carried away to the stomach to be destroyed.

Another factor to be considered in connection with the immunity of the oral cavity to infection may be the antagonism of organisms to one another, the organism not common to the mouth succumbing to those normally present. The following experiment, carried out by Miller on himself, throws light on this question. He thoroughly rinsed his mouth with a bouillon culture of *Bacillus prodigiosus* containing over 2,000,000,000 bacilli. The number of bacilli in a loop of his saliva was ascertained at the beginning of the experiment, and at the end of one, two, three, six, and eighteen hours with these results:—

Bacteria at beginning	97,600
,, after 1 hour	1,220
,, ,, 2 hours	127
,, ,, 3 ,, ...	17
,, ,, 6 ,, ...	0

His mouth at the end of three hours was practically free from organisms. The elimination of pathogenic organisms such as those of tubercle, typhus, &c., which are constantly finding an entrance to the mouth, may be brought about by a struggle with the normal flora of the cavity.

To sum up, the facts quoted above would seem to indicate that the mouth is rendered immune—

(1) By the process of phagocytosis.

(2) By the normal functional activity of the mouth, causing desquamation of the epithelial cells with the adherent bacteria, the latter being destroyed by the gastric juice.

(3) By the mutual antagonism of the micro-organisms.

(G) SALIVARY CALCULI

A calculus occasionally forms in the ducts of the salivary glands. It may form in the substance of the gland, but this is very rare, as a deposit formed in this situation is usually washed into the duct. If the deposit is situated in the substance of the gland, it gives rise to serious inflammatory trouble; the flow of saliva from the duct of the gland is obstructed and the trouble may lead to abscess or even destruction of the gland.

A calculus is more frequently met with in the submaxillary ducts than in the parotid duct, and this is possibly due to the mucoid character of the submaxillary secretion and to the position of the duct rendering it more liable to injury.

Symptoms.—When a salivary calculus is deposited in the duct of a gland, the obstruction, which may be either as small as a millet seed or larger than a filbert, will give rise to a swelling of the duct and gland. Salivary calculi situated in the floor of the mouth may simulate ranula, from which they should be diagnosed by noting that in the case of salivary calculus the flow of saliva is stopped, and that a small probe cannot be passed along the duct, while careful digital examination will reveal a hard concretion in the duct.

At times, the presence of a salivary calculus in Wharton's duct will give rise to appearances and symptoms suggestive of malignant disease. In one case seen the floor of the mouth was much swollen, the tongue pushed upwards, and there was a fungating excrescence surrounded by tissue in an indurated

condition. The tissues covering the mandible and the neck were much swollen, and the lymphatic gland lying in the submaxillary region enlarged. The patient presented a cachectic appearance. The whole condition seemed typical of malignant disease.

In a case recorded by Mr. T. E. Constant, a calculus in the parotid duct caused symptoms simulating a dento-alveolar abscess.

Origin.—The origin of the formation of salivary calculi is not clear. It has been suggested that they arise in a manner similar to other calculi, by precipitation and accretion of the salts around a foreign body. This view is supported by the occasional presence of a nucleus of foreign matter within a salivary calculus. A minute foreign body can easily enter the main salivary ducts, and so form a nucleus.

Bland Sutton[1] considers that the principal conditions determining the formation of gall-stones are catarrh of the epithelial lining of the gall-bladder plus the presence of micro-organisms, and it is possible that salivary calculi may arise in a similar way.

Size.—Salivary calculi vary considerably in size. They may weigh as much as 25 gr., and the fusiform-shaped ones reach 1 in. in length.

Treatment.—Treatment consists in making an incision over the hard swelling and removing the calculus. It is best to secure the concretion in a fixed position before making the incision. Cases remaining untreated may give rise to suppuration, either in the region of the duct or in the gland itself. The abscess at times opens externally, and thus gives rise to a salivary fistula. Salivary calculus as a deposit on teeth will be considered in the following chapter.

A case in which six calculi were found in the parotid duct in a child aged 13 is recorded.[2]

(H) DEGENERATION OF THE SALIVARY GLANDS

Lymphoid degeneration of the salivary glands has been described by W. S. Handley.[3] The change consists in the total destruction of the epithelial elements of the gland accompanied by hypertrophy of its lymphoid elements. The microscopical

[1] "Gall-stones and Diseases of the Bile-ducts." Nisbet, 1907.

[2] *Amer. Med. Surg. Bull.*, July 25, 1897.

[3] *Trans. Odonto. Soc.*, vol. xxxix, p. 186.

structure of the gland becomes practically indistinguishable from that of the tonsil or of a lymphatic gland, and the saliva-secreting function of the gland is destroyed.

The clinical features of the condition are pain, tenderness and swelling of the gland, accompanied by a mucoid discharge. A small calculus is sometimes present in the duct. In the cases recorded, the primary change would appear to be a chronic catarrh of the salivary duct due to bacterial invasion from the mouth. The most satisfactory treatment is excision of the gland.

A case of purulent discharge from both parotid glands has been placed on record by C. S. Tomes.[1] In this case the trouble dated from an attack of typhus thirty years previously. The discharge was indistinguishable from pus, but its power of affecting starch had not been destroyed.

(I) SECONDARY PAROTITIS

This is an acute inflammatory affection of the parotid gland, and is distinguished from primary parotitis, "mumps," by :—

(1) Its appearance as a complication during the course of other affections.

(2) Its non-contagious character.

(3) Its tendency to suppurate and give rise to a parotid abscess.

The condition occurs in the course of acute and chronic diseases, and also after operations, more especially those in which sepsis has been present. Secondary parotitis has been shown to be due to an ascending infection of Steno's duct, and to be dependent on a septic condition of the mouth. The duct is rendered liable to infection by conditions which tend to diminish the flow of the saliva and the consequent flushing of the duct, and by the presence of specific organisms in the cavity, such as those of typhoid fever, and the increase in number and virulence of the normal buccal organisms.

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CHAPTER XXI

Deposits on Teeth

Salivary Calculus—Subgingival Deposits—Stains

(A) SALIVARY CALCULUS

SEVERAL varieties of calculi are deposited on the teeth, the commonest being that derived mainly from the saliva, and familiarly known as "tartar."

(1) **Situations.**—The lingual surfaces of the mandibular incisors and canines and the buccal surfaces of the maxillary molars are the most common situations of these deposits. The deposition of salivary calculus is assisted by: (*a*) Rough surfaces, as in "hypoplastic" teeth; (*b*) the presence of foreign bodies, such as wires or clasps on dentures which are not kept clean.

(2) **Varieties.**—Clinically there are two varieties, "soft" and "hard." The distinction is purely arbitrary. The difference depends upon the rapidity with which the deposit takes place. **Rapidly deposited tartar** is soft in character, buff-coloured, and occurs in large quantities. **Slowly deposited tartar** is dark and hard in character, and is exceedingly tenacious to the tooth surface. The colour of the tartar is affected by conditions which produce staining, such as tobacco smoking.

(3) **Mode of Deposit.**—The deposit starts at the cervical margin, and, as the calculus increases, it tends to assume a wedge shape, the base being towards the tooth. The deposits may reach a large size. The deposit leads to more or less chronic gingivitis and absorption of the alveolar processs. The friction of mastication removes the tartar. Disuse of teeth favours its deposition.

The calculus is formed by precipitation of the salts from the saliva. Calcium carbonate and calcium phosphate are insoluble in pure water, but soluble in water containing carbonic acid gas. When the saliva reaches the oral cavity, the carbonic acid

gas begins to pass out of solution and the lime salts to be precipitated.

(4) **Composition.**—Berzelius gives the following composition:—

Phosphates of lime and magnesia	79·0
Salivary mucus	12·5
Ptyalin	1·0
Animal matter soluble in HCl.	7·5
	100·0

These figures can only be approximate. Dr. Stevenson gives the following analyses of the two varieties:—

	Water and Organic Matter.	Inorganic.
Soft tartar	21·48	78·52
Hard tartar	17·51	82·49

The deposit found on the buccal surfaces of the maxillary molars is composed almost entirely of calcium carbonate. The deposit on the lingual surfaces of the mandibular incisors contains much more calcium phosphate than carbonate, owing to the excess of the former in the submaxillary secretion.

(5) **Treatment.**—The treatment of salivary calculus consists in thoroughly removing all the deposits and polishing the surfaces of the teeth. The force for detaching the deposit may be used in a direction towards the gum or away from it. Force is used towards the gum when there is much tartar, and away from it when the quantity is small. When using force in a direction towards the gum, the right hand should be steadied by placing a finger or fingers upon the teeth, the cutting edge of the instrument being placed upon the tartar, and a pushing motion used, when the tartar will be found to come off in large flakes. The greater part of the tartar can be removed in this way, the remaining adherent portions being removed in a direction from below upwards, the instrument being prevented from slipping by supporting the hand on the cutting surface of the teeth. When there is much deposit, it will often be necessary to see the patient more than once, as it is quite impossible to effect complete removal at the first sitting. At the completion of the scaling, the teeth must be polished with fine pumice applied by means of a circular brush on the dental engine.

(B) SUB-GINGIVAL DEPOSITS

In dealing with marginal gingivitis and also chronic periodontitis, reference was made to the frequent presence of **calculus under cover of the gum margin.** In character it is hard and dark (p. 642), and is found more frequently on the approximal than on the labial and palatal surfaces. The source of this deposit is not clear. It probably originates from some abnormal secretion of the gingival organ in combination with the discharges from the marginal gingivitis. The presence of the calculus is generally marked by a hyperæmic condition of the gum margin. The roots of teeth which have been the subject of chronic suppurative periodontitis are often covered with a calcareous deposit (see figs. 717 to 719). Analyses of these deposits show them to be composed mainly of phosphates. Oxalates are sometimes present.

Fig. 717.—Showing well-marked deposit around the neck of a mandibular molar.

Fig. 718.—A maxillary molar showing large deposit of calculus on the apical portion of the palatine root.

Fig. 719.—A maxillary molar showing irregular deposit of calculus over a large portion of the surface of the root.

The deposit noticed in teeth removed on account of gouty periodontitis was referred to on p. 632.

Occasionally, calculus is present and yet the gum tissues appear quite healthy, but when this is the case it is probable that marginal gingivitis has occurred at an earlier period.

Treatment.—The deposit must be removed and the condition of the gum or periodontal membrane accompanying it treated.

(C) STAINS[1]

(1) Green Stain.—A green stain is often found on the teeth, more especially in the young. The colour varies from a greyish-

[1] The matter contained in the following section relating to "stains" has been obtained almost entirely from an excellent paper by Dr. Miller (*Dental Cosmos*, April, 1894) entitled "The Deposits upon the Teeth with Special Reference to Green and Metallic Deposits."

green to bluish-green. It appears more frequently on the maxillary than on the mandibular teeth. The labial surfaces of the anterior maxillary teeth are the most frequent sites, the discoloration commencing at the gingival margin and encroaching on the surfaces in a direction towards the cutting margin. At times, more than half the surface is covered. The stain may extend to the approximal or even to the gingival surfaces. The stain may be limited to any pits, grooves, or depressions present on the surface of the tooth. The green stain is nearly always preceded by lack of cleanliness on the part of the patient. The stain is intimately connected with the enamel cuticle. Removal of the stain by acids leaves a colourless surface behind. Green stain may occur beyond the enamel margin on the teeth of adults.

Cause.—The origin of green stain is not clear. The following facts are known: The colouring matter is characterized by its insolubility in nearly all the ordinary solvents, viz., glycerine, alcohol, chloroform, turpentine, &c.; tincture of iodine has no marked decolorizing effect. The colouring matter is rapidly destroyed by chlorine and hydrogen peroxide. Calcination experiments show that the green stain deposit may be either of an organic or inorganic nature. The theory that the green stain is produced by chlorophyll is negatived by the fact that the stain is not soluble in ether, chlorophyll being readily soluble in ether. In some conditions there is reason to believe from experimental investigations that the green colour is to be attributed to the presence of sulpho-methæmoglobin.

The relation of green stain to enamel decalcification is not clear. When the stain is removed the enamel appears quite normal in the majority of cases, but in some cases the surface shows signs of decalcification.

Treatment.—The stain should be removed by means of suitable wheels or brushes on the dental engine, a little powdered pumice stone being used to increase the abrasive action. Acid applications are *not* to be used.

(2) Metallic Stains.—(*a*) *Copper.*—Workers in copper invariably show a green stain upon their teeth. Miller found in 150 persons who had been working in copper for more than a year, distinct discoloration of the teeth in all of them. The colour

varies from green to dark dirty green, reddish-green, bluish-green, greenish-blue to bluish-purple, the latter being seen in "phosphor-bronze" workers. Persons using brass musical instruments at times show staining of the teeth.

In copper workers, the gingival margin is hyperæmic, owing to irritation from the more or less oxidized particles of the metal which may have worked their way up into the gums.

The stain from the use of copper amalgam was referred to on p. 451.

(*b*) *Iron.*—Iron seems to produce a brown stain of varying tints. In workers in iron, Miller found that nearly all showed brown spots or deposits on their teeth, the mandibular teeth being more frequently the seat of discoloration than the maxillary. Medicines containing iron may stain the teeth if the mouth is not cleansed each time ofter taking the medicine. The forms of iron detrimental to the teeth are those containing free acid, such as the perchloride.

(*c*) *Mercury.*—Deposits of mercury in the form of sulphide are seen in teeth filled with amalgam. These deposits occur also on the teeth of patients subjected to prolonged mercurial treatment, the mercury affecting the teeth through the saliva. The stain may be due to the use of mouth-washes containing mercury. The presence of the mercury on the teeth can be demonstrated by chemical tests.

(*d*) *Lead.*—Lead poisoning may produce a blue line in the gum margins (p. 644). According to Hirt,[1] in chronic lead poisoning the teeth are discoloured and appear dark brown at the necks, shading to light brown towards the occluding surfaces.

(*e*) *Nickel.*—A tooth from the mouth of a worker in nickel is figured by Miller. The deposit is thick and of an opaque bluish to greenish-black colour.

(*f*) *Silver.*—Silver, when used in the mouth, produces a dark stain which is due to the formation of the sulphide. Silver employed in the form of silver nitrate stains the dentine and cementum black.

Treatment of Stains.—The various stains can be easily removed by the use of abrasives.

[1] Quoted by Miller.

CHAPTER XXII

Odontomes

MR. BLAND-SUTTON defines an odontome as a "tumour composed of dental tissues in varying proportions and different degrees of development, arising from tooth germs or teeth still in the process of growth."

Odontomes may be classified as follows:—

(A) Aberrations of the enamel organ.
  Epithelial odontomes.
(B) Aberrations of the follicle.
  (*a*) Fibrous odontomes.
  (*b*) Follicular odontomes.
  (*c*) Cementomes.
  (*d*) Compound follicular odontomes.
(C) Aberrations of the papilla.
  Radicular odontomes.
(D) Aberrations of the whole tooth germ.
  Composite odontomes.

(A) ABERRATIONS OF THE ENAMEL ORGAN

Epithelial Odontomes.—Two varieties of epithelial odontomes are described by Mr. Eve:—[1]

(*a*) Epithelial odontomes (cystic variety), or cystic epithelial tumour.

(*b*) Epithelial odontomes (carcinoma), usually described as spheroidal or columnar-celled carcinoma.

(*a*) **Epithelial Odontomes (Cystic Variety).**—These tumours usually involve the mandible, and the molar region is usually, though not exclusively, involved. They are composed of collections of cysts, varying in size, but rarely exceeding an inch in

[1] "The Pathology and Treatment of Tumours of the Jaws," *Brit. Med. Jour.*, June 29, 1907.

diameter. The cysts are separated by thin, fibrous septa, and in some specimens by osseous tissue. The growing portions of

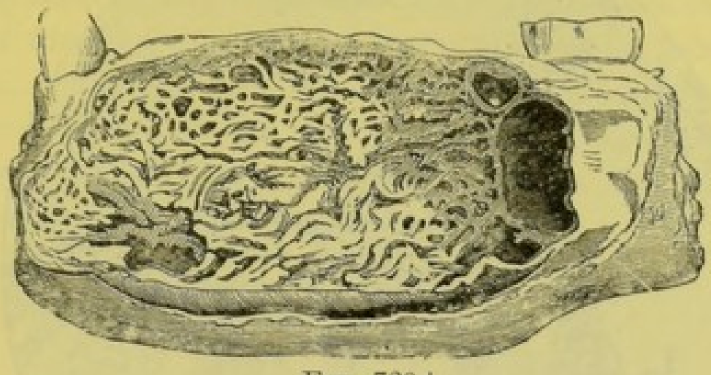


FIG. 720.[1]

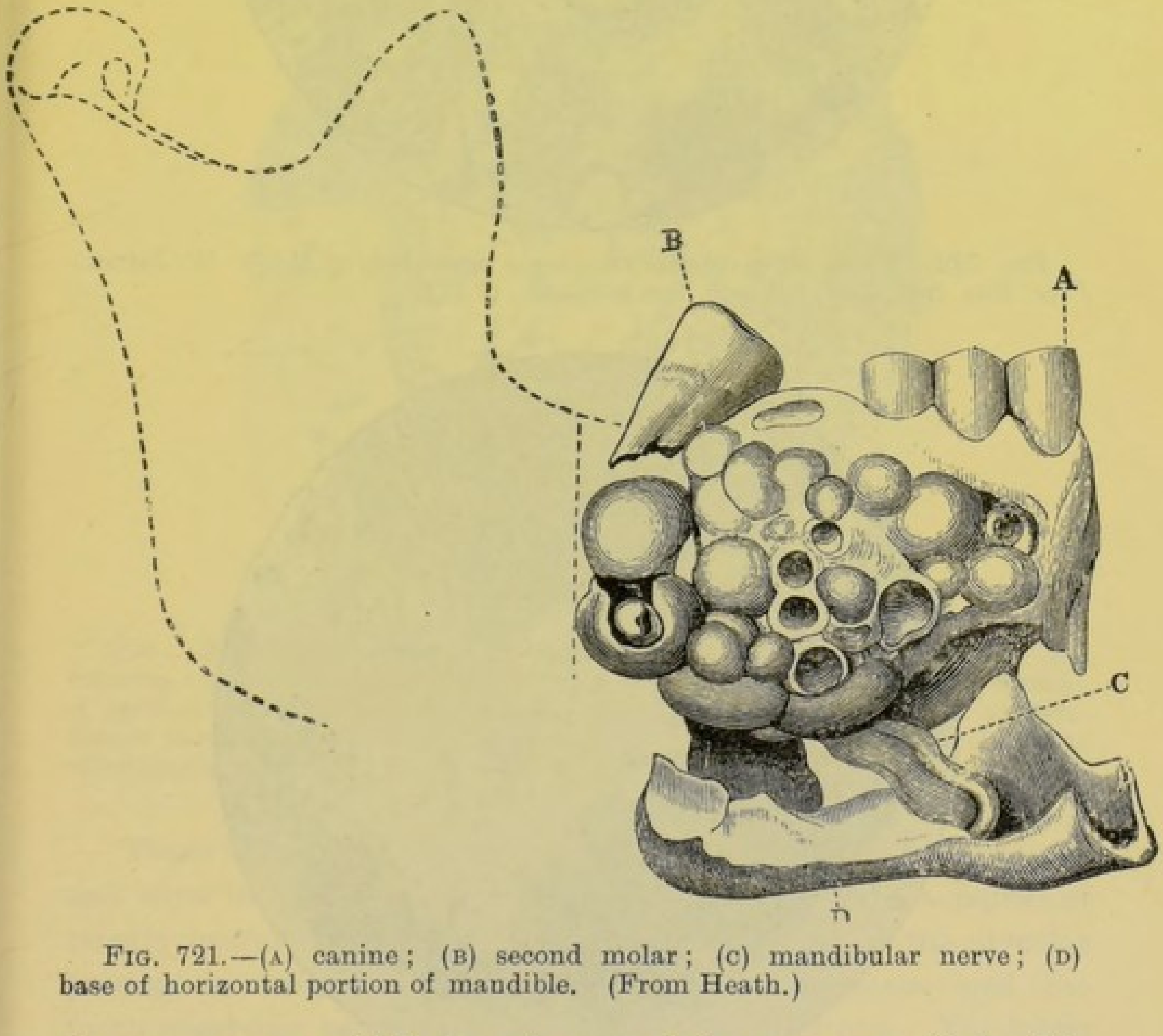


FIG. 721.—(A) canine; (B) second molar; (C) mandibular nerve; (D) base of horizontal portion of mandible. (From Heath.)

the tumour are reddish in colour, and the cysts are filled with a brown mucoid fluid. The appearance of these tumours is shown in figs. 720 and 721.

[1] From *Trans. Odonto. Soc.*

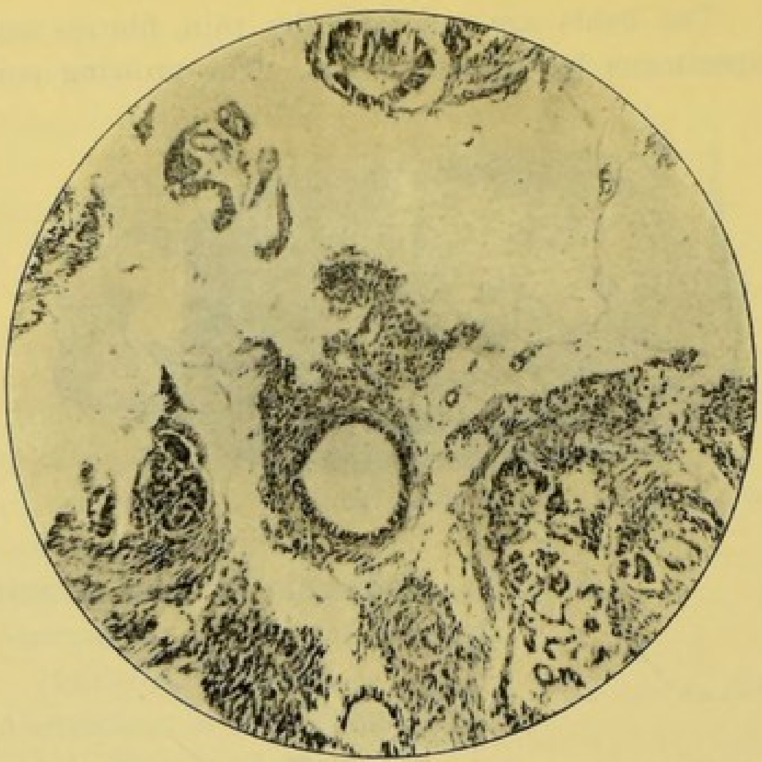


FIG. 722.—From an epithelial odontome described by Mr. W. W. James, *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. ii., p. 171.

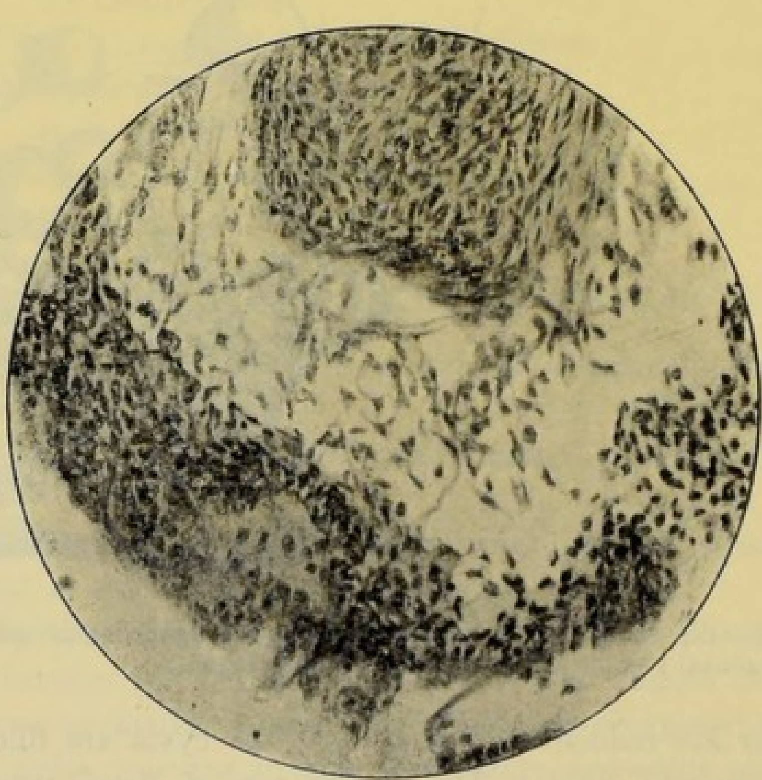
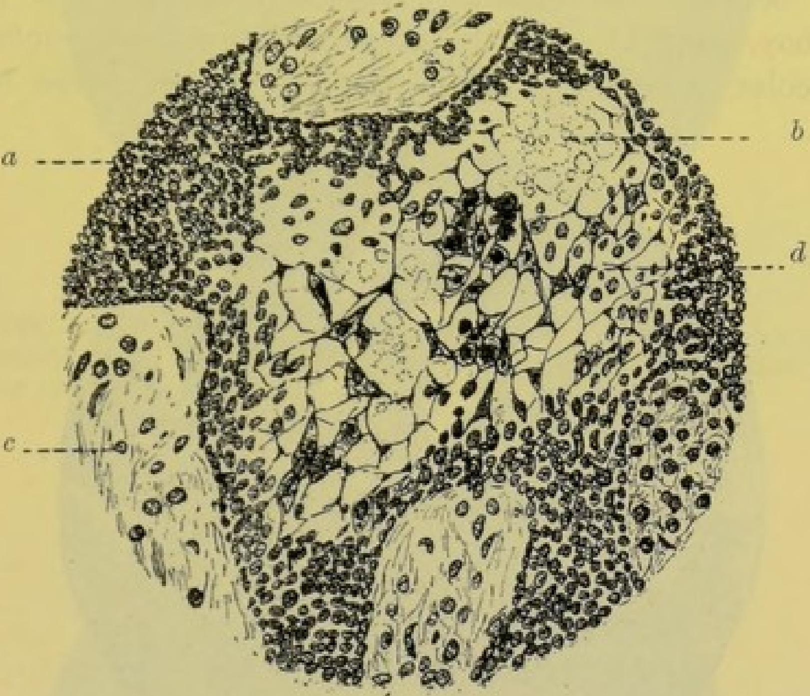


FIG. 723.—Section showing cells resembling those of the stellate reticulum of the enamel organ. From an epithelial odontome descibed by Mr. W. W. James, *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. ii., p. 171.

Microscopically, according to Eve, "they consist of anastomosing and branching epithelial columns, which are made up of a peripheral layer of columnar cells, while the central cells undergo a peculiar form of degeneration, resulting in the formation of a reticulum. This degeneration is due to a colloid metamorphosis of the protoplasm of the cell. These changes are an exact imitation of those which take place in the formation of the enamel cap." (See figs. 722 and 723.)



× 250.

FIG. 724.—Epithelial cells in epithelial odontome, breaking down and forming commencement of a cyst (from a drawing by Mr. A. Hopewell-Smith). *a*, epithelium; *b*, colloid appearance of earliest contents of cyst; *c*, mesoblastic tissue which constitute the mass of the odontome; *d*, stellate character of epithelial cells.

These odontomes give rise to a growth which is often insidious and slow in progress, extending in some cases over a period of twenty years. "A growth in the neighbourhood of the alveolar process is noticed, the swelling gradually increases, and the tooth overlying becomes loosened and may fall out. Not infrequently a glairy fluid is discharged from a vacant alveolus, the orifice of which may become ulcerated." The surface of the swelling is often lobulated, and may therefore be mistaken for a myeloid sarcoma.

These tumours are usually only locally malignant, but Eve states he has seen cases in which metastasis took place.

The **treatment** consists in opening up the cyst, care being taken to break down all the loculi and thoroughly remove the cyst wall. Should the growth return, free excision must be resorted to.

(*b*) **Epithelial Odontomes (Carcinoma).**—The following examples are given by Eve of this type of odontome:—

"A tumour of seven weeks' growth sprang from the alveolar process between the maxillary central incisors. The patient was a boy, aged 11, and the growth was entirely confined to the alveolar process and did not extend either to the inferior

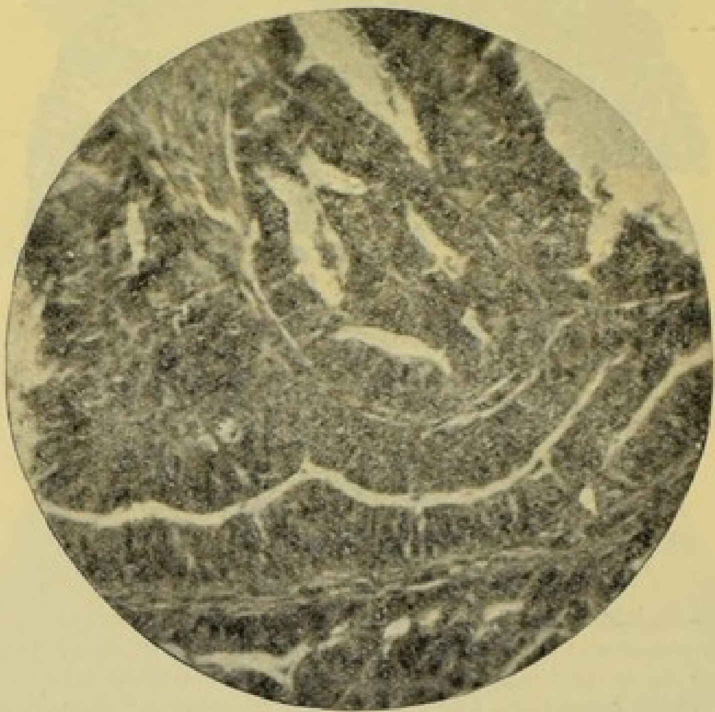


FIG. 725.[1]—(High power.) Growth from alveolar process of maxilla, composed of rounded and elongated spaces lined with columnar epithelium.

meatus or the antra. The microscopical characters of the growth are shown in figs. 725 and 726.

"Fig. 725, from the centre of the tumour, shows columnar cells, arranged in rounded masses or in tubulous columns with a central space formed by degeneration of the central cells.

"Fig. 726, taken vertically through the gum, shows the

[1] For the use of illustrations Nos. 725 to 729 and Nos. 757 to 761, I am indebted to Mr. F. Eve.

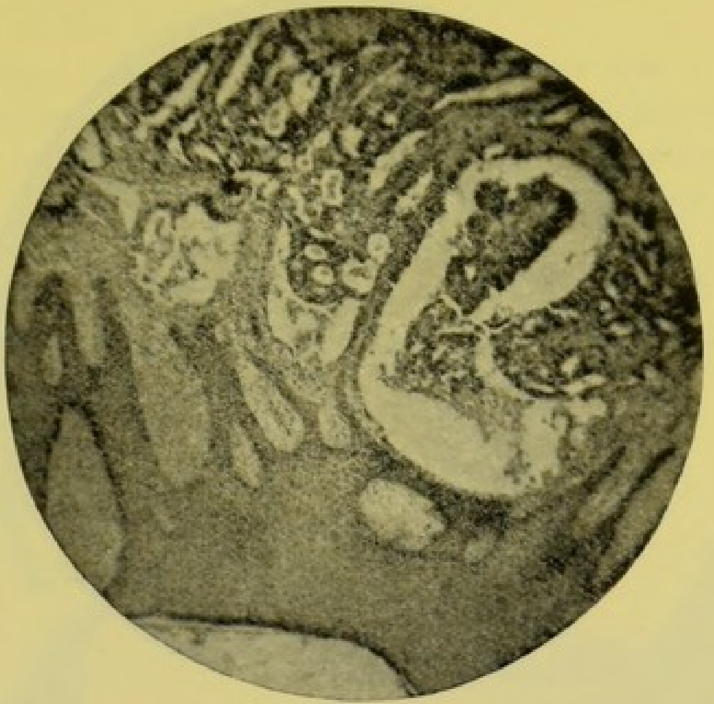


FIG. 726.—(Low power.) This section is taken vertically through the gum; beneath this, and distinct from it, is the columnar-celled growth undergoing cystic degeneration.

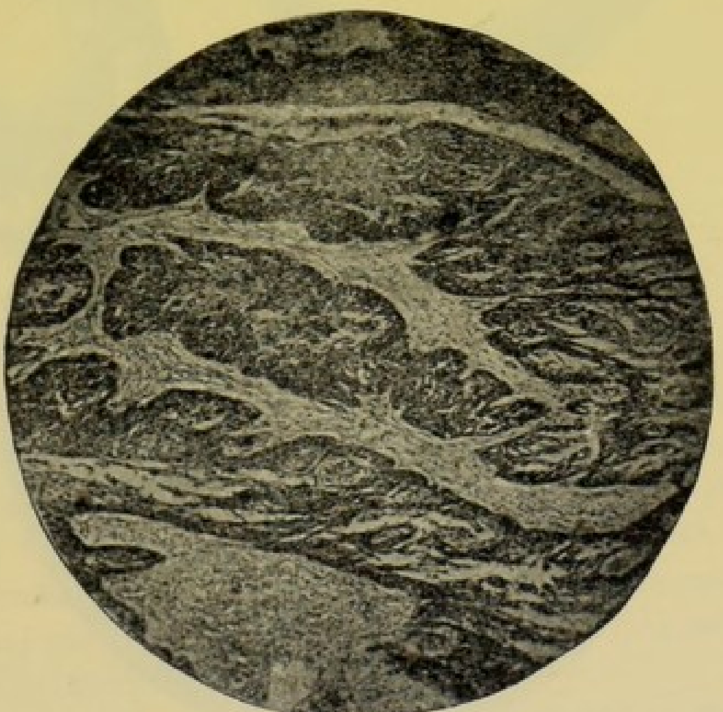


FIG. 727.—(Low power.) Epithelial odontome (carcinomatous). The tumour is composed of strands of epithelium with crenated edges, lying in a fibrous stroma. The epithelial element greatly predominates over the stroma.

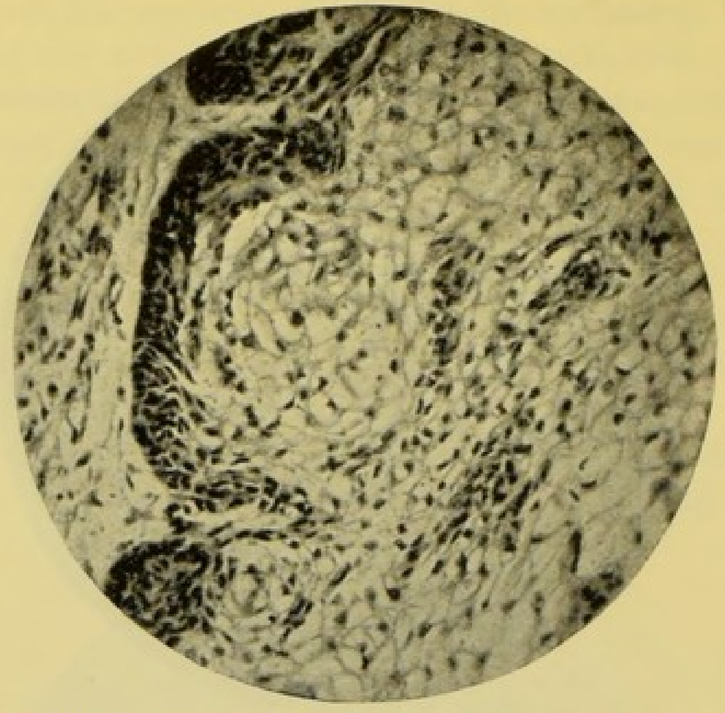


FIG. 728.—(High power.) From the same tumour as fig. 727, under a higher objective, showing a reticulum formed by the epithelium in the strands.

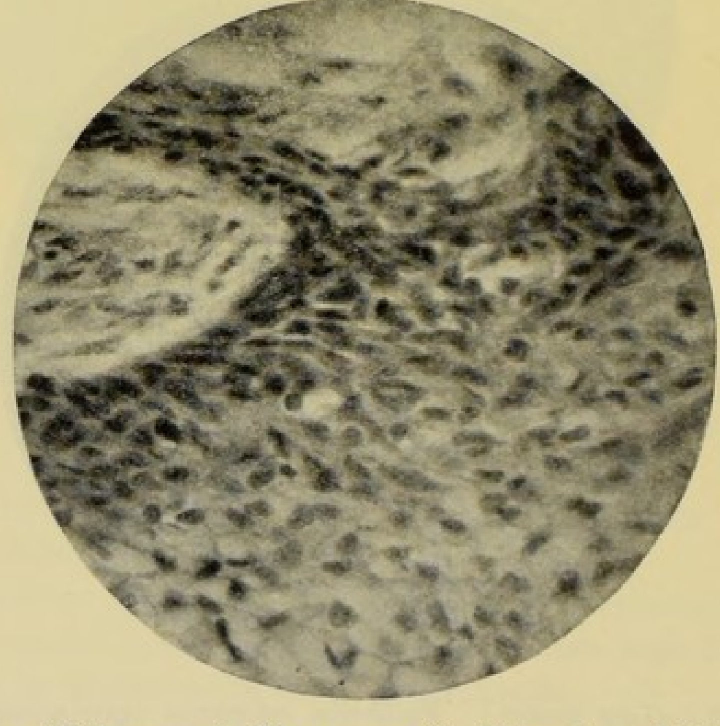


FIG. 729.—(High power.) The same as fig. 728 under a higher objective, showing elongated epithelium at the margin of the epithelial strands and a reticulum.

columnar-celled growth beneath, but entirely distinct from the epithelium of the gum."

In another patient, a man, aged 61, there was a fungating mass, springing from the alveolar process at the position of the premolars and first molars. The growth had existed for six weeks. The microscopic characters of the growth are shown in figs. 727 to 729. Fig. 727 shows under a lower power the epithelial columns with crenated edges. Figs. 728 and 729 (higher powers) show elongated cells at the margins of the column, and a well-marked reticular structure.

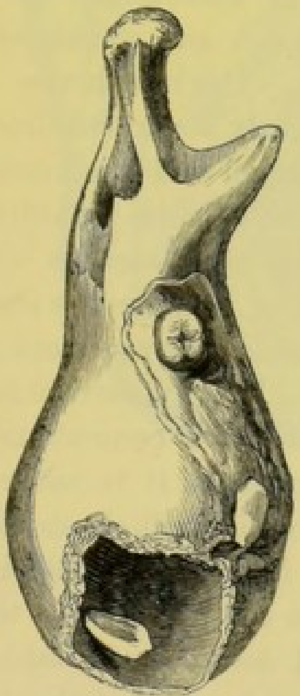


FIG. 730.[1]

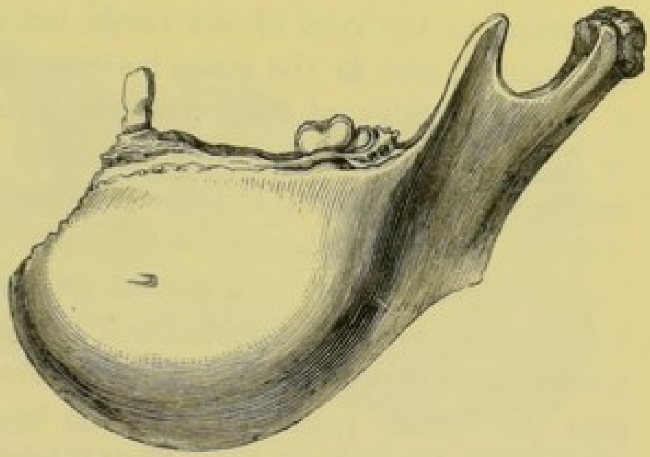


FIG. 731.[1]

Epithelial odontomes probably originate in aberration of enamel organs of teeth which, under normal conditions, should go on to full development, or they may arise from epithelial ingrowths around the dental alveoli, some of which should, perhaps, be regarded as the representatives of teeth suppressed in the process of evolution. In Eve's opinion many of the spheroidal or columnar-celled carcinoma occurring in the maxilla should be regarded as odontomes.

He bases his opinion "on the arrangement of the epithelial columns, the presence in most instances of the peculiar degenera-

[1] From Salter.

tion of the cells, characteristic of enamelogenous tumours, and in some of a peripheral layer of columnar cells."

(B) ABERRATIONS OF THE FOLLICLE

Under this heading are included odontomes which arise from the tooth follicle or sac, and in order to trace the development of the various tumours included under this heading it will be useful to recount one or two anatomical points.

If a section of a jaw be made so as to include a tooth about to erupt, it will be noticed that the tooth is surrounded by a membrane (the tooth follicle) and that both tooth and membrane are completely enclosed in a capsule of bone. The membrane is adherent to the root of the tooth, but is slightly separated from the enamel, and in the space between the enamel and the tissue a small quantity of fluid sometimes collects. If the quantity of fluid secreted is excessive, the walls of the bony capsule will gradually expand and a follicular odontome or dentigerous cyst will be formed. Should the follicular wall undergo hypertrophy, the odontome will be of a fibrous character. The hypertrophied follicle may become calcified and so give rise to a cementome; the function of the follicle being to form cementum, it is natural that the tissues resulting from the hypertrophied follicle should be cemental in character. The thickened follicle may calcify *en masse*, or only in a sporadic manner. In the latter case, the tumour will be composed of numerous small denticles embedded in a thickened wall and is classified as a compound follicular odontome.

(1) **Follicular Odontomes.**—A follicular odontome, as stated above, is the result of an excessive secretion of fluid between the tooth and the follicle. As the fluid collects, the bony surroundings of the tooth are absorbed and, at the same time, fresh bone is deposited on the outside of the jaw (figs. 730 and 731). In this way, the jaw may gradually become enormously distended as shown in fig. 732.

In the maxilla, the cyst may encroach upon the cavity of the antrum.

The walls of the follicular odontomes are formed by fibrous tissue lined with epithelium. Sections through the walls of follicular odontomes show them to be formed of fibrous tissue

with an internal lining of epithelium. The fact that the latter cannot always be demonstrated is possibly to be accounted for by the loss of the epithelium in the process of preparation of the specimen. Dr. Kauffmann[1] gives the following account of a cyst

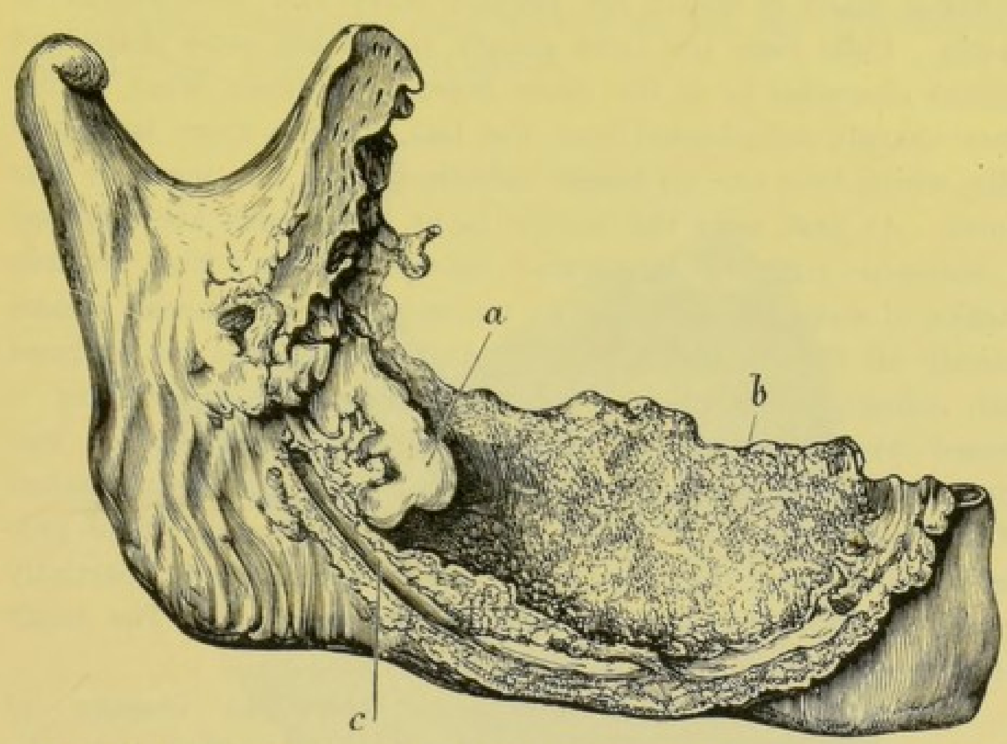


FIG. 732.—(*a*) tooth; (*b*) inner wall of cyst; (*c*) canal for mandibular nerve. (From Heath.)

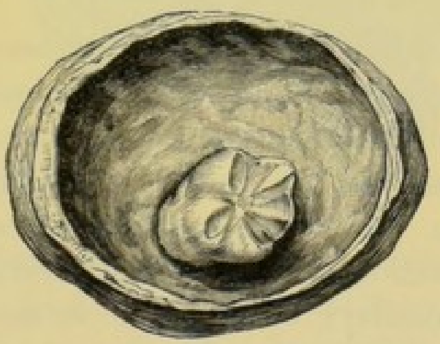


Fig. 733.[2]—A follicular odontome (natural size).

wall examined by him: "The sac of the dentigerous cyst is composed of fine fibrous connective tissue, stratified, and for the greater part of straight fibre. The outer part is comparatively

[1] *Journ. Brit. Dent. Assoc.*, 1893, p. 93.
[2] From *Trans. Odonto. Soc.*, vol. xxvi, p. 182.

rich in cells, which are for the most part spindle-shaped, and contain large nuclei. Interstitial tissue here is scanty, or, in other words, the fibrous tissue is still in embryonic state. A middle layer, the most fully developed, consists more largely of fibres, many of which are slightly wavy and may consist of elastin. Cells here are more scanty, but of the same shape and general character as in the outer layer. An inner layer, somewhat sharply deliminated from the last, consists more largely of cells, which here are no longer spindle-shaped, but more or less round. At first, near the middle layer, these cells are disposed in columns running lengthwise between fibres; but towards interior of walls the cells are so numerous as to conceal almost entirely all fibrous groundwork. At one part, the sac is lined with columnar epithelioid cells. Elsewhere, the inner limit is formed by the connective tissue cells last described. It was impossible to say whether the epithelioid cells have been washed off the rest of the inner wall." A tooth is generally found projecting into the cavity, the roots, frequently only partially formed (fig. 733), being embedded in the cyst wall. The tooth sometimes lies free in the cavity of the cyst.

Teeth from follicular odontomes show an absence of Nasmyth's membrane. This would seem to suggest that the origin of the fluid in these cysts is from the cells composing the stellate reticulum.

The fluid from a follicular odontome is generally of a yellowish, glairy character and contains crystals of cholesterin.

The walls of follicular odontomes may undergo calcification. An example is described by Salter[1] (fig. 734). The cyst had invaded the antrum. A feature of this case was the development of the cyst in connection with a supernumerary tooth. Suppuration is another secondary change, and is more commonly met with, according to Sutton, in the lower animals. Complete disappearance of the fluid contents of the cyst has been observed by Heath.[2]

Follicular odontomes rarely occur in connection with deciduous teeth.

Cases of multiple cysts have been recorded. In a case

[1] "Dental Pathology and Surgery," p. 219.

[2] "Injuries and Diseases of the Jaw." Fourth Edition, p. 189.

recorded by Salter, cysts occurred on both sides of the maxilla of a young girl.

In a case recorded by Mr. Hern,[1] there were three cysts; two in the maxilla in connection with the lateral incisors, and one in the mandible around the unerupted left canine.

Follicular odontomes may develop at any age, but they are generally met with in young adults.

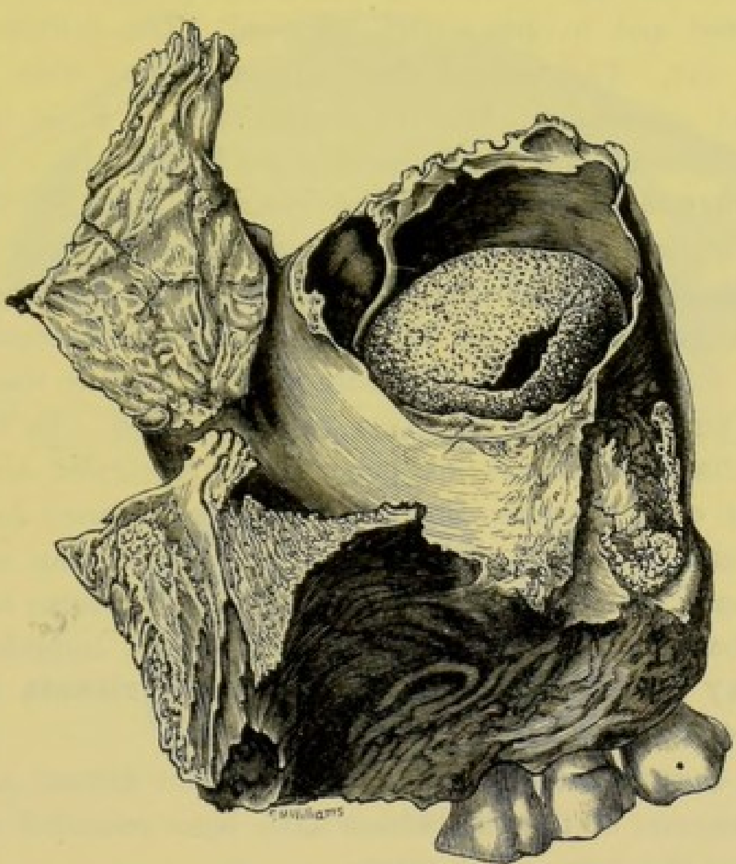


FIG. 734.

Signs and Symptoms.—Follicular odontomes produce slow-growing swellings, leading in the mandible to an expansion of the walls, while in the maxilla they frequently invade the antrum, and may give rise to a distension of its walls. No pain is usually experienced unless suppuration has taken place. Upon manipulation of the swelling, the bony walls will often (but by no means always) yield to pressure and resume their shape as soon as the pressure is removed, the movement producing a curious kind of

[1] *Trans. Odonto. Soc.*, vol. xxvi, N.S., p. 91.

crepitation which has been termed "crackling." Occasionally, the bony wall does not exist and distinct fluctuation can be obtained. There is usually a history of absence of a tooth in the region of the swelling, and this is an important diagnostic sign.

The **differential diagnosis** from other tumours in the mouth is dealt with in chapter xxxiii.

Treatment.—Treatment consists in removal. The muco-periosteum covering the cyst wall is first reflected and the bony wall divided and in great part removed. The tumour is then dissected out. The wound thus left is packed with iodoform gauze and allowed to heal by granulation. It is frequently advisable to break down and crush in the bony walls.

(2) **Fibrous Odontomes.**—The external parts of the tooth sac are composed of fibrous tissue, and if this tissue becomes hypertrophied a fibrous odontome is formed. The nature of these odontomes is shown in fig. 735. Examined microscopically, the thickened follicle is found to be composed of fibrous tissue, laminated in character and at times partly ossified. In the lower animals these odontomes are generally symmetrical, and in one case, that of a dasyure, the skeleton was softened by rickets. The presence of rickets in this case may have been an accidental circumstance, but in view of the fact that rickets seems to thicken the membrane covering growing bone, it is not improbable that **there may be some relationship between rickets and this class of odontome.**

Bland-Sutton contends that many of the fibroid and fibro-cellular tumours of the jaw which have been recorded are really examples of this form of odontome.

An odontome of this variety is described by Jordan Lloyd under the name of endosteal fibroma.[1] The patient, a girl aged 8, was the subject of a large swelling on the right side of the mandible, extending from the angle of the bone to within an inch of the symphysis. The deciduous and first permanent molars on that side were missing, the former having been extracted. The tumour was exposed by removing the outer plate of bone, and was shelled out of its bed without difficulty. It was found to be attached only at its lower and posterior part, and was lying over the first permanent molar, which was displaced to

[1] *Journ. Brit. Dent. Assoc.*, vol. xiv, p. 564.

the lower border of the mandible. The following is the description of the tumour: "It measured nearly three inches in length, two in depth, and nearly one and a half in thickness. It was of uniform pearly colour, and of a regular tough consistence. At its lower and hinder part was a large well-formed permanent molar tooth lying with its crown against the tumour, to which it was held in organic connection by a delicate fibrous membrane passing

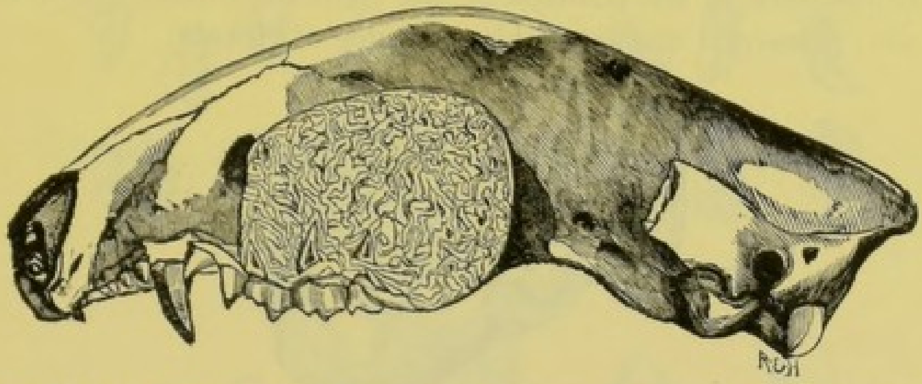


FIG. 735.[1]—Portion of the skull of a dasyure, showing a fibrous odontome in section. The tumour was intimately connected with a molar tooth.

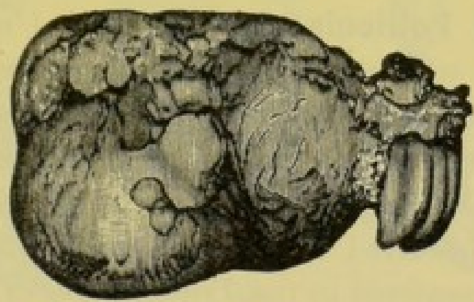


FIG. 736.[1]

from the outer surface of the tooth roots to the delicate connective tissue capsule which covered the tumour." A microscopical examination showed the growth to be "closely allied to fibrous tissue on the one hand, and to fibrous cartilage on the other, rather nearer the former than the latter."

(3) Cementomes.—These odontomes are produced by the ossification of fibrous odontomes, the resulting tissue being cementum. They are rare in man, but common in horses and ruminants. The growth resembles cementum in character, and causes a hard tumour of the jaw, generally painless in the early

[1] From *Trans. Odonto. Soc.*

stages, but later giving rise to pain which is apt to be mistaken for periostitis or necrosis. Fig. 736 is the drawing of a cementome recorded by Dr. Forget; the odontome was about the size of a pigeon's egg and came away with a carious molar which he decided to extract before opening the tumour.

The possible association of fibrous odontomes and cementomes with rickets is shown in a case recorded by Mr. W. A. Maggs,[1] of a cementome in the position of the right manibular molar of a boy who presented unmistakable evidence of rickets.

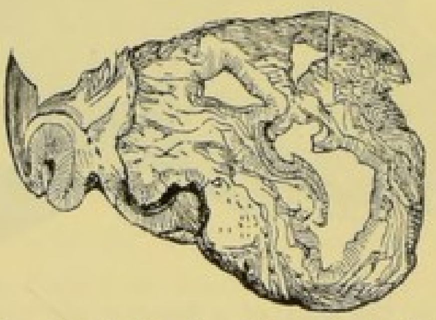


FIG. 737.[2]—Section through fig. 736.

(4) Compound Follicular Odontomes.—Under this heading are described cysts which contain a great number of small masses of dental tissue, and, in some instances, bone. Several cases have been reported in man, while Logan has recorded one in a horse, and Bland-Sutton one in a thar. Of the cases recorded in man, the first occurred in the practice of Mr. Tellander, of Stockholm, and is reported in the *Transactions of the Odontological Society* (vol. iii, p. 282, O.S.). The patient was a female, aged 27; the cyst developed in the right maxilla, and was first noticed at the age of 12. The first molar, the two premolars and the canine were absent. When seen by Mr. Tellander, suppuration had supervened, and probably some of the calcified contents of the cyst had been lost. Twenty-eight denticles were removed —nine were tiny single teeth, each perfect in itself, with conical roots and crowns tipped with enamel. Six masses were built up of adherent single teeth, while the remaining denticles were exceedingly small. In fig. 738, A, will be seen drawings of some of the denticles.

[1] See "Tumours, Innocent and Malignant," Bland-Sutton, p. 233.
[2] From *Trans. Odonto. Soc.*

The second case recorded[1] was in the practice of Mr. Mathias, and occurred in a Hindoo, aged 25, in the region of the central and lateral incisors. The cyst was also suppurating. Fifteen fragments were removed from the cyst. These are shown in fig. 738, C. Two of the fragments were fairly formed teeth, and, to one of the fragments, bone similar to that of alveolar process was attached.

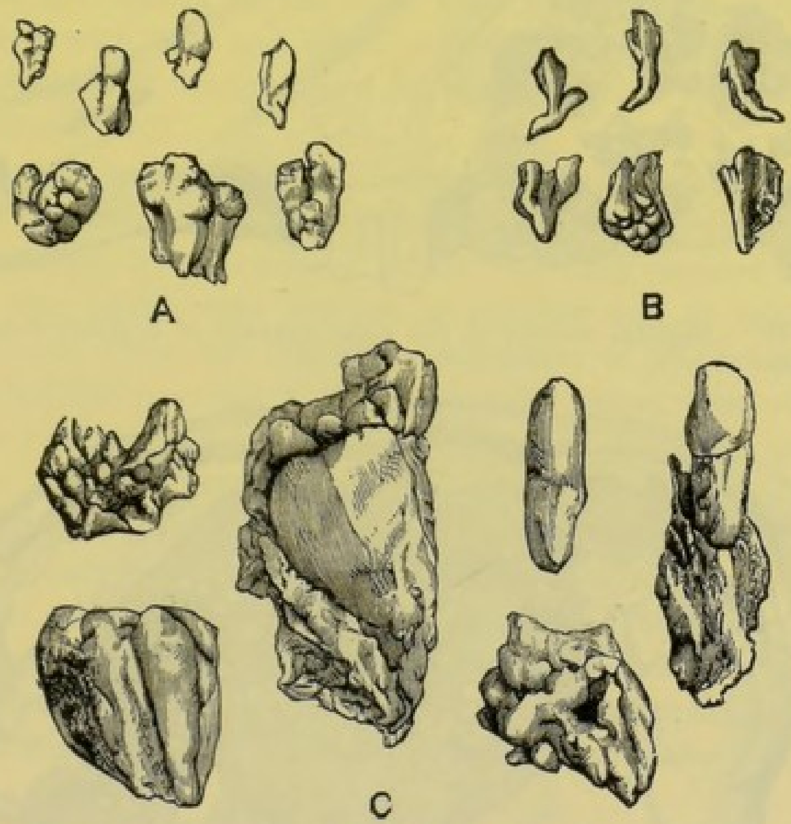


FIG. 738.[2]

The third example recorded of this class of cyst came under the notice of Mr. Sims.[3] The patient was a boy, aged 10, and the swelling occupied the region of the right maxillary lateral incisor and canine. The corresponding deciduous teeth had never erupted. This cyst had not suppurated. On being opened, it was found to contain about forty small denticles. Types of these are seen in fig. 738, B.

A fourth case has been recorded.[4] The patient was a boy

[1] *Trans. Odonto. Soc.*, vol. iii, p. 366, O.S.

[2] From *Trans. Odonto. Soc.*

[3] *Journ. Anat. and Physiol.*, vol. xxi, 1887.

[4] "A Case of Compound Follicular Odontome," A. W. de Roaldes, *New York Medical Journal*, 1894, vol. lix, p. 612.

(age not stated). The swelling invaded the right antrum and caused bulging of the external wall of the antral fossa. The cyst

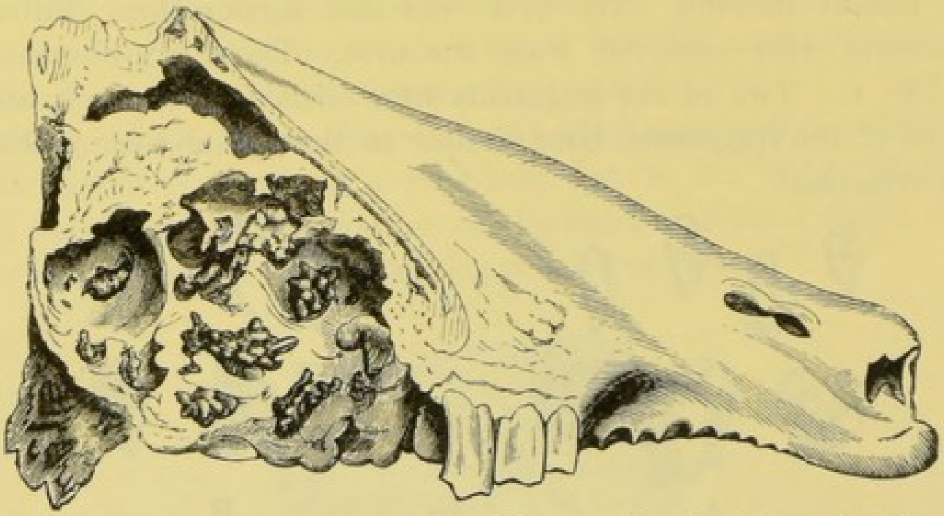


FIG. 739.[1]—Sagittal section of the right maxilla of a thar, showing the cyst *in situ*.

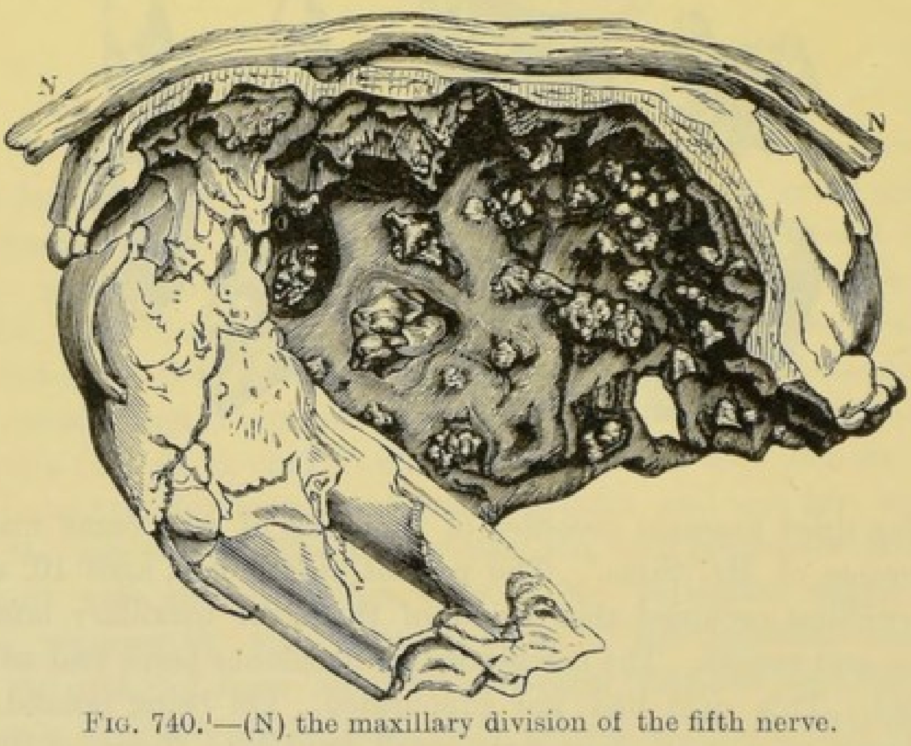


FIG. 740.[1]—(N) the maxillary division of the fifth nerve.

was supposed to have arisen in connection with the permanent canine. Over fifty denticles, which consisted entirely of cementum, were removed.[2]

[1] From *Trans. Odonto. Soc.*

[2] See also "A Case of Compound Follicular Odontome," J. W. Cousins, *Brit. Med. Journ.*, June 6, 1908.

The case described by Mr. Bland-Sutton in the thar[1] has thrown light upon the nature of these interesting cysts. He describes the condition he found as follows: "Each antrum contained, in fact, a cyst with dense thick walls. The outer shell was of bone, lined with thick fibrous tissue. The interior was occupied with denticles, fragments of cementum, and bone of varying shapes and sizes, amounting to nearly three hundred. Those in the middle of the cyst were glued together by thick pus mixed with hay and chaff, while the peripheral fragments were embedded in fibrous tissue or sprouted from the cyst wall" (figs. 739 and 740).

A curious tumour, probably belonging to this group, was also recorded by Bland-Sutton.[2] In a girl, aged 11, the right maxilla was distended by a swelling which had been noticed for two years. The teeth were correct in number and in relation to one another. Over five hundred small pieces of true bone, which were embedded in a matrix of soft vascular tissue, were removed from the tumour. The osseous tissue was of a loose cancellous character, similar to that forming the alveolar process.

Structure of the Denticles.—In the case recorded by Roaldes cementum only was present.

In the case recorded by Cousins the two denticles examined consisted of cementum traversed by irregular canals.

The **treatment** of compound follicular odontomes is similar to that of the follicular odontomes already described.

(C) ABERRATIONS OF THE PAPILLA

Radicular odontomes, which are included under this heading, arise after the completion of the crown and during the formation of the root. Radicular odontomes may be classified as follows :—

(1) Radicular dentomes.

(2) Radicular osteo-dentomes.

(3) Radicular cementomes.

In the first, dentine is the principal constituent of the growth ; in the second, osteo-dentine ; in the third, cementum.

Radicular odontomes are comparatively common in the lower

[1] *Trans. Odonto. Soc.*, vol. xx, p. 185.

[2] *Ibid.*, vol. xxxiv, p. 96.

animals, more especially those whose teeth grow from persistent pulps. In animals, radicular odontomes are not uncommonly multiple, and, in one instance recorded by Bland-Sutton,[1] an

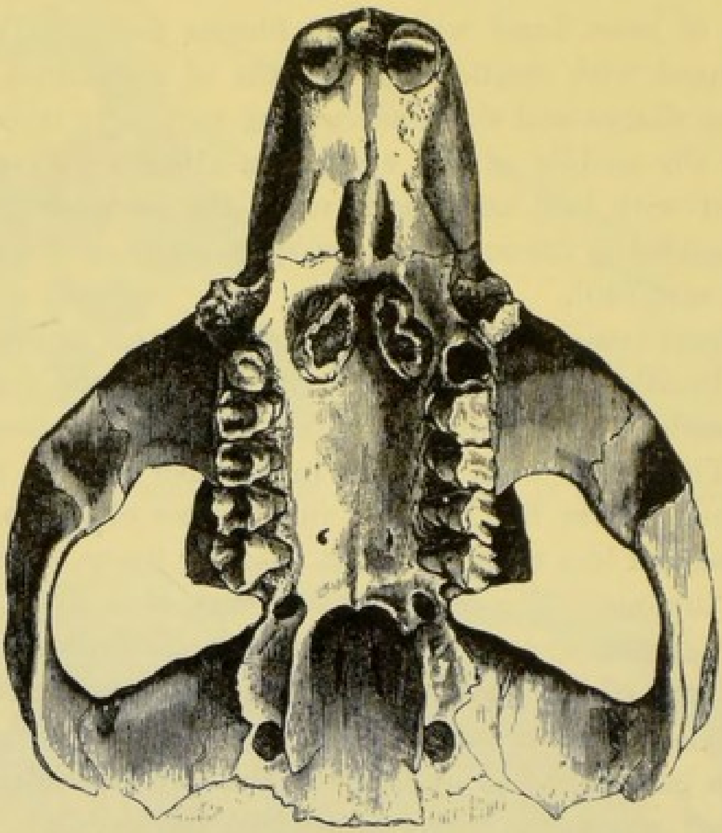


FIG. 741.[2]—Hard palate of marmot. Odontomes connected with the roots of the upper incisor teeth appearing in the hard palate.

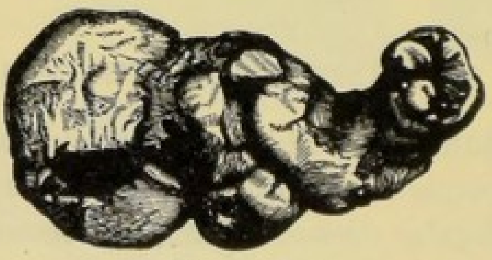


FIG. 742.[2]

odontome existed at the base of each incisor tooth in the maxilla and mandible (fig. 741).

The specimen shown in fig. 742 was removed by Mr. Hare,

[1] *Trans. Odonto. Soc.*, vol. xx, p. 65.
[2] From *Trans. Odonto. Soc.*

of Limerick, from the maxilla of a man aged 45. The patient had suffered much pain, and a sinus connected with the growth had opened on the face. Mr. C. Tomes made a microscopical examination of this specimen, the details of which are to be found in the *Transactions of the Odontological Society*, vol. iv, p. 82.

Sections were made through the tumours at the position *a b* and *d d*, fig. 743.

Along the line *b c* the tissues displayed were, on the outside, a thin layer of cementum, next a layer of dentine, and next a solid mass of bony tissue.

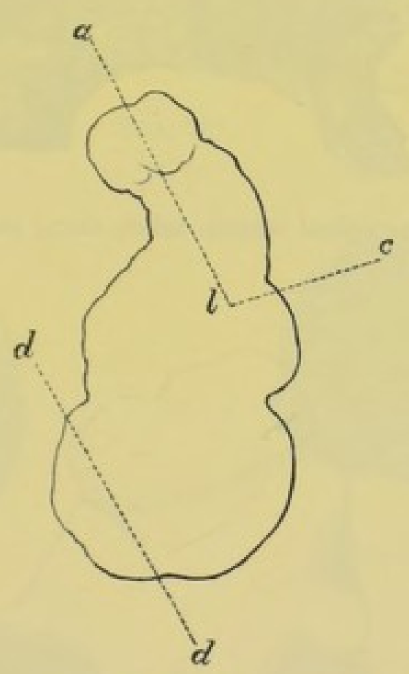


FIG. 743.

"The section marked *d d* exposed only the irregular, bony tissue, with its covering of cementum; no dentine was found here, even on microscopical examination."

Another remarkable specimen is in the Museum of the Royal College of Surgeons of England (figs. 745 and 746). This was examined by Mr. Salter.[1] The outer layer consists of cementum; inside this for a distance of two-thirds the circumference is a layer of dentine, the remaining portion of the growth being composed of a confused mass of bone structure arranged and separating an

[1] "Dental Pathology and Surgery," by S. J. Salter.

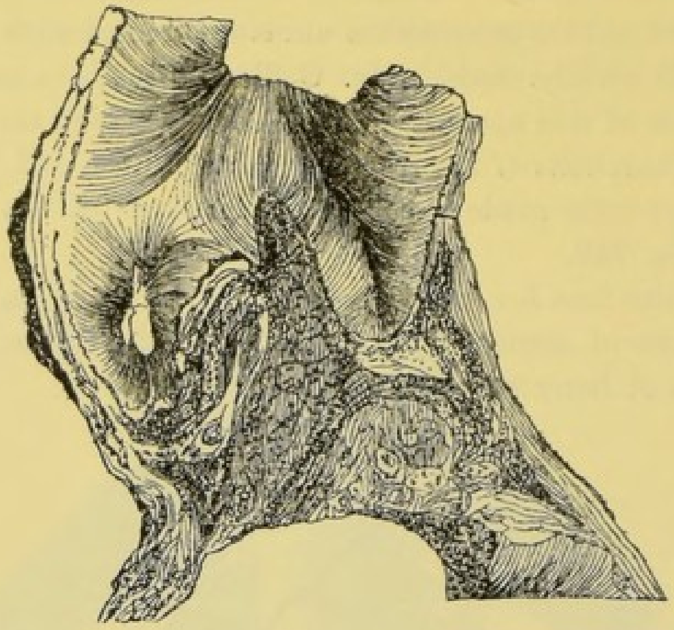


FIG. 744.—Microscopical section taken along the line *a b*, fig. 743.

FIG. 745.—(Salter.)

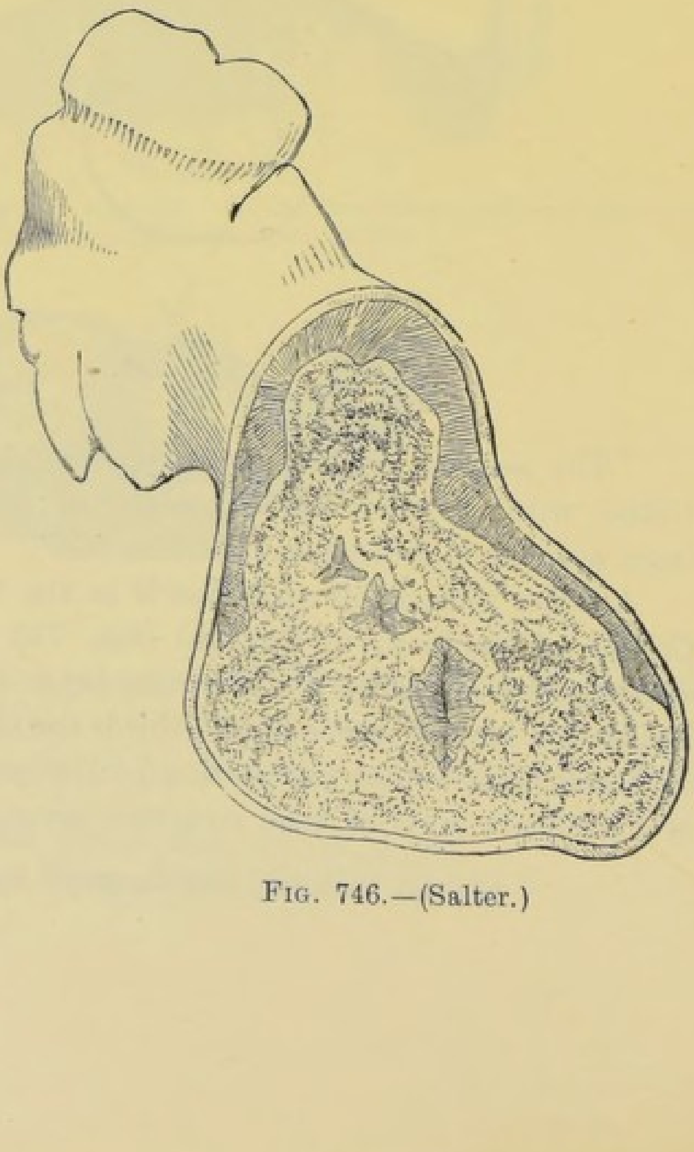


FIG. 746.—(Salter.)

elaborate vascular network of the same character as that of a dentine pulp.

The odontome shown in fig. 747 was described by Professor Windle and Mr. Humphreys.[1] It occurred in a man, aged 25, and was situated in the mandible on the right side in the region of the second molar. The specimen is probably a cementome.

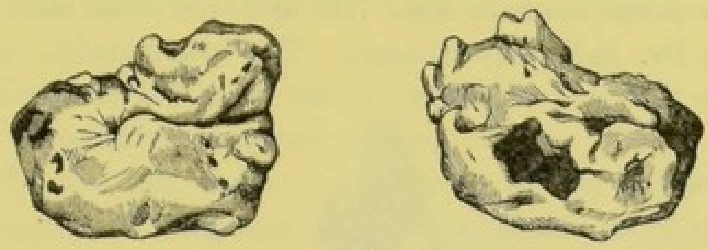


Fig. 747.

Fig. 748.[2]

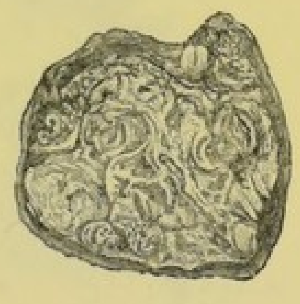


Fig. 749.[2]

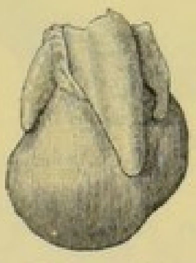


Fig. 750.[2]

Fig. 751.[2]

An odontome of this class, which occurred in the practice of Mr. R. Markham, is shown in figs. 748 and 749. The tumour was examined and described by Mr. G. Watson.[3]

[1] *Journ. Anat. and Physiol.*, vol. xxi, p. 665.
[2] From *Journ. Brit. Dent. Assoc.*
[3] *Journ. Brit. Dent. Assoc.*, vol. xv, p. 667.

The odontome was in connection with the left third maxillary molar, and must have considerably encroached upon the cavity of the antrum. The structure consists of an outer layer of irregularly laminated cementum, highly vascular, and containing numerous well-marked lacunæ. The main portion is composed of a narrow band of very intricate convolutions of white and yellow tissue, namely, vaso-dentine and osteo-dentine (fig. 749).

The odontome seen in figs. 750 and 751 was sent to me to examine by Dr. Salisbury Sharpe. The abnormality consists in

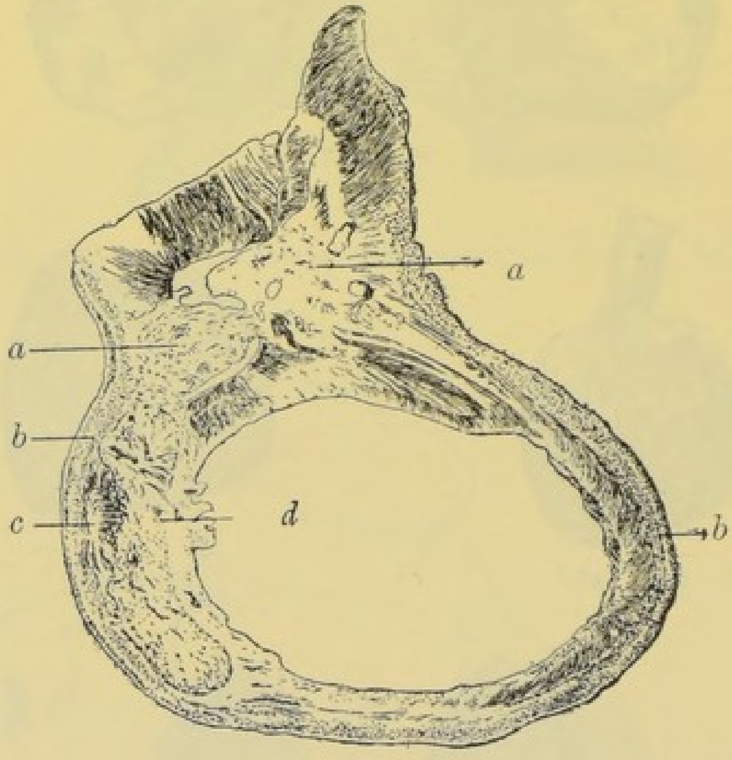


Fig. 752.[1]

a large globular swelling about the size of a full-grown acorn, involving one root of a four-rooted maxillary molar. On dividing the tooth with a saw, the globular swelling was found to be hollow, and lined with a tissue which presented distinct evidence of having been soft in character. A thin section was then obtained.

The original pulp chamber, it will be noticed, is very nearly filled up with a form of secondary dentine (fig. 752, *a*), presenting

[1] From *Journ. Brit. Dent. Assoc.*

very little structure beyond a few blood-vessels. The globular swelling itself is bordered by a layer of cementum (fig. 752, *b*), the lacunæ being more numerous on the right side of the specimen, as will be seen from the figure. This outside cemental layer is bounded—

(i.) Internally on the right side with dentine fairly regular in type, and continuous with the dentine of the main body of the tooth. The dentinal layer is succeeded by one cemental in character.

(ii.) Towards the base, the cemental layer is still covered by a dentinal tissue presenting few tubuli.

(iii.) To the left, the inner covering of the cemental layer is for the most part composed of tissue irregular in type, containing large blood-vessels and irregularly shaped lacunæ, with a few

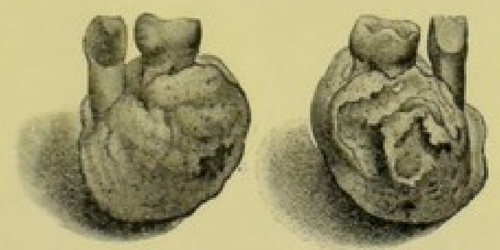


FIG. 753.[1] FIG. 754.[1]

dentinal tubes (fig. 752, *d*), and is, as far as can be ascertained, continuous with the secondary dentine in the pulp chamber. Inside this layer is a tissue of rather different pattern, but still cemental in character. At one spot (fig. 752, *c*), a transverse section of dentine appears.

The aberration seems to have consisted of an overgrowth of one radicle of the pulp, followed by calcification in a direction from without inwards.

A growth (figs. 753 and 754), which is probably a type of radicular odontome, is described in Wedl's "Atlas of the Pathology of the Teeth" (Second Edition). The patient was a boy, aged 11½, and the swelling occurred in the mandible in the region of the first deciduous molar. The tumour was

[1] Copied by permission from Wedl's "Atlas of the Pathology of the Teeth."

very sensitive to pressure, owing to severe periostitis. After removal, it was found to be composed of a mass of tissue about the size of a large cherry, intimately coalescent with the deciduous canine and first molar. It was covered with a distinct membrane of connective tissue which was closely adherent to the hard tissue. A section of the growth showed that it consisted of hard tissue containing cavities filled with connective tissue and blood-vessels (fig. 755). The distal root of the molar showed considerable absorption. Microscopical examination showed the hard tissue to be a rudimentary dentine, which has remained stationary at the stage of development of globules with inter-globular spaces.

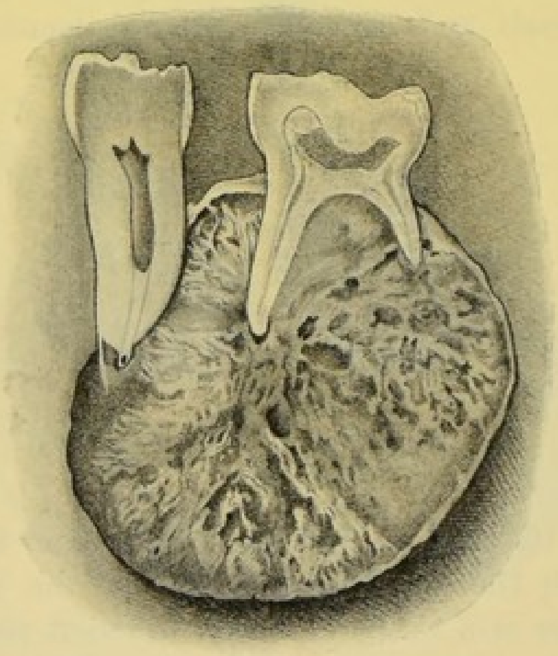


FIG. 755.[1]

An odontome similar in character to the foregoing is recorded by Mr. Bland-Sutton.[2] In a case which came under the notice of Mr. C. F. Rilot[3] at the Royal Dental Hospital, there was a hard circumscribed mass enveloping the roots of two mandibular molars. One molar had a septic pulp chamber and the general

[1] Copied by permission from Wedl's "Atlas of the Pathology of the Teeth."

[2] "Tumours, Innocent and Malignant." Fourth Edition, p. 327.

[3] Reported by J. Murray, *Trans. Odonto. Soc.*, vol. xxxvii, p. 176.

structure of the growth seemed to suggest that it was a case of inflammatory tissue which had partially ossified and calcified.

A remarkable example of a radicular odontome is shown in fig. 756. It was removed from a Kaffir boy, aged 14, and occupied the position of the left premolars and molars. In the mass, which is composed of dentine imperfectly calcified and very irregular, there seems to be some cementum but no enamel. The weight of the growth was 59 gm. or 885 gr., and the size 70 mm. by 62 mm by 39 mm. The parents first noticed a swelling when the boy was 6 months old, but they paid no attention to the growth.

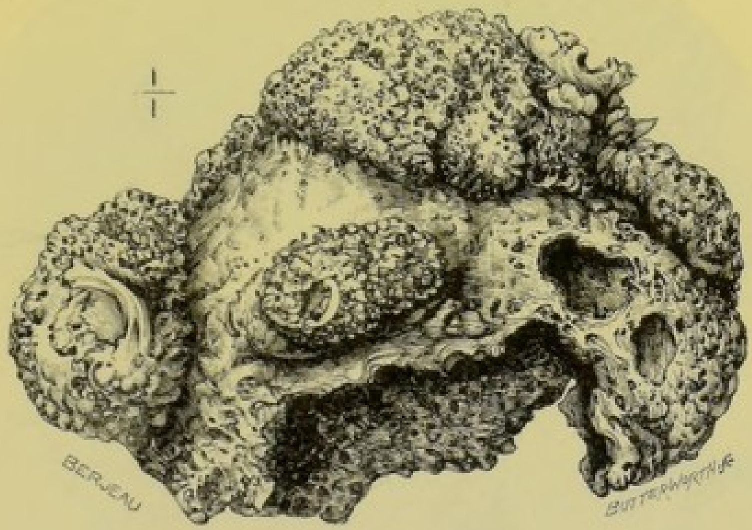


FIG. 756.[1]

(D) ABERRATIONS OF THE WHOLE TOOTH GERM

Composite odontomes are included under this division. These odontomes may be classified into two main varieties: (1) the uncalcified; (2) the calcified.

(1) **Uncalcified.**—To this variety Eve gives the name of composite embryoplastic odontomes, and he considers that these may be innocent or malignant in their growth.

(*a*) **Composite Embyroplastic Odontome** (Innocent).—A tumour of this type is described by Eve.[2] The tumour, which had been growing for four years, was situated in the left half of

[1] From "Tumours, Innocent and Malignant," by J. Bland-Sutton.

[2] *Trans. Odonto. Soc.*, vol. xiii, p. 52.

the mandible of a man aged 24. "It was surrounded by a capsule of bone and was shelled out after removing only the outer wall of the cavity. Microscopically, the tumour was composed of anastomosing bands of enamel epithelium in fibrillar connective tissue. In places these were elongated bands of columnar enamel cells" (fig. 757).

(*b*) **Composite Embryoplastic Odontome** (Sarcomatous).—Under this heading Eve describes a group of tumours which,

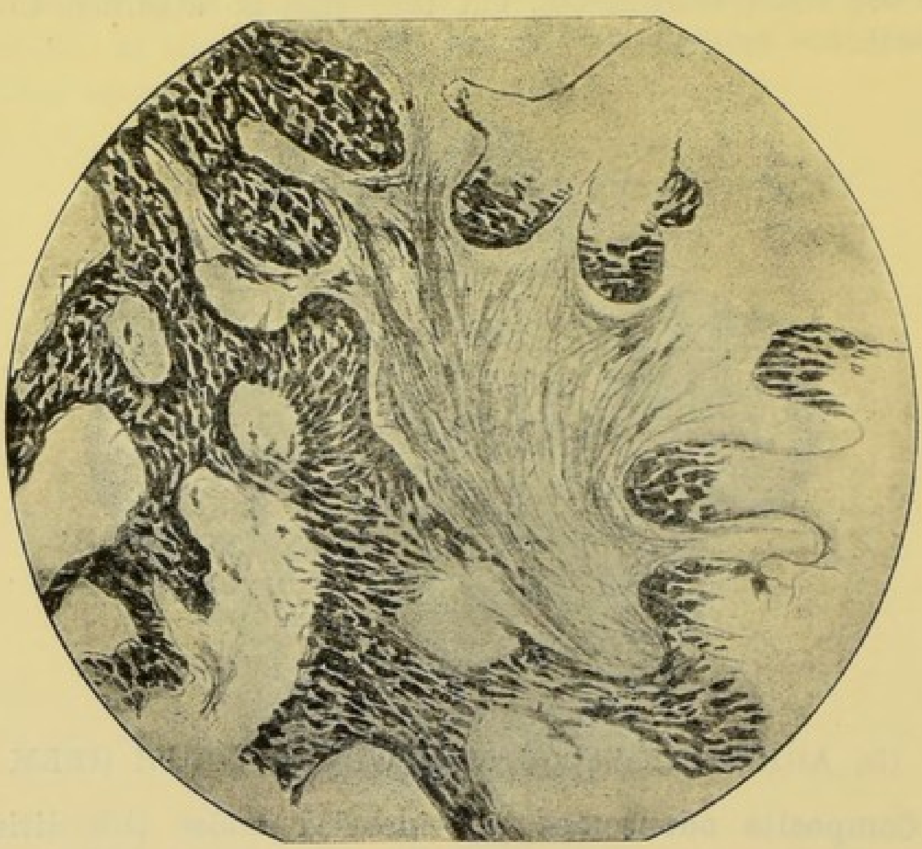


FIG. 757.—Composite embryoplastic odontome composed of anastomosing bands of epithelium in fibrillar connective tissue.

clinically, resemble sarcomata. Of the four cases he records, three occurred in the mandible and one in the maxilla. The patients were aged 21, 33, 53, and 55 respectively, when the tumours commenced. In one case the growth was of eleven years' duration, while in the one recorded in the maxilla the swelling had only been noticed for four months.

Microscopically these odontomes are composed of irregularly

shaped masses and columns of enamel epithelium embedded in a sarcomatous stroma (figs. 758 to 761).

Eve[1] says: "The dental character of these tumours cannot be doubted, owing to the characteristic appearance and arrangement of the epithelium. The peripheral layer of columnar cells is well shown in figs. 760 and 761. At places in the columns are rounded or flask-shaped enlargements due to microscopic cysts, or to small rounded areas of stroma, which appear to penetrate the epithelial column just as the tooth papilla invaginates the enamel organ (see *b* in fig. 760). A degeneration of the central

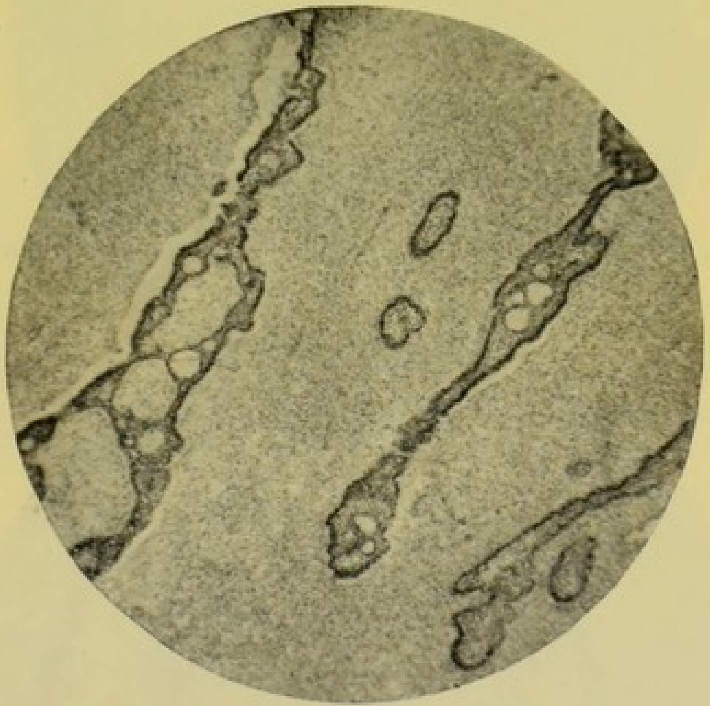


FIG. 758.—(Low power.) Composite embryoplastic odontome showing strands of enamel epithelium lying in a sarcomatous ground substance. The strands enclose small cysts, and areas of stroma.

cells of the columns leading to the formation of a reticulum was present in all the specimens (see *a* in fig. 760).

(2) **Calcified.**—These odontomes consist of irregularly shaped calcified masses, and are composed of enamel, dentine and cementum disposed in apparently no definite arrangement. They probably arise from an abnormal growth of all the elements of a tooth germ, namely, enamel organ, papilla and follicle. They

[1] *Brit. Med. Journ.*, June 29, 1907, p. 1526.

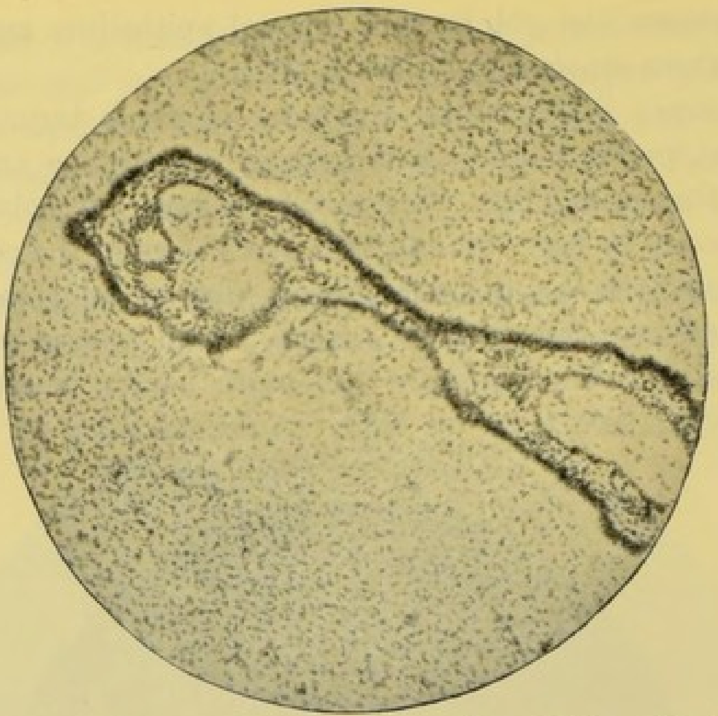


FIG. 759.—The same as fig. 758, but under a higher objective.

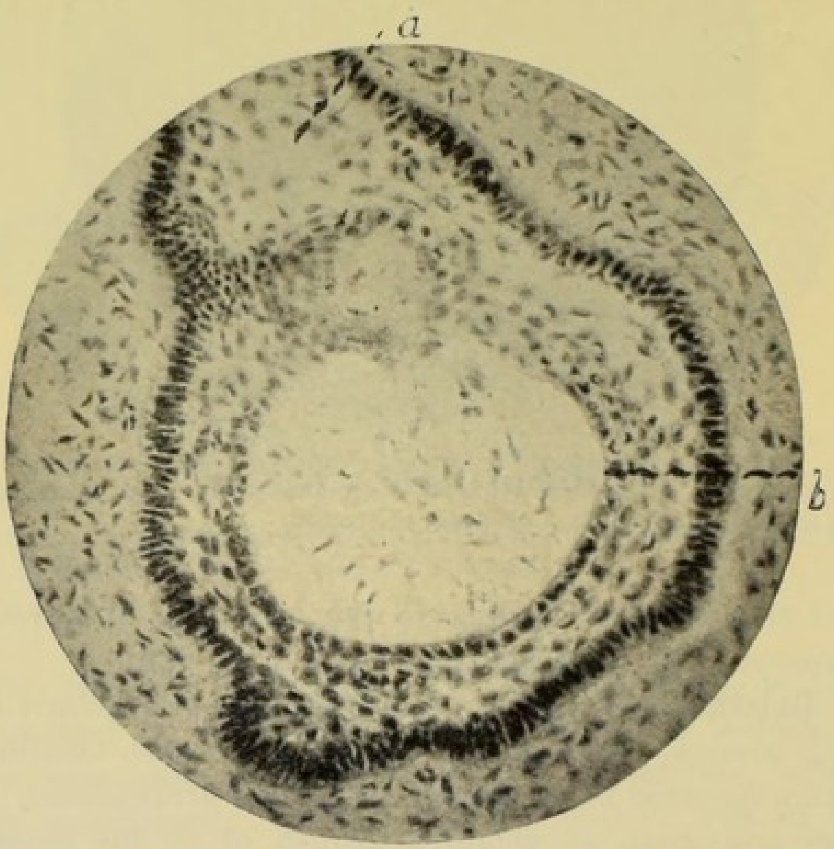


FIG. 760.—Part of section shown in fig. 759, but under a higher objective. The figure shows a rounded strand of enamel epithelium, lined externally with columnar cells. The intermediate layer exhibits a reticulum (*a*). At its centre the strand is penetrated by a round area of stroma (*b*).

may occur in either the maxilla or the mandible. They vary considerably in size and in the arrangement of the tissues composing them. In one recorded by Mr. J. J. Andrew,[1] occurring

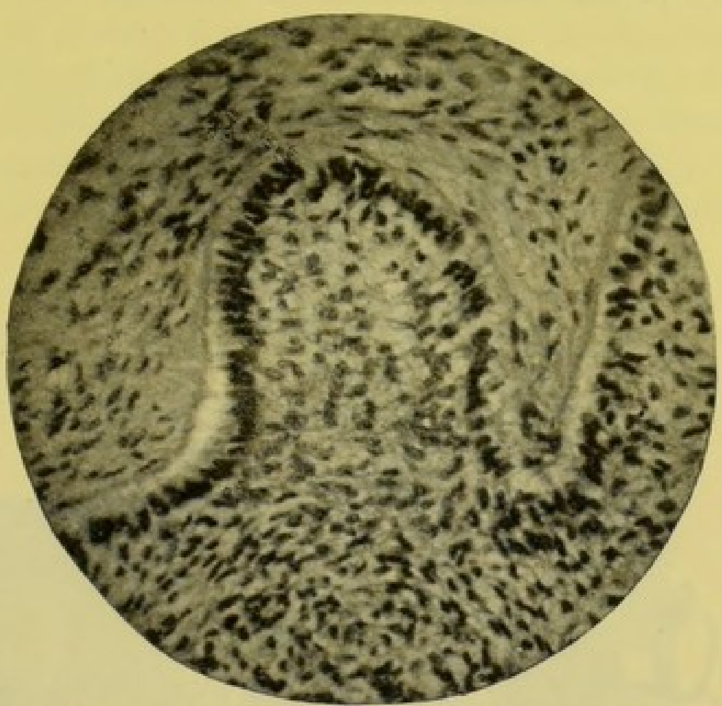


FIG. 761.—(High power.) The peripheral cells of epithelial strand are columnar, and the intermediate cells form a reticulum.

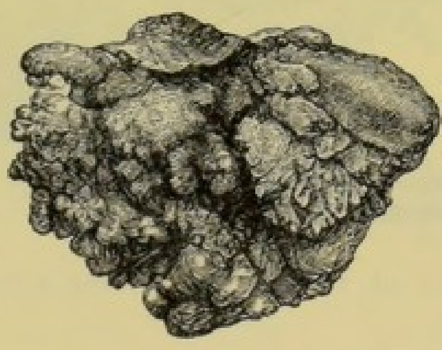


FIG. 762.[2]

in the right maxilla, the length was $1\frac{5}{8}$ in.; girth $4\frac{1}{2}$ in.; width, $1\frac{1}{4}$ in., and the weight was estimated at 500 gr. In the one shown in fig. 762 and recorded by Heath,[3] the measurements

[1] *Trans. Odonto. Soc.*, vol. xxvii, p. 42.

[2] From "Injuries and Diseases of the Jaws," by Christopher Heath.

[3] "Injuries and Diseases of the Jaws," by Christopher Heath. Fourth Edition, p. 319.

were $1\frac{1}{2}$ in. antero-posteriorly, 1 in. transversely, and $1\frac{1}{4}$ in. from above downwards; weight 315 gr.

According to Bland-Sutton the largest odontome known to have grown in the human antrum is preserved in the museum

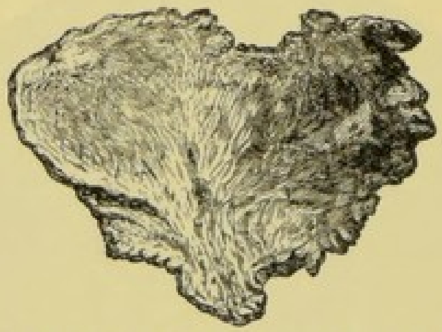


FIG. 763.[1]—Section of odontome shown in fig. 762.

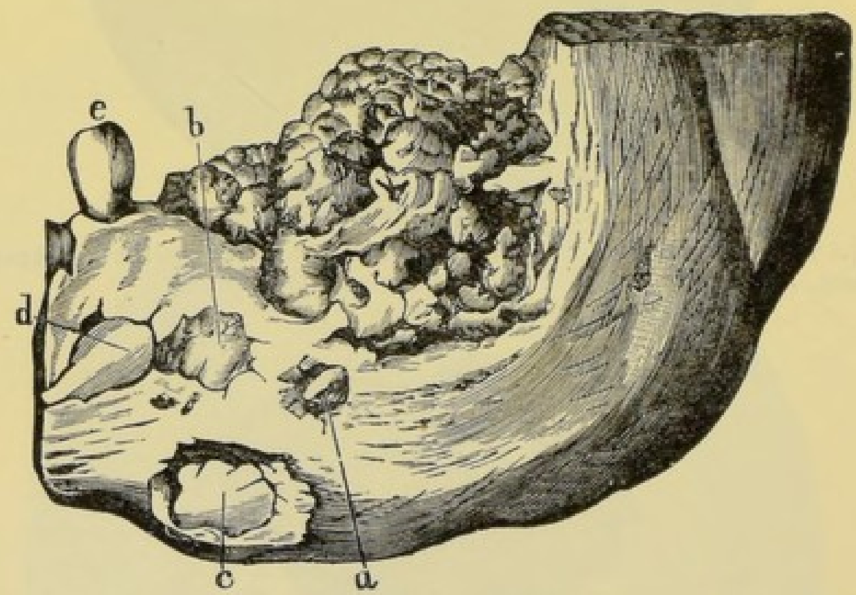


FIG. 764.[1]—Portion of a mandible showing a composite odontome in position.

of Guy's Hospital (fig. 765). The clinical history of the case was recorded by Hilton[2] as follows:—

A man, aged 36, had a large osseous tumour occupying the antrum. The pressure of this tumour had caused the front wall of the antrum, with the integument and soft tissues covering it, to slough. The trouble was first noticed thirteen years before. As the cheek enlarged the eyeball became displaced and finally burst. For a long time the surface of the tumour was

[1] From "Injuries and Diseases of the Jaw."
[2] *Guy's Hospital Reports*, 1836, vol. i, p. 493.

exposed, the suppuration being copious, and occasionally pieces of bone, irregular in shape, came away; at last, to the man's astonishment, the bony mass dropped out, leaving an enormous hole in his face.

The tumour weighed nearly 15 oz., and measured 27·5 cm. (11 in.) in its greatest circumference. This tumour presented, on section, an ivory-like surface, and on close scrutiny a number of closely arranged concentric laminæ (fig. 766). Sections ground thin and examined under the microscope showed large numbers of lacunæ and canaliculi arranged in a very regular manner.

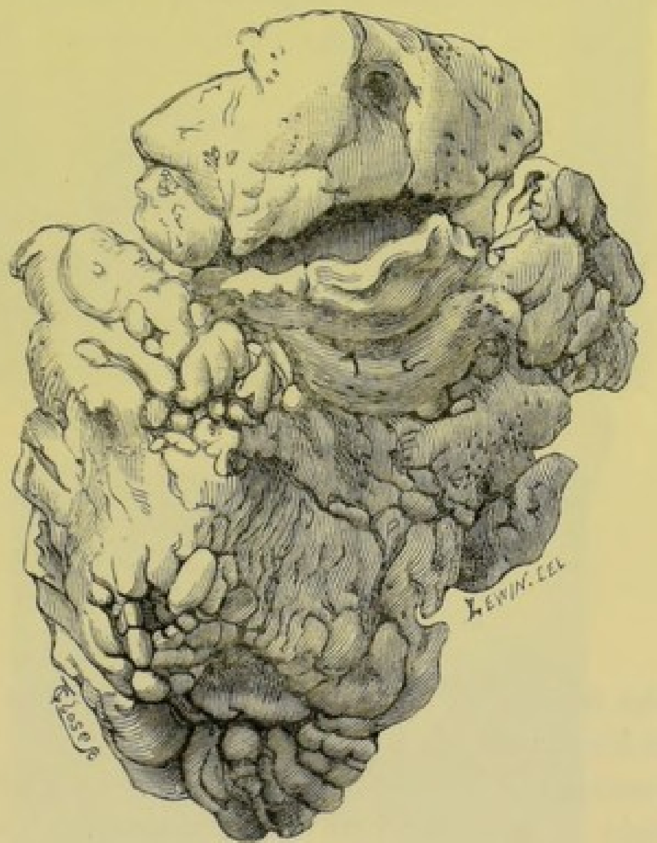


Fig. 765.[1]

Composite odontomes are rare among the lower animals. The specimen shown in figs. 767 and 768 is interesting, as it demonstrates that a cyst may develop in connection with a composite odontome and prevent the eruption of normally formed teeth. The cyst has encroached on the pterygoid fossa, the bone at this part being very thin. The cavity is about 19 cm. at its greatest diameter and 7·6 cm. deep. Pm_2, pm_3, and pm_4 are in

[1] From "Tumours, Innocent and Malignant," by J. Bland-Sutton.

position but m_1 has been lost *post mortem*, and the socket of this tooth can be seen in the specimen (*a*). Buried in the cavity of the cyst is the second molar in a vertical position (*b*), and further back is the third molar in a completely horizontal position (*c*), the occluding surface being directed toward the pterygoid fossa. Situated towards the palatine aspect of the cyst was the enormous odontome (fig. 768).

The odontome was making its way through the palate, and had been subjected to considerable attrition. The exact position the odontome occupied was impossible to determine, but it must have been near the median line of the palate. In its broadest

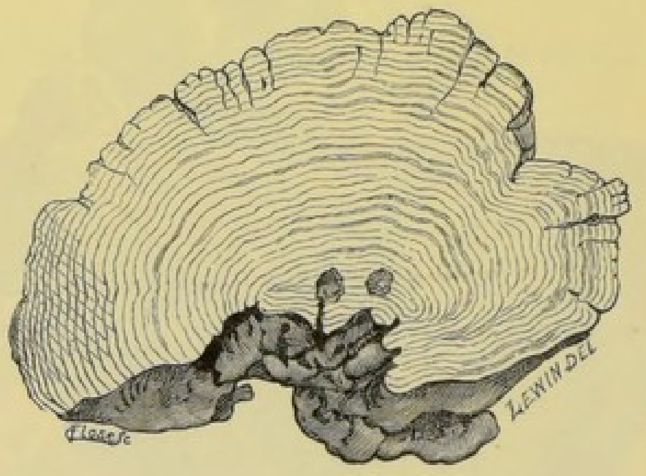


FIG. 766.[1]

diameter the odontome measures 11·4 cm., and the tissues entering into its formation are cementum and dentine.

The specimen is interesting, as it seems to shed a little light on the origin of these curious tooth masses. There is reason to think that the odontome originated from some suppressed tooth germ. In the hollow-horned ruminants pm_1 is absent, together with the incisors and canine. Goodsir believed that he found uncalcified tooth germs in the incisor region in the fœtuses of many specimens, but this has been denied by M. Pictkewickz.[2] Miss F. Mayo, according to Tomes in his "Manual of Dental Anatomy and Physiology," Sixth Edition, p. 446, "confirms the view generally accepted that the germs are absent, but she points

[1] From "Tumours, Innocent and Malignant," by J. Bland-Sutton.

[2] *Journal d'Anatomie*, Ch. Robin, 1873, p. 452.

out that in the region of the missing canine differentiation proceeds a little further than in the incisor region, though it never

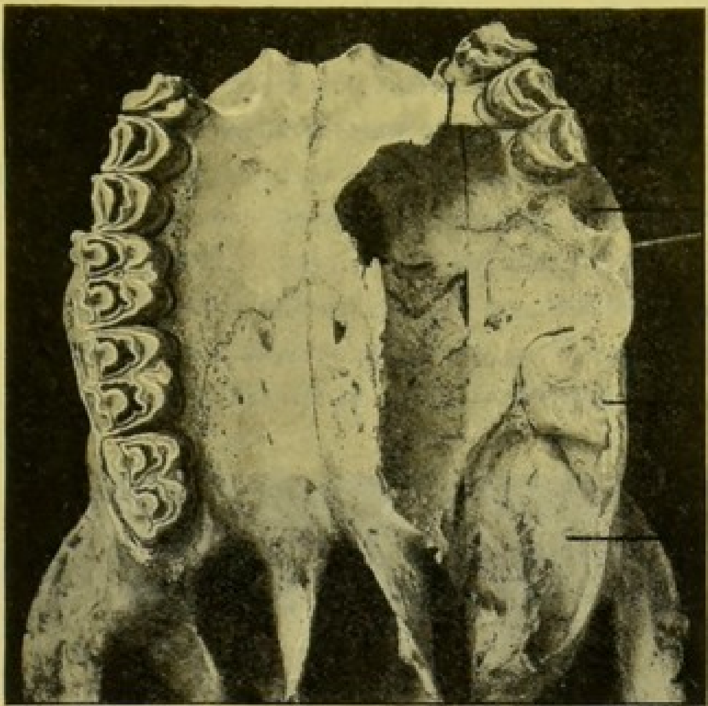


Fig. 767.[1]

Fig. 768.[1]

attains to the formation of a real tooth germ, *i.e.*, that the suppression of the tooth has been progressive, and that the canine

[1] From *Trans. Odonto. Soc.*

has been lost at a later period than the incisors. She bases this idea upon the occurrence of those knots of epithelium which we are accustomed to find where an enamel germ is atrophying." It seems, therefore, possible that in the region of the first premolar the differentiation proceeds still further than in the canine region, and a dentine germ appears, which may at times develop and calcify. On these grounds it seems reasonable to think that the odontome under consideration was connected with the tooth germ of the suppressed first premolar. The history of the case might then be read as—the calcification of an aberrant tooth germ, and the development of a cyst in connection with it, the cyst causing the displacement of m_2 and m_3.

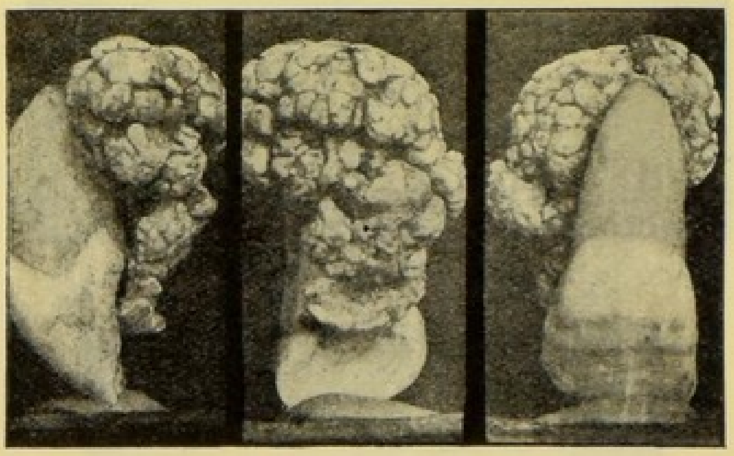


FIG. 769.[1]

In fig. 769 an illustration is given of a right maxillary central incisor, on the palatal aspect of which is a cauliflower-like mass of tooth tissue. This mass, although not an integral part of the root of the tooth, has nevertheless grown, as it were, around the root so that when the odontome is separated from the tooth a marked groove is seen on the former corresponding to the shape of the palatal surface of the root. An examination of the specimen shows that the odontome covered not only the root, but also the upper half of the palatal aspect of the crown of the tooth. The occlusal surface of the tooth shows no signs of attrition, and therefore suggests that the tooth did not erupt into correct position; the root of the tooth shows signs of absorption

[1] From *Trans. Odonto. Soc.*

around the apical portion. The fact that the root is fully formed and the odontome has grown around it seems to indicate that the formation of the odontome was subsequent to the growth of the root. A section of the specimen shows that it is composed of enamel, with cemental-like tissue; a few dentinal tubes are seen in places. The odontome must therefore be regarded as belonging to the composite class.

It is interesting to examine this specimen, in the light of knowledge gained from others, to see what relation, if any, such specimens bear to supernumerary teeth. In the first place, we have in the region of the premaxillæ the ordinary supernumerary tooth appearing in the form of a well-shaped or an irregularly shaped incisor.

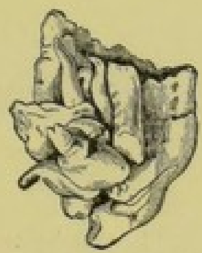
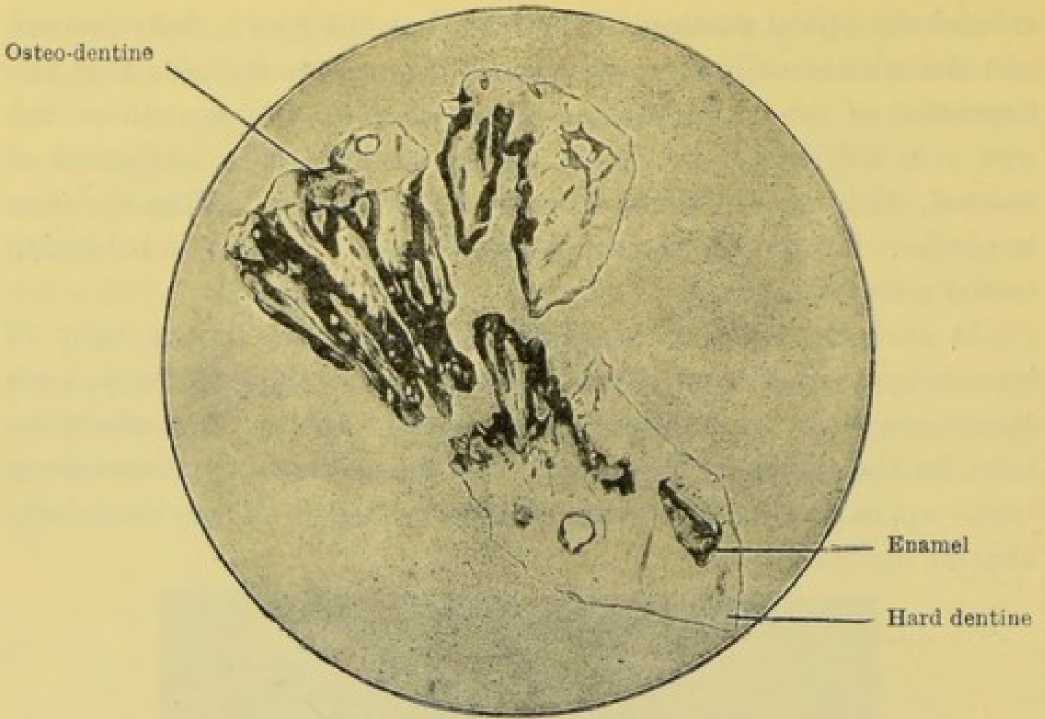


Fig. 770.

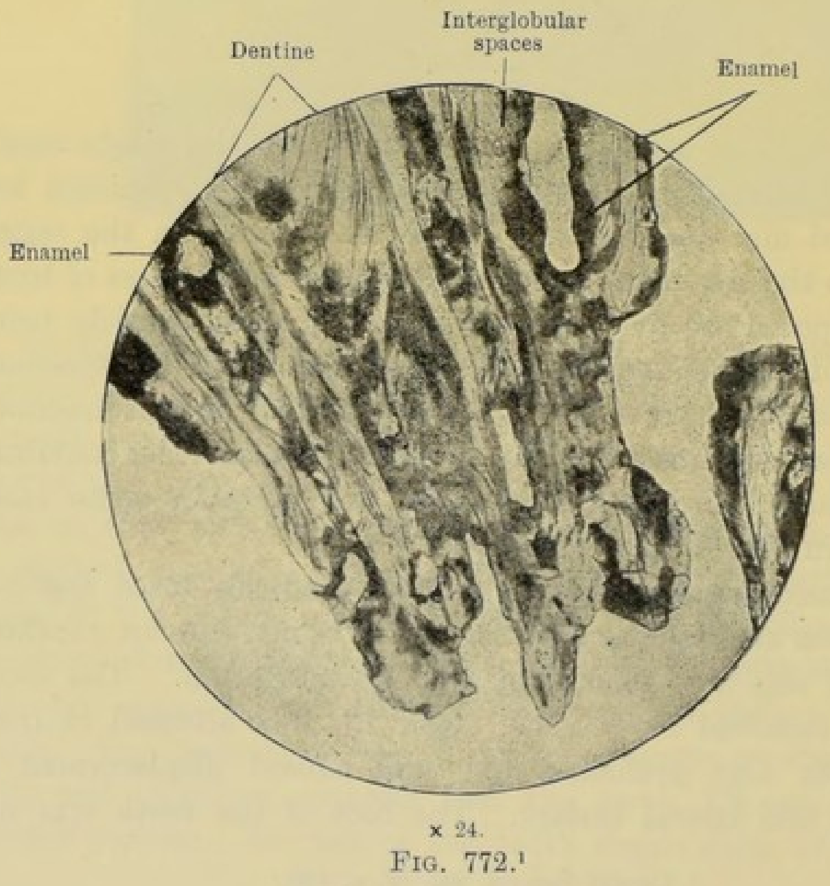
Next, we have a stage, where in place of the single tooth, several well-formed denticles are present; such a specimen has been figured and described by Dr. M. H. Cryer. In the region posterior to the left maxillary central incisor was a mass of tooth tissue composed of five seperate denticles, each denticle being composed of enamel, dentine and cementum. Another specimen belonging to Dr. Cryer takes us a step further. In this specimen a tumour had displaced the central incisor, the denticles contained in the tumour numbered thirty-five, and were in some cases single and in others fused together.

In the next stage, we have numerous denticles fused together so as to form an irregular mass of tooth tissue, and an excellent example of this was figured by Mr. Bland-Sutton.[1] The tooth (fig. 770), removed from a lad, aged 19, was situated in front of the right first premolar and had caused displacement of the canine and lateral incisor. The root of the tooth was not

[1] *Dental Record*, vol. ix, p. 435.



× 6.
Fig. 771.[1]



× 24.
Fig. 772.[1]

[1] From *Brit. Dent. Journ.*

formed and the crown showed nine distinct eminences, Mr. Sutton, in referring to this case, says that "the appearance of the specimen is as though a group of supernumerary teeth had become confluent"; also, "It is easy to imagine that if the cusps of this odontome had remained distinct and each had been separately erupted they would have been called supernumerary teeth. Indeed, many of the cusps can be easily detached from the main mass." On the other hand, if the denticles had remained separate and a cyst had developed in connection with them we should have the condition known as "compound follicular cyst." Thus "this strange specimen," to use Mr. Sutton's words, "serves to bridge the gap between compound follicular cysts and composite odontomes."

FIG. 773.[1]—Mag. 12 diam.

In the specimen shown in fig. 769, the stage of complexity seems to have advanced one step further, and in place of a tendency towards well-formed denticles we have more or less defined excrescences of enamel embedded, as it were, in a matrix of tissue cemental-like in character.

The odontome is not always the aberration of one tooth germ,

[1] From *Trans. Odonto. Soc.*

for in some examples there is evidence of at least two teeth germs being implicated in the growth.

An idea of the microscopical character of some of these odontomes can be formed from figs. 771 to 774.

In figs. 771 and 772[1] the section is composed of alternate layers of enamel and dentine, which are seen to run for the most part in a vertical direction. Here and there spaces exist, some being circular, others quite irregular in outline; the majority of these spaces are lined with enamel more or less perfectly calcified. Patches of enamel may also be seen dotted about the section.

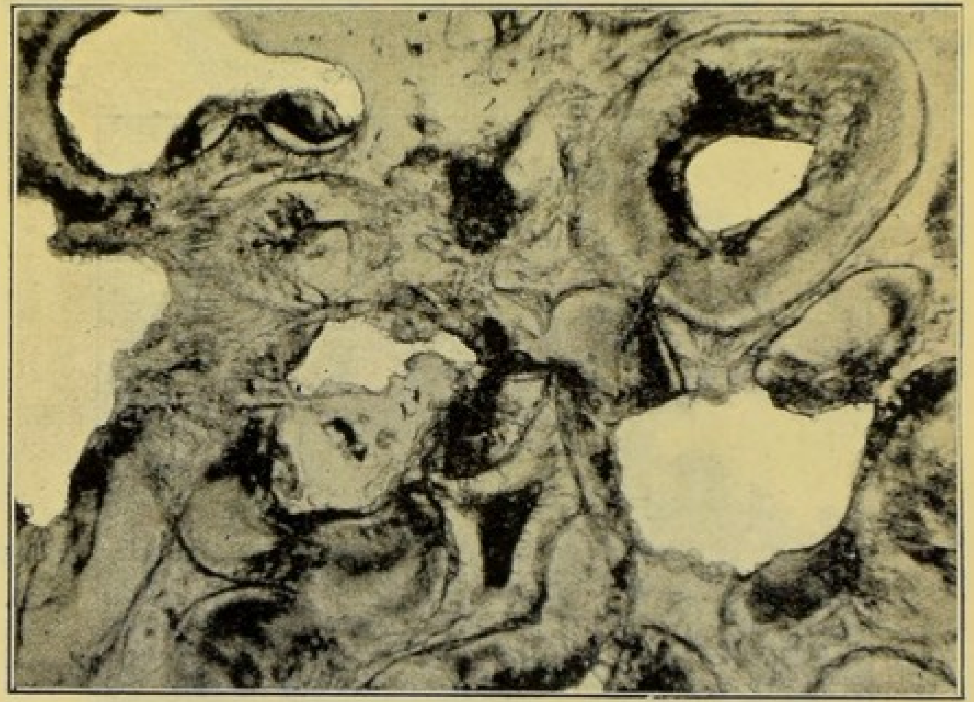


FIG. 774.[2]—Mag. 80 diam.

The arrangement of the structures in this loose fashion renders the tissue exceedingly friable.

In figs. 773 and 774[3] the structure is complex and very mixed; in parts, labyrinthine or folded in appearance; in others, osteo-dentinal. "The main body of this odontome was dentine, though

[1] Recorded by J. Lewin Payne (*Brit. Dent. Journ.*, June 15, 1904, vol. xxv, p. 402).

[2] From *Trans. Odonto. Soc.*

[3] Recorded by J. J. Andrews (*Trans. Odonto. Soc.*, vol. xxvii, p. 42).

of a very irregular character, full of openings and canals, with patches and crescents of enamel in all kinds of positions scattered through it. There was very little cementum, but a few lacunæ occurred in parts."

Signs and Symptoms.—An odontome is covered by a capsule from which it derives its nourishment, and during the period of growth gives rise to no painful symptoms, so that its presence often passes unnoticed. Composite odontomes, like teeth, are said to pass through an eruptive stage. The capsule is at some point destroyed, and suppuration takes place, so that the odontome is likely to be mistaken for a more serious disease of the jaw.

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CHAPTER XXIII

The Treatment of Dental Disease in Children

In connection with the treatment of dental disease in children there are a few points which may conveniently be considered under a separate heading. No part of the work of the dental surgeon requires more tact than the treatment of children. Some possess the gift of readily winning the confidence of the young, but this power is not given to all. The operator must constantly bear in mind the fact that he is dealing with children, and that they are interested only in simple topics. Every effort should be made to interest them and to avoid giving them pain, but if pain is unavoidable, under no circumstances should they be misled or deceived.

Two much stress cannot be laid upon the importance of regular and thorough attention to the teeth of children. Dental supervision should commence as soon as the deciduous dentition is complete, and the child should be brought to the dental surgeon at least three times a year for examination. Cavities can then be filled while quite small, with the result that the teeth are more easily saved and the operation is rendered practically painless—a point of no small importance in dealing with children.

In treating dental disease in children **the importance of rendering the mouth functional** must be clearly kept in mind. If the mouth is rendered functional it will be kept clean by natural means. The chief causes of a functionless mouth in children are :—

(*a*) Mouth-breathing.

(*b*) Caries of the teeth.

(*a*) **Mouth-breathing** arising from nasal obstruction produces a persistent gingivitis of the gum in the front of the mouth, and so predisposes the teeth to caries, especially the incisor teeth. Mouth-breathing is often overlooked, more particularly in

children who suffer from intermittent nasal obstruction. *The sign of nasal obstruction which may be regarded as diagnostic consists in a marginal gingivitis limited to the incisor teeth, the gums at the back of the mouth being healthy.*

Too much importance cannot be attached to the proper performance of nasal breathing, and, if there is sufficient naso-pharyngeal trouble present to cause even intermittent mouth-breathing, the trouble must be removed. *Unless a child regularly breathes through the nose it cannot have a healthy mouth.*

(*b*) **Caries of the Teeth.**—It is a matter of common experience that children "bolt their food," and so place in abeyance the function of mastication. *Unless mastication is properly performed the mouth cannot be kept healthy.* It is therefore essential that children's teeth should be rendered capable of performing their function without the least discomfort.

Small cavities, whether in the crown or approximal surfaces, should be filled with amalgam, and special care should be taken to restore the contour of the tooth. (See p. 431.) Approximal cavities, when they have been opened up and the caries removed, are usually cup-shaped, and the retentive shaping must therefore be carried out by grooving. If the tooth is sensitive, it is sometimes judicious to bring the filling of amalgam against the approximal tooth. With children it is sometimes impossible to remove all the carious dentine in the deeper parts of the cavity. Under these conditions the surface of the dentine should be covered with a little powdered nitrate of silver before the filling is inserted.

If the pulp of the tooth is exposed, the better line of treatment, in the majority of cases, is to remove the tooth. This practice may not coincide with that of the majority of practitioners, but the impossibility of thoroughly treating pulp chambers in children, and the fact that suppuration frequently occurs after treatment incline me to the opinion that by extraction the mouth is more likely to be rendered functional. The only instances where conservative treatment is indicated are cases of second deciduous molars in children under the age of six years, that is, in cases where the first permanent molars have not erupted; but even in these cases, the teeth should be carefully watched, and, if periodontitis appears, they should be removed.

If it be decided to retain the tooth, the pulp should then be removed from the coronal portion of the pulp cavity, and, if possible, from the root canals. Sterilization should then be carried out and the pulp chamber filled with iodoform or loretin. No attempt should be made to fill the canals, the cavity in the tooth being completed with amalgam.

A tooth with a septic pulp chamber in a child often causes no objective symptoms, but yet is the seat of a slight chronic peri-odontitis; moreover, the constant absorption of the septic matter from the pulp chamber is liable to cause chronic lymphadenitis.

The cases, however, which demand most serious consideration are those where the majority of the deciduous molars are absolutely unsavable. If the first permanent molars are in position, the best treatment seems to be to remove all the deciduous molars. This treatment has the advantage of removing all sources of sepsis and of isolating the first permanent molar, a point of the greatest importance when the value of this tooth in mastication is considered. As a rule, all opposing teeth, even if free from caries, should be removed. The necessity for removing all opposing teeth will perhaps be made more clear by giving an example. Suppose the right maxillary deciduous molars and the left mandibular molars are unsavable, and their removal is called for, then the remaining teeth, namely, the right mandibular and the left maxillary molars, are rendered functionless and are of little use; indeed they will harbour food *débris* and so prevent the mouth being kept naturally clean. The removal, then, of all deciduous teeth not functional is called for, if we are to render the mouths of children clean.

It may be urged that this treatment robs the child of masticating power, but that it is not really so, as such teeth are useless as far as the function of mastication is concerned; moreover, they are apt to render the first permanent molars functionless, as they will become tender through want of use, and a child with tender teeth will "bolt" its food and not chew it. Another argument advanced against this treatment is that the removal of the deciduous molars allows the first permanent molars to come forward, and so cause, in the future, crowding of the anterior teeth. With regard to this argument, it may be pointed out that such travelling forward of the permanent teeth occurs mainly in

mouths where the growth of the jaws is interfered with by want of function, due either to insufficient mastication or to lack of nasal breathing. From observation—but one expresses oneself guardedly in this respect—one is inclined to think that if by removing the deciduous molars the first molars can be rendered functional, the growth of the jaw will be stimulated, and room will be made for the development of the second and third molars. With no forward pressure from the second and third molars, and with the first molars occluding correctly, there will be little, if any, forward movement. But, granting that the suggested treatment by extraction does cause a forward movement and subsequent crowding, the removal of four teeth will easily alleviate the condition. One has to decide between the disadvantage arising from the possible loss of four teeth on the one hand and the constant presence of oral sepsis and all the sequelæ on the other. In my opinion the risk of sepsis is by far the greater evil. Still further, it must always be remembered that even if the deciduous molars are retained with the object of preventing a forward movement of the molars, it is quite possible that the removal of teeth to prevent crowding would be necessary, as in mouths such as these in question some interference with the development of the jaws would probably have taken place.

When the first molars have not erupted, the removal of the sound antagonistic teeth should be delayed until the permanent teeth have erupted, but there should be no hesitation in removing deciduous teeth that cannot be rendered aseptic. If children are treated on the lines just mentioned it will usually be found that the general health undergoes marked improvement.

In cases where the deciduous teeth are decaying on all surfaces, a condition not infrequently arising from the sucking of sugar bags or the constant presence of an easily fermentable carbohydrate on the surfaces of the teeth, a considerable improvement can be effected by careful regulation of the diet, and regular cleansing of the teeth, combined with local treatment of the teeth. For local treatment no drug acts better than nitrate of silver, which should be applied to all the carious surfaces of the teeth. To apply the drug, a small piece should be melted on the end of a steel intrument so as to form a small bead; the nitrate of silver can then be applied at any point

with accuracy and safety. About four applications should be made at intervals of about one a week, and after this regularly at intervals of three months. Once a day spirits of wine should be applied to the teeth as follows: the surfaces of the teeth should be thoroughly dried, the spirit applied on cotton-wool, and the saliva kept away, if possible, for one or two minutes. The spirit in evaporating dehydrates the dentine and apparently hardens the surface. Twice a day, morning and evening, an alkaline mouth-wash should be used. If the directions above given are faithfully carried out, the teeth can often be retained for the normal period. Nitrate of silver must be applied with caution. On no account should it be held between the blades of conveying forceps, as it may slip from them and pass either into the larynx (as is known to have happened in one case), or into the stomach. In the first case, inversion might be tried, but skilled surgical aid should immediately be sought; in the second, a plentiful supply of common salt should be given in order to create a chemical reaction leading to the formation of the insoluble and inert chloride of silver.

The practitioner should impress on parents the necessity of keeping the first permanent molars scrupulously clean during eruption, explaining to them that these teeth form the vanguard of the second dentition, and that during the period of eruption the destructive agents are most active, the loose flap of gum overlying the crown acting as a food-trap.

As soon as the first permanent molar shows signs of caries in the fissures on the occluding surface, the fissures shoud be cut out as thoroughly as the patient will permit and filled with amalgam.

The removal of the deciduous teeth by extraction is dealt with in chapter xxvii.

CHAPTER XXIV

Odontalgia and Neuralgia

PAIN arising in connection with disease of the teeth is usually designated by the term "Odontalgia."

Pain from visceral disease may be:—

(1) Local, *i.e.*, located in the part diseased.

(2) Referred to the terminations of some nerve trunk implicated in the disease; or

(3) "Painful impressions may be conducted up the sensory fibres of the sympathetic into the central nervous system, and then referred to the peripheral distribution on the surface of the body of these nerve fibres that enter the same segment. This is true visceral reflected pain" (Head).

Pain from a tooth, therefore, may be localized to the tooth, referred to another part—for example, the temporal region—or associated with a painful area in the skin. It would seem, however, better to restrict the term "odontalgia" to pain definitely referred to a tooth or teeth and to consider all cases in which the pain is referred to other parts as "neuralgia."

ODONTALGIA

Odontalgia may be divided into:—

(*a*) *Local.*

(*b*) *Referred.*

By "local odontalgia" is meant pain in or around teeth which are themselves the cause of the trouble; by "referred odontalgia" is connoted pain in a tooth which is not itself the seat of the cause.

(A) LOCAL ODONTALGIA

Nearly all morbid conditions of the teeth may be cited as causes of local odontalgia. For convenience they will be grouped under:—

(*a*) Morbid conditions of the periodontal membrane.

(*b*) Morbid conditions of the pulp.

The principal affections under the first head are acute and chronic periodontitis and its sequelæ, and under the second, acute and chronic pulpitis.

Local odontalgia may be acute or chronic, and for practical purposes the source of the pain may be regarded as either the pulp or the periodontal membrane.

(1) **Acute local odontalgia** is generally due either to acute pulpitis or to acute periodontitis. **If due to pulpitis,** the pain will be of a sharp, shooting, throbbing character, more severe when the patient assumes the horizontal position, and greater at night than in the morning. Paroxysms of pain will also be caused by alternations of temperature. A small pledget of cotton-wool placed in the cavity and gently pressed upon with a blunt instrument will generally produce pain, as in this form of odontalgia the pulp is usually exposed. In a few cases, the application of cold brings relief, while heat intensifies the pain. A condition of this character points to a suppurating pulpitis, the cold constricting the arteries and so reducing the blood-pressure, the heat dilating the vessels and therefore increasing it. A sharp, shooting pain, associated with marked tenderness of the tooth to pressure, usually implies tension in the pulp chamber from a putrescent pulp.

If periodontal inflammation is the cause, the pain will be found to be of a dull, gnawing, constant character. Percussion of the tooth with an instrument will generally cause pain. In pain arising in connection with the pulp, percussion does not as a rule cause pain. Pressure with the finger upon the crown of the tooth will also produce pain, and the alveolar process is usually tender. A pledget of cotton-wool introduced into the cavity, if one exists, will not give rise to any pain except that which is caused by the pressure transmitted to the periodontal membrane. Alternation of temperature from hot and cold fluids may affect the pain, but not to the same extent as in pulpitis. By limiting the heat or cold to the tooth, the source of pain can be easily diagnosed. With periodontitis, pain will not be felt.

The **treatment of acute local odontalgia** depends upon the cause. The remedy for each morbid condition has already been

dealt with in previous chapters. Temporary relief of the pain in cases of pulp trouble may be obtained by applying to the cavity, on a piece of cotton-wool, some sedative, such as oil of cloves, oil of peppermint, or carbolic acid, covering over the drug with some loose dressing, such as cotton-wool dipped in gum sandarac or mastic. Periodontal pain can generally be relieved by the application of tincture of iodine, to which some tincture of aconite may be added. When the pain is due to tension in the pulp cavity from a putrescent pulp, relief can be obtained by opening the pulp chamber and so giving exit to its contents.

(2) **Chronic Local Odontalgia.**—The **causes,** like those of the acute form, may either be connected with the pulp or with the periodontal membrane. **The symptoms arising from the pulp** will be pain at irregular intervals, but less intense than in the acute form, with a tendency for the pain to wander and follow the course of the nerve.

Alternations of temperature, or the application of irritant food substances, such as sweets, sours, &c., generally produce a paroxysm of pain, which may pass away at once or continue for some time. When the odontalgia arises **from the periodontal membrane,** the patient will complain of a grumbling sensation in the tooth and tenderness on pressure. The gum over the alveolar process will be slightly swollen, congested, and tender to pressure. The pain is usually constant, not paroxysmal, like the pain arising from pulp trouble, but it may be affected by alternations of temperature. A frequent cause of local odontalgia, and one that is often overlooked, is absorption of the septa between the teeth in chronic periodontitis (see p. 574). Food collects in the space formed, and pain results owing to pulp irritation *via* the cemental tissue or by infection *via* the periodontal membrane.

The **treatment,** as in the acute form, depends upon the cause, and the remedy for each condition has been dealt with in chapters xv. and xvii.

(B) REFERRED ODONTALGIA

Referred odontalgia may arise from many causes.

Any conditions which give rise to irritation of the terminal portions of the fifth nerve and its connections may cause reflex odontalgia, and by far the commonest condition which comes

under this heading is that which is **dental in origin,** *i.e.*, where the cause lies in a tooth which is not itself the seat of pain. Such cases are of frequent occurrence. A patient complains of pain, say, in a mandibular molar, which, on examination, is found to be free from disease, the cause eventually being discovered in, perhaps, a maxillary tooth. This condition, generally called "referred toothache," is at times so pronounced that manipulation of the offending tooth will cause paroxysms of pain in the sound one, and in one case within the author's recollection the application of arsenic to the pulp caused pain in the sound tooth during the process of devitalization. Pain may be referred from a maxillary to a mandibular tooth or the reverse; it may also be referred from one tooth to another on the same side of the same jaw. Perhaps the most common and most instructive example of referred pain is that of a mandibular third molar causing symptoms in a mandibular premolar. Pain is never referred across the median line of the mouth. **Morbid conditions of the periosteum of the jaws, and ulcerations of the mucous membrane,** &c., may act as causes of odontalgia, and likewise **operations upon or morbid conditions of the eye and nose.** Cases supporting the latter statement are quoted by Galezowski and Macnaughton-Jones.

Toothache is frequently met with in patients with uterine troubles, in those with disorders of the alimentary tract, and in those who are the subjects of malaria, gout, rheumatism, and syphilis. The probable explanation of these cases is that the blood is charged with toxic matter, and slight lesions of the teeth cause pain which would not be felt under ordinary conditions.

The diagnosis of referred odontalgia cannot always be readily arrived at. If no local cause can be found for pain which is referred by a patient to a tooth or teeth, a systematic examination of all the teeth must be carried out. As this examination is practically similar to the method to be pursued for investigating cases of neuralgia, it will be considered under that heading.

NEURALGIA

Neuralgia is a term used to denote pain in the course of the nerve, or within the area of its distribution. When pain occurs in connection with the fifth nerve, it is known as trigeminal or

trifacial neuralgia. It is not itself a disease, but only a symptom of organic and functional disease. To this statement, however, an exception must probably be made in the case of "epileptiform neuralgia," which is held by some to be a definite affection of the nervous system.

Many different conditions are described under the name neuralgia, and these Dr. Head divides into:—

(A) Neuralgia quinti major (tic douloureux, epileptiform neuralgia).

(B) Neuralgia secondary to disease of the nerves of the head, for example, tumours involving the fifth nerve.

(C) Neuralgia minor.

(*a*) Visceral referred pains due to disease of the intimate structure of some organ of the head.

(*b*) True neuralgia minor.

(D) Neuralgia secondary to general disease, such as anæmia, hysteria, malaria, &c.

(A) Neuralgia major is considered by some authorities to be a definite disease of the nervous system with a distinct course and character. A most excellent descriptive account of this disease is to be found in Dr. Head's article on trigeminal neuralgia, (Allbutt's "System of Medicine," vol. vi, p. 724). The disease is of importance to the dental practitioner, as many of these cases come under his notice in their early stages. In the early stage, the disease simulates a simple neuralgia, flashes of pain starting from one or more foci. The paroxysms increase in severity and duration, until they become almost unbearable. When the disease is fully developed, the paroxysms of pain are distressing to the onlooker. On the side of the head and face affected there are "alternate flushes and pales, and the muscles are in violent spasm, the skin sweats profusely, and the mouth and eye pour out saliva and tears. At the height of an attack the pulse fails, and the patient becomes almost unconscious from pain and shock. The paroxysms are started by a stimulus of any degree or kind applied to the sensory area to which the pain is referred, or may be quite spontaneous."

The Gasserian ganglion would seem to be the starting point of these impulses, because the removal of the ganglion cures the disease. There is, at present, no known microscopical method

which will enable a normal Gasserian ganglion to be distinguished from one removed from a patient affected with neuralgia major.

In an admirable paper on this disease, R. Rollinson-Whitaker[1] states that the disease, when at all severe, is never seen in patients who do not also show signs of arterio-sclerosis, and he inclines to the view that in about 90 per cent. of the cases the exciting cause lies in the mouth. In patients with chronic sepsis, he thinks "a steady stream of afferent impulses ascends, so slight that they are not noticed save when something causes an extra outburst; and these, so to speak, try the patience of a long-suffering Gasserian ganglion to such an extent that all that is needed to cause it to burst into paroxysms of pain some day is a new and severe pain stimulus—maybe of very short duration—or even the general constitutional depression which any acute intercurrent disease may so readily cause."

It would be idle to deny the force of this author's argument with regard to the possibility of sepsis in the mouth acting as the cause, on the grounds that in many of these cases the teeth are sound. In recent years our views as to what a sound tooth really is have changed. A tooth, although quite free from caries, may be the seat of a chronic periodontitis, and it is this type of tooth which is so frequently regarded by the medical practitioner as normal. It is not reasonable to argue that, because removal of the teeth fails to cure the disease, the teeth cannot have been the cause of the disease. It is well within the range of probability that their presence has already sown the seeds of a disease to be started by the slightest pain stimulus.

Sir Victor Horsley states[2] that he has seen cases of peripheral origin where the neuralgia had arisen from an ascending neuritis traceable to chronic osteitis of the tooth sockets.

(B) Neuralgia due to organic disease of the fifth nerve is difficult to distinguish from the pain of neuralgia major. The pain may be intense, and radiate over the area supplied by the nerve, or it may be local, although paroxysmal and active in character. In differentiating between this type of neuralgia and neuralgia major, it must be observed whether the pain "is usually

[1] "Concerning Cranial Neuralgias," *Brit. Dent. Journ.*, vol. xxx, p. 193.
[2] *Brit. Med. Journ.*, September 9, 1905, p. 556.

accompanied by marked loss of sensation over the area to which the affected branch is distributed."

(C) Neuralgia Minor.—(*a*) **Visceral Referred Pain.**—The reason for cutaneous tenderness in visceral disease is explained by Dr. Head as follows :—

" When impulses pass up sensory sympathetic nerves from an organ which is diseased they set up a disturbance in the segment to which they are conducted. Now any second sensory impulse from another part, *e.g.*, from the surface of the body which passes into this same segment, will be profoundly altered, for it no longer falls into a normal and quiescent segment of the nervous system, but into one whose activity is already disturbed. The resultant stimulus, conducted upwards towards the brain, therefore differs from that which would have passed inwards from that segment under normal circumstances. The second stimulus will appear to be exaggerated, or may perhaps undergo some actual increase in its passage through the excited segment."

" Thus any otherwise painless stimulation applied to the surface of the body falling within the area supplied by fibres that enter the disturbed segment, will appear to be painful, and the skin will be said to be tender."

" In the head, these areas are supposed to represent the segmental origin of the nerves for pain, heat, and cold."

The exact relationship of each tooth to the segmental areas seems to vary. The following table is given as approximate :—

Maxilla.		Mandible.	
Incisors ..	.. Fronto-nasal.	Incisors ..	.. Mental.
Canine ..	.. Naso-labial.	Canine ..	.. ,,
Premolar I. ..	.. ,,	Premolar I.	.. ,,
,, II. ..	.. Temporal or maxillary.	,, II.	.. Doubtful.
Molar I. ..	.. Maxillary.	Molar I. ..	.. Hyoid.
,, II. ..	.. Mandibular.	,, II. ..	.. ,,
,, III. ..	.. ,,	,, III. ..	.. Superior laryngeal or hyoid.

The diagrams (fig. 775) show these areas, and the maxima points of these areas.

The method of testing for the superficial tenderness is by means of the blunt end of a pin. To the normal skin the touch feels blunt, but when the skin is sensitive the patient complains

that the touch hurts, and that the part is tender, or he may think he is being pricked. The tender area over the hairy scalp may be defined by gently pulling the hair, while with skin overlaying soft structures, such as the neck, gentle pulling between the fingers is advised.

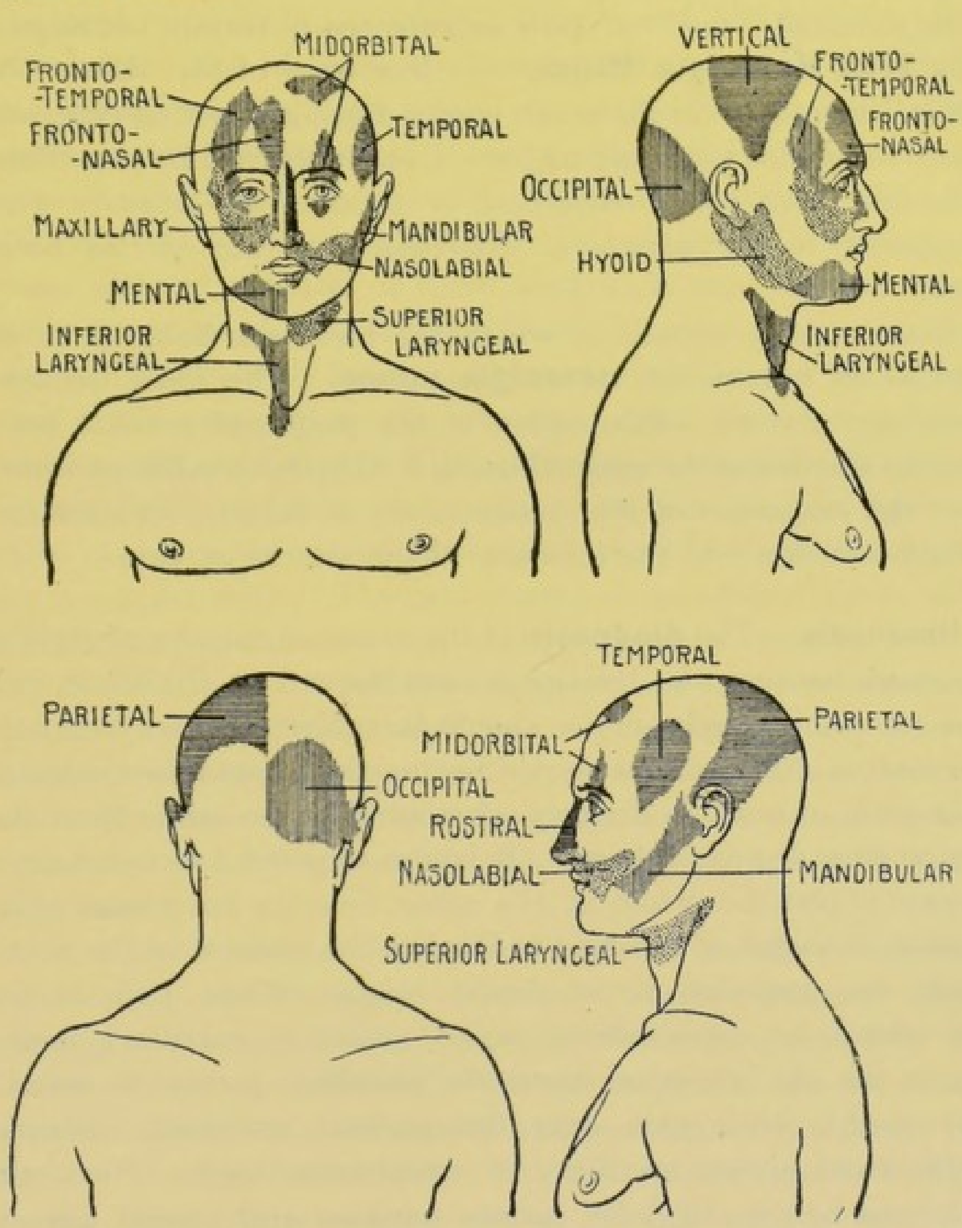

FIG. 775.[1]

Dr. Head's observations are interesting, but further investigations are required before their practical value in diagnosis can be definitely determined. The "segmental" areas are not to be

[1] From Allbutt's "System of Medicine."

confounded with so-called "foci" of pain observable in certain neuralgias.

It must be clearly kept in mind that the "segmental" areas do not correspond to the distribution of the peripheral branches of the cranial nerves, and the maxima points do not correspond to the so-called "foci" of pain experienced in certain neuralgias.

(*b*) **True Neuralgia Minor.**—In this form of the disease the pain is "neuralgic" in character, is of a darting, shooting type, and closely resembles neuralgia major. Usually there is no superficial tenderness; *but when tenderness is present, the sensitive area corresponds to the peripheral distribution of the affected nerve trunk.*

Causes.—Any disease to which the teeth are liable is to be regarded as a cause of **neuralgia minor.** The most frequent causes are chronic inflammation of the pulp and chronic peri-odontitis starting at the gingival margin. General conditions which lower the resistance of the tissues, such as fatigue, rheumatism, and anæmia, increase the intensity of the attacks of pain.

Diagnosis.—The **diagnosis** of the cause of facial neuralgia is important, because the treatment must depend on the cause, and all cases coming under notice should be subjected to a systematic examination. The patient should be questioned as to the character of the pain, in order to discover whether the pain arises from the pulp or from the periosteum. It is also important to ascertain if the pain is periodic, while at the same time the knowledge of its situation is useful in assisting to localize the position of the tooth should the neuralgia be of dental origin. Thus, pain in the infra-orbital or supra-orbital region points to maxillary teeth; pain in the ear, shooting down the shoulder, points to mandibular teeth; while pain over the parietal eminence indicates trouble from either maxillary or mandibular teeth. Next, the teeth must be examined for carious cavities, and should any be found a search should be instituted to discover if any chronically inflamed pulps exist. This examination should be carried out with a mirror and a probe, care being taken to look for approximal cavities near the gum margin. After this, periodontal causes should be excluded by pressing and tapping the teeth and carefully examining the "pockets" around the teeth. Irritability of

the pulp through pathological changes must next be eliminated by looking for exposed surfaces of dentine or cementum. Exposure of the root in local suppurative periodontitis is a fruitful cause of neuralgia (see p. 574). Each tooth should next be tested with heat and cold, and in doing this attention should be bestowed upon teeth containing large metal fillings. In testing with heat, a ball of base-plate gutta-percha should be made hot and applied to each tooth separately; while the test with cold is easily carried out by touching each tooth with a small pledget of cotton-wool dipped in ice-cold water, or spraying with ethyl chloride. If a jet of cold water is used from a syringe, the water will run over two or three teeth at a time, and so prevent ready detection of the offending tooth. It must not be overlooked that most teeth with live pulps, if submitted to the above treatment, will respond to the changes; but when the pulps are healthy, the condition will be quite transient, while, if diseased, the test will probably set up an acute paroxysm of pain. In cases of doubt the neighbouring teeth should be tested as well as the suspected teeth. The pain started in the affected tooth will be greater in comparison to that in the approximal teeth. Suppurative conditions of the periodontal membrane are to be regarded as frequent causes of trigeminal pain. The exposure of the roots leads to irritability of the pulps from thermal and other irritations, while in advanced conditions the pulps may be affected *via* the apical foramen by spread of inflammation from the periodontal membrane.

If a cause has not been discovered by the above-mentioned examination, the absence of third molar teeth, a frequent cause of neuralgia in those between 18 and 30, should be considered. Such causes as morbid conditions of the periosteum of the bony canals through which the nerve passes, and peripheral irritation in other parts of the distribution of the fifth nerve, must next be excluded. Failing these, the presence of antral mischief or tumours in the region of the trunks of the nerve should be looked for, and then the question of organic disease in the brain and neuralgia major considered.

Treatment.—If the neuralgia is dental in origin, the cause must be removed by measures indicated for the treatment of such lesions. When the cause is constitutional, remedies appropriate

to the condition must be adopted. For instance, if arising in connection with general debility, anæmia, or overwork, a general tonic treatment with such drugs as iron, quinine, and arsenic will be beneficial, careful attention being paid to the condition of the bowels. Phenacetin, one of the antipyrin group (10 to 15 gr.), is useful in neuralgias of peripheral origin. If of malarial origin, quinine in large doses, *i.e.*, 5 to 10 gr., will bring immediate relief, and if given before an attack will, in some cases, ward it off, and, in others, greatly minimize its severity. Should there be any suspicion of syphilis, iodide of potassium would be indicated; while with gout and rheumatism the same drug may prove useful. In addition to the internal administration of drugs, local applications may be tried, such as chloral and camphor, in equal parts, aconite and chloroform, or counter-irritants, such as cantharides, capsicum, and mustard. If no cause can be found, and the above treatments fail, the drugs which may be termed "neuralgic specifics" should be tried, amongst these being tinct. gelsemii, veratrina, butyl chloral hydras. In combination with these, such drugs as dilute hydrobromic acid, chloral and bromide of potassium may be given. In more severe cases, electricity, the injection of cocaine or morphia, may be resorted to.

In cases where treatment by drugs fails, the patient continuing in great pain, surgical measures may be adopted. These questions belong to the domain of general rather than dental surgery.

The following articles will repay perusal:—

HEAD, H. "Trigeminal Neuralgia," Allbutt's "System of Medicine," vol. vi, p. 724.

ROLLINSON-WHITAKER, RAY H. "Concerning Cranial Neuralgias," *Brit. Dent. Journ.*, vol. xxx, p. 193.

"Discussion on Neuralgia," Dental Section, British Medical Association, September 9, 1905, p. 546.

CHAPTER XXV

Diseases arising from Sepsis in connection with the Teeth

General Considerations—Conditions attributable to Septic Processes in the Mouth—Affections of the Mouth and Associated Parts—Affections of the Respiratory Tract—Gastro-intestinal Affections—General Conditions arising from Bacterial Intoxication and Infection—Conditions due to the Absorption of Infective Organisms in the Mouth—Diseases which are influenced by the Presence of Oral Sepsis

In the preceding chapters the various pathological processes arising in connection with the teeth have been considered, and in many of these processes septic and infective conditions were shown to exist. These processes or conditions are now commonly denoted by the term "oral sepsis." It is well, therefore, for the student to remember that the term "sepsis" is used in a broad sense, and includes not only septic but also infective processes.

In recent years there has been an increasing tendency to regard the mouth as a focus of infection, and it has been conclusively shown that many obscure pathological conditions are wholly or in part due to absorption of toxins and organisms from mucous surfaces, and that the most important source of infection is the gastro-intestinal tract. Although it cannot be doubted that the intestinal tract may become infected and inflamed without any marked or noticeable "oral sepsis," yet it must be obvious that, given sepsis in the mouth, the chances of infection are greatly increased. It is, therefore, the primary duty of the dental practitioner to see that the mouth is kept as aseptic as possible, and he should be very cautious in undertaking any operation which is liable to produce sepsis.

(A) GENERAL CONSIDERATIONS

A brief consideration of certain general principles may assist the student more readily to understand the means by which

septic processes in connection with the teeth lead to disease, either localized or general in character.

(1) **The Toxic Powers of Bacteria.**—Bacteria, with regard to their toxic properties, may be divided into two groups: The non-pathogenic and the pathogenic.

(*a*) *Non-pathogenic.*—Organisms which, although present in the body, do not under normal conditions cause disease. An example of this type is the *Streptococcus brevis*, a constant inhabitant of the mouth.

(*b*) *Pathogenic.*—These micro-organisms produce toxic substances which cause disease. They may grow on the surfaces, but are more common in abnormal discharges, such as pus. The toxins thus formed may set up local irritation, or they may be absorbed into the general circulation, although the organisms themselves may not gain an entrance to the tissues. To this condition the term "bacterial intoxication" or **toxæmia** is applied. In other cases the bacteria themselves gain entrance to the tissues and form toxins in the tissues, and to this condition the term "bacterial infection" or **bacteriæmia** is applied.

The terms "pathogenic" and "non-pathogenic" can only be regarded as relative descriptions, for there is little doubt that under certain conditions, such as altered environment or association with other organisms, non-pathogenic organisms may become pathogenic.

The toxins formed by the different species of bacteria vary considerably in their virulence; and the virulence of a particular species may also vary, for example, "a streptococcus, which produces merely a local inflammation or suppuration, may produce a rapidly fatal septicæmia when its virulence is raised."

Toxins vary in their affinity for different tissues, for example, the toxins produced by the tetanus bacillus have a special affinity for the spinal cord.

The dose of the infective agent is important; as a rule, the larger the dose the more marked the symptoms.

The nature of toxins is by no means clear. Some observers hold that primary and secondary toxins exist, the primary being of the nature of ferments or enzymes, the secondary the active toxic substances. This view, which is based mainly on the

researches of Dr. Sidney Martin on the action of the organism of diphtheria, is, stated briefly, that the primary agent produced by an organism is a ferment; and that the ferment digests the surrounding proteid tissue and provides the secondary toxins, which are probably of the character of albumoses.

(2) **The Normal Defences of the Body.**—"The human body," to quote Adami, "and indeed the bodies of all multicellular organisms, is to be regarded as a close corporation in which one of the special functions of the outer layer of cellular units is, for the benefit of the whole system, to hinder the entrance of individual organisms of other natures. And here it must be kept in mind that these outer layers are not the external layers only in the usual acceptance of the term, but are all layers bounding surfaces and channels which, however indirectly, communicate with the exterior. The mucous membrane of the stomach and intestines is thus strictly external."

"Living outside this close corporation are countless other individual organisms. On the very surface of the human body, for instance, we know that there exist millions of microbes, mainly bacteria, many of them potentially pathogenic—pyococci, streptococci, *B. coli*, &c. The mouth contains them in abundance—pyococci, streptococci, pneumococci. There may be countless millions in the intestinal canal, but these are outside the body; and, while they find nourishment in the cast-off dead cellular *débris* in certain discharges from the surfaces, and in the food material ingested, they are not taken into the tissues, or, if they gain entrance, there are many mechanisms for arresting their growth and destroying them."

These mechanisms are:—

(*a*) *Surface Discharges.*—A good example of this is the saliva which washes the organisms from the mouth and carries them to the stomach, where the gastric juice kills them. In conditions where the flow of gastric juice is decreased and there is a diminution in the amount of hydrochloric acid, inhibition of the organisms does not occur, and they pass on to the small intestines, where, in the alkaline secretions, they find a favourable medium for growth.

(*b*) *Moistened Surfaces.*—It must be remembered that, in health, **"A certain number of microbes is always gaining admission**

to the tissues; under such circumstances they do not cause infection, as they tend to be destroyed very soon after their reception." Moistened surfaces such as the pharynx and turbinated bones arrest the organisms. The phagocytes pass between the epithelial cells and either take up the organisms or discharge their bactericidal contents. The phagocytes are then swept away by the saliva to the stomach or pass back between the lining cells into the subjacent tissues and are rapidly destroyed. In the intestines the organisms may be arrested—

(i.) In the subcutaneous lymph nodes.

(ii.) In the mesenteric and retroperitoneal lymph glands; or

(iii.) In the venous radicles of the portal vein, where the endothelial cells arrest the leucocytes with the contained bacteria.

In addition to the destroying agencies mentioned above there are other means at work to prevent infection. The following summary is given by Adami:—

(i.) Physical and bactericidal action of the discharges of the body.

(ii.) Structure of the surface layer.

(iii.) Bactericidal activities of the wandering cells.

(iv.) Phagocytic and bactericidal action of the lymphoid cells and vascular endothelium.

(v.) Bactericidal and excretory action of the cells of certain excretory glands (*i.e.* liver, kidney).

(vi.) Antibacterial powers of circulating fluids of the body.

(3) Modes of infection.

(*a*) *An alteration of surface discharges and excretions* in quality and amount causing microbes to—

(i.) Unduly proliferate on the surface, so

(ii.) Producing toxic matter, and so

(iii.) Affecting the surface cells. These are lowered in their vitality and perhaps destroyed; and the microbes thus allowed to gain a focus of growth within the tissues. From the tissues the organisms may pass into the lymphatics, and so eventually into the blood-stream. An example is to be seen in the alterations in the secretions of the mouth resulting from mouth-breathing.

(*b*) *Traumatic solution of continuity of the surface layers.*

Here (i.) the protective layer has disappeared, and (ii.) in the

surface discharge a favourable medium exists for growth of the organisms. In cases of traumatic solution of the surface the organisms may pass into the blood-stream either (*a*) *directly* by passage into a blood-vessel, or (*b*) *indirectly via* the lymphatics.

(*c*) "*Cryptogenic Infection.*"—This term is used to denote growth of bacteria and infection in an internal organ with no recognizable solution of continuity of a surface. This, as previously pointed out, is constantly going on. **Infection occurs** however, when

(i.) There is an excessive number of virulent organisms at one surface region.

(ii.) When the mucous surface is so damaged as to permit the passage of an increased number of leucocytes to the surface; these re-enter the tissues with the microbes.

(iii.) When the microbes accumulate at one spot, or, owing to recurrent deposit, the bactericidal power of the cells in that region has become exhausted.

(iv.) The temporary or habitually lowered vitality of the tissues of such a region antecedent to the introduction of the microbes.

To sum up: **The degree or nature of infection depends upon the relation of the virulence of the organisms to the resistance of the tissues.**

If we apply these general considerations to the mouth we shall find that many of the dental lesions recorded in previous chapters are sufficient—

(1) To provide the necessary infection; and

(2) To affect directly or indirectly the normal defences of the body, and so permit local or general intoxication or infection.

In most pathogenic processes in the mouth there is a great increase in the number of organisms. Goadby has shown that, in certain morbid processes, the bacteria possess only a slight degree of virulence and, although this may be quite true, nevertheless it must be clearly kept in mind that, as stated above, the toxic powers of such organisms may, under suitable conditions, become markedly increased. There is ample evidence, too, that the mouth bacteria may gain entrance to the blood-stream.

It may reasonably be asked why "oral sepsis" does not more often lead to remote conditions. The answer is to be found in

the general defences of the body against infection. As long as the reaction of the tissues is sufficient to neutralize the toxic products or destroy the bacteria a normal standard of health may apparently be maintained. It would seem, however, that reaction to infection cannot be continued indefinitely, and that eventually the defences break down, and infection results. Such a proceeding would fully account for cases in which a septic condition of the mouth has existed for years without giving rise to any remote condition, and has then been followed by a rapid decline in health and the appearance of a definite lesion. The fact that the mouth is immune to disease to an extraordinary degree has already been referred to in the chapter on saliva, but even here the defences break down under continued strain, and serious local pathological conditions arise.

(B) CONDITIONS ATTRIBUTABLE TO SEPTIC PROCESSES IN THE MOUTH

The conditions attributable to septic processes in the mouth may for convenience be considered in groups :—

(1) Affections of the mouth and associated parts.

(2) Affections of the respiratory tract.

(3) Affections of the gastro-intestinal tract.

(4) General conditions arising from bacterial intoxication or infection.

(5) Conditions due to the absorption of infective organisms in the mouth.

(6) Diseases which are influenced by the presence of oral sepsis.

(1) Affections of the Mouth and Associated Parts

By the spread of infection along the surface pathological changes in the mucous membrane of the pharynx and larynx may arise, and, by extension down the Eustachian tube, ear trouble may be started.

The constant damage to the oral epithelium would seem in a few instances to be closely associated with the appearance of epithelioma. In cases of **squamous-celled carcinoma** starting in the buccal surfaces of the cheeks there is invariably a history

of long-continued sepsis in connection with the adjacent teeth, and, although many of these patients are syphilitic, the constant association of oral sepsis with the carcinomatous condition strongly suggests that a relationship exists between the two conditions.

In the majority of septic processes already described, the damage to the tissue is restricted to the neighbourhood of the tooth, the reaction of the tissues being sufficient to hold the infective process in check. Occasionally this defence breaks down, and the infection extends into the deeper parts, and a **spreading cellulitis** ensues. In connection with the mandibular teeth, the submaxillary region and deeper tissues of the neck may become involved. The suppuration may spread below the deep cervical fascia, leading to a condition known as "angina Ludovici." In the maxilla the **infection may spread to the orbit** *via* the antrum.

The path of transmission is either through the lymphatic system or by the veins. The toxic products in the antrum create a spreading phlebitis in the plexus of veins situated in the mucous membrane of that cavity. The morbid process enters the orbit either along a direct venous communication through its floor or by means of the facial vein, the facial vein being intimately connected on the one hand by anastomoses with the antral veins, and on the other hand with the orbit, either through the angular vein or by its connection with the pterygoid plexus of veins. The infection may spread by a more superficial route through the periosteum of the maxilla, leaving the antrum unaffected.[1]

Orbital periostitis and cellulitis are the most common of the troubles which come under this heading. The inflammation may vary greatly in character and intensity, and may be considerably modified by external influences. A diffuse suppurative cellulitis may be set up, and involve all the contents of the orbit, threatening the life of the patient by meningitis or septic thrombosis of the cavernous sinus. It is probable that orbital periostitis, either alone or attended by cellulitis, occurs as a complication of dental caries more commonly than is generally

[1] See case recorded by N. Bishop Harman, *Brit. Med. Journ.*, September 25, 1909, p. 878.

supposed. A severe case of suppurative orbital cellulitis of dental origin was recorded in the *British Medical Journal* (October 19, 1895) by Messrs. Morton Smale and Juler. The disease may assume a much more insidious form, and may be unattended by proptosis, limited movement, diplopia and the other common manifestations of orbital cellulitis. It may, on the other hand, cause changes in the fundus oculi, viz., papillitis, neuro-retinitis, or choroiditis.

Certain cases of **acute retro-bulbar optic neuritis** are probably secondary to orbital cellulitis of dental origin. **Ocular muscular paresis,** involving one or more of the extra-ocular muscles, may arise from infection around the teeth spreading to the orbit. A case of paresis of the orbicularis palpebrarum is reported by Ely, in which the paresis disappeared on the evacuation of a dento-alveolar abscess.

Absorption of toxins via the lymphatics may lead to lymphadenitis, either acute or chronic in type.

The glands affected by the teeth and gums are :—

(*a*) *Submaxillary group,* situated in the digastric triangle and running along the margin of the mandible in close relationship with the salivary gland. Into this group drain the lower gums, lips, floor of the mouth, sublingual and submaxillary salivary glands, and lympathics from the tissues around the roots of the teeth. This group of glands send their lymph partly into the superficial and partly into the deep cervical glands.

(*b*) *Supra-hyoid or submental group,* three or four in number and situated between and superficial to the anterior bellies of the diagastrics. Into these drain the central portions of the lower gums and lips and the tip of the tongue.

(*c*) *Parotid group,* some of which are situated superficially and others more deeply in the parotid gland. Into these may drain the lymphatics from the region of the maxillary molars.

(*d*) *Superficial cervical* along the external jugular vein, receiving lymphatics directly from the gums and indirectly *via* the submaxillary, but principally from the scalp and skin of the neck.

(*e*) *Deep cervical* over the internal jugular vein. Into these, lymph is received from the gums directly or *via* the submaxillary glands.

Acute lymphadenitis is met with usually in connection with acute septic conditions of the teeth, but it may be due to the suppuration of a gland which has been chronically inflamed.

Chronic lymphadenitis is more frequently met with, and is important because such glands frequently become the seat of tubercle. In examining statistics dealing with this question, one finds a considerable difference of opinion as to the exact relationship of carious teeth to chronic lymphadenitis. It is possible that this difference of opinion is to be attributed to the personal equation, and arises not so much from a difference of the facts as a difference in observation of the facts; thus, a gland which one observer would describe as enlarged would by another be regarded as not abnormal. It is questionable whether a gland should be described as enlarged simply because it is palpable. The most satisfactory test would seem to be to put the skin on the stretch, and if the gland can then be seen, to consider it as enlarged. This test may be carried out as follows: If the glands on the right side are involved, turn and stretch the head towards the left and look at the neck with the light athwart. If the gland causes irregularity of the surface it should be considered as enlarged.

Because carious teeth are associated with chronic lymphadenitis, it does not follow that the glandular enlargement is directly attributable to the teeth; infection from the tonsils, and adenoid tissue around, is probably as frequent a cause of lymphadenitis as septic teeth.

In cases where the enlarged glands become the seat of tubercle, the infection probably reaches the glands *via* the blood-stream and not direct *via* the lymphatics. There is a growing impression among pathologists that the tubercle bacillus gains an entrance to the body by way of the alimentary canal. The glands damaged by the absorption of toxins are in a state of diminished resistance, and are, therefore, liable to become infected by the tubercle bacillus contained in the blood-stream,[1] but in whatever way the tuberculous organisms reach the place, the constant association of oral sepsis with tuberculous glands is an indisputable and important fact.

[1] See "The Etiology of Pulmonary Tuberculosis," Sir William Whitla, *Lancet*, July 18, 1908.

(2) Affections of the Respiratory Tract

The liability of operations on the tongue and jaws to be followed by septic bronchitis or septic pneumonia is no doubt due to the inhalation of moist particles carrying bacteria. Pneumonia occasionally follows prolonged etherization. This condition is probably brought about through the ether vapour lowering the vitality of the tissues of the bronchi and finer tubes, and so rendering them more susceptible to infection. The more aseptic the condition of the mouth the less the liability to infection, and it is therefore obvious that the mouth should always be thoroughly disinfected before anæsthetization.

(3) Gastro-intestinal Affections

Gastritis.—There is ample evidence to show that a close relationship often exists between oral sepsis and gastric affections. In many instances the gastric condition is the direct result of the constant presence of septic and infective saliva, and cases are constantly occurring in practice in which, with the removal of the oral sepsis, the gastric condition completely clears up. In such cases the chain of events is probably as follows: The food, imperfectly masticated and incorporated with infected saliva, undergoes excessive fermentation, with the result that, sooner or later, a catarrhal inflammation of the gastric mucosa is started. The chronic gastritis is probably of the mucous variety in which the acidity is always slight, a point of considerable importance as far as the inhibition of the microbes is concerned. The catarrhal inflammation is kept alive by the constant presence of the septic matter, and may become infective in character. There is reason to believe that sepsis from the mouth is the cause of ulcer of the stomach found in old people, but the gastric ulcer seen in young girls no doubt arises from some other cause, as, in a large proportion of the latter cases, the mouths are clean. But whatever the cause of the gastric ulcer, it is probable that healing would be retarded or prevented when the ulcer is associated with oral sepsis.

As pointed out above, the gastric juice under normal conditions inhibits or destroys the majority of organisms entering the stomach, so that the number passing into the duodenum is

relatively small. The effect of gastritis[1] is to interfere with this bactericidal power of the gastric juice, with the result that there is an increase in the number of organisms passing through the pyloric opening, and consequently a greater risk of infection in the small intestine.

At times the gastritis is of an infective character, and such a case is quoted by Dr. Hunter,[2] in which he considers that the gastritis was distinctly traceable to the mouth condition. The following is the history of the case: "This was a case of subacute gastritis in a woman, aged 62. The patient suffered from severe intermittent sickness and gastric pain, necessitating the use of morphia, lasting eight months, with loss of weight and increasing weakness. Cancer was suspected, but on examination no sign of malignant disease was visible in the stomach, the abdomen, the rectum, or the uterus. Constant complaint was made of a bitter taste in the mouth, nausea, and loathing and distaste for food. The vomit in this case was loaded with streptococci, staphylococci, and a few bacilli. The only teeth present were three roots, around which there was a free discharge of pus. With the removal of these teeth the gastric condition rapidly improved." In this case it would seem that the mouth condition was responsible for the infection of the gastric mucosa which, owing to persistent damage, had been deprived of its natural powers of resistance and so rendered susceptible to attack.

There is every reason to think that a duodenitis may result from the increased number of organisms passing through the pylorus, and that the infection may spread along the common bile-duct and cystic duct to the gall-bladder. A chronic cystitis is started, a condition which, pathologists maintain, is necessary for the formation of gall-stones. It seems probable that infection may spread along the pancreatic duct and give rise to a pancreatitis, which will cause pressure on the common duct and thus lead to jaundice. This view is supported by the fact that,

[1] Hankin, as quoted by Adami, found that, in normal health, he could swallow billions of living virulent cholera spirilla without ill-effect. Repeating the experiment when he was suffering from transient gastric catarrh he developed acute diarrhœa with spirilla in the fæces.

[2] *Lancet*, January 27, 1900.

in many cases of jaundice, Cammidge's pancreatic reaction[1] may be obtained. The passage of the toxic products from the stomach, in addition to starting a duodenitis, may lead to an enteritis and, possibly, colitis. P. Daniel[2] maintains that in cases of oral sepsis the lower part of the ileum is always in an injected state.

With a general gastro-enteritis established, toxic matter will be produced in abundance, which, on being absorbed, will initiate various general lesions. These lesions it is proposed to discuss in the next group. To sum up briefly, it would seem that oral sepsis leads to gastritis, and that the latter condition leads directly or indirectly to a general inflammation of the intestinal canal. It is in the intestine that the toxins are produced in greatest quantity, and it is from this area that they are mainly absorbed.

(4) General Conditions arising from Bacterial Intoxication and Infection

Chronic Toxæmia.—Many patients with marked oral sepsis exhibit a condition where there are no definite symptoms, but yet there is a general feeling of ill-health. There is a lack of energy, a general condition of mal-nutrition, a sallow, unhealthy appearance, and, invariably, a history of gastro-intestinal disturbance. This condition may be regarded as the result of the continued absorption of small doses of toxins and should be classed as a *chronic toxæmia*. This toxæmia is probably due to (1) absorption of toxic products of organisms; (2) absorption of toxins produced from abnormal digestive processes. With the disappearance of the oral sepsis there is a rapid improvement in the gastric condition and the general health; the improvement, be it noted, commencing before the insertion of dentures. In these cases the extraction of the teeth not only eradicates the main source of toxins from the mouth, but also, by removing the cause of the gastro-intestinal condition, stops the formation and absorption of toxins from that area.

Chronic Rheumatism.—There is every reason to believe that many of those ill-defined conditions embraced by the terms "chronic rheumatism" and "muscular rheumatism" owe their

[1] In certain pancreatic lesions the kidneys secrete a substance which, in hydrolysis, gives the reaction of a pentose.

[2] *Lancet*, January 15, 1910.

origin to sepsis, and that the focus of infection is often in the mouth. It is a common experience to find that such conditions clear up with the removal of the oral sepsis. For example, a patient, a woman, aged 40, had suffered from tarso-metatarsal rheumatism to such a degree as to render walking unbearable; with the removal of a well-marked general suppurative periodontitis, the foot condition completely disappeared.

Anæmias.—In a series of papers communicated during recent years to the various journals, Dr. W. Hunter[1] has drawn attention to the association of oral sepsis with severe anæmias.

Septic Anæmia.—Under this name he describes a condition in which the "septic factor" is predominant, and owes its origin to sepsis in connection with the oral, gastric, and intestinal tract. This anæmia in its severe forms is characterized by (1) "an oligocythæmia comparable to that found in Addison's anæmia, including the existence of poikilocytes, normoblasts, and at times megaloblasts"; (2) hæmorrhages; (3) dirty yellow and anæmic complexion; (4) the frequent existence of oral, gastric, and intestinal sepsis and symptoms; (5) fever; (6) the severe and often fatal course the disease takes; (7) nervous effects and symptoms in many cases; (8) favourable prognosis if the cause is removed in time; (9) chronic nephritis; (10) *absence of the hæmolytic and bone-marrow changes found in progressive pernicious anæmia.*

The relationship of the anæmia and oral sepsis is shown by the rapid improvement which follows the removal of the sepsis.

Clinical evidence, according to Dalton, goes to show that septic processes in the alimentary tract are more liable to produce anæmias than septic processes in other parts of the body. The theoretical explanation advanced to account for this fact is as follows:—

(1) Anæmia is due to defective formation and not to destruction of the blood-cells.

(2) The toxins from the mouth and alimentary canal are not only absorbed but also mix with the food and thus seriously affect

[1] *Lancet*, January 27, February 3 and 10, 1900. "A Discussion on Pernicious Anæmia and Allied Conditions," *Brit. Med. Journ.*, November 9, 1907, p. 1299. "Oral Sepsis as a cause of Disease in Relation to General Medicine," *Brit. Med. Journ.*, November 19, 1904, p. 1358.

nutrition and the assimilation of the particular food elements which go to form the blood.

Idiopathic or Progressive Pernicious Anæmia.—Hunter regards this type of anæmia as "a specific, hæmolytic, infectious disease, localized to the alimentary tract, with characteristic mode of onset, clinical features and course; hæmolytic and infective lesions."

"Its features include the blood changes above mentioned in connection with 'septic anæmia,' generally more marked and of greater severity than in septic anæmia. They include, however, certain features which mark it off from simple septic anæmia. (1) An intense hæmolysis, accompanied by pigment changes in the liver, kidney and spleen—these changes being no less characteristically absent in 'septic anæmia,' even the severest forms. (2) A chronic septic infection associated with a specific glossitis and oral, gastric and intestinal sepsis."

In this anæmia Dr. Hunter does not consider that septic infection from the mouth or intestinal tract, however severe, can be held to be the direct cause of the disease. In the disease, however, there is often an antecedent history of oral, gastric or intestinal troubles, and he considers that they possibly play an important *rôle* in the onset of the disease.

Arthritis.—The form of chronic arthritis in which several or all of the joints are attacked is considered by many to be septic in origin. The focus of infection is at times to be found in the mouth, and many cases undergo marked improvement with the removal of the oral sepsis and the resulting improvement in the gastro-intestinal conditions. It is not to be assumed that oral sepsis is the cause of all cases of chronic polyarthritis, the focus of infection often being in other parts of the body, and frequently in the genital tract. In cases due to sepsis from the mouth there is invariably a history of gastritis over a long period preceding the onset of the joint condition.

(5) Conditions due to the Absorption of Infective Organisms in the Mouth

The conditions already described are probably due to the absorption of toxins. We must now consider the conditions that may arise from the direct absorption of the infecting organisms

themselves. In discussing certain general conditions attention was drawn to the manner in which the microbes themselves might pass into the blood-stream. In the mouth, conditions often exist which favour this absorption, notably in cases of advanced periodontal disease. It does not therefore seem unreasonable to suppose that, in localized infection in other parts of the body, the mouth is often the focus of infection. In fact it is very probable that such is the case, but definite proof of the connection is difficult to obtain.

Malignant Endocarditis and Septicæmia.—The organisms identified with these conditions are various and indicate that the disease is not due to any one special organism, but simply to pyogenic infection. In cases reported, the clinical and *post-mortem* evidence suggest that the focus of infection was the mouth. It is interesting to note that H. P. Pickerill[1] found in one case of acute septic endocarditis a staphylococcus, *Streptococcus brevis* and a short bacillus (? the *Bacillus necrodentalis* of Goadby) present *post mortem* in the mouth, bronchi, the alveoli of the lungs, and on the valves of the heart.

That general infection may result from lesions associated with the teeth is shown by cases which have been reported from time to time. The majority of these cases have been in connection with acute dento-alveolar suppuration.

The suppuration of a chronic character such as is seen in general periodontal disease (pyorrhœa alveolaris) must, however, also be regarded as a potential cause of general infection. A case of this type is recorded by Dr. G. Bellei,[2] and is sufficiently instructive to record, as it demonstrates the sequence of events: (*a*) Suppurative periodontitis; (*b*) septic tonsillitis; (*c*) general infection.

The patient was a man, aged 48, who had been in good health until the age of 40 years, when he began to suffer from chronic inflammation of the gums and the maxillary alveoli, accompanied by the formation of pus. At the age of 45 years his right testicle was removed because it was found to be affected by tuberculosis. He made a good recovery after the operation, and, apart from his dental trouble, his health was satisfactory. One day he was attacked with a severe sore throat, which he did not treat in any way, but went to his business as usual. In the evening he had a violent fit of shivering

[1] *Brit. Med. Journ.*, February 13, 1909, p. 394.

[2] *Lancet*, March 22, 1902.

followed by high temperature, and it was obvious that the sore throat and pyrexia were caused by a phlegmon of the pharynx. In the course of the next few days an abscess formed in the right tonsil. This abscess was opened four days after the beginning of the inflammation of the pharynx; a moderate quantity of pus escaped, and this, on cultivation, showed the presence of a very small streptococcus and of a saccharomyces. After the operation the patient felt very much better, the pain in his throat subsided, so that he became able to swallow, and his temperature, which had hitherto been about 100° F., fell to 98°. But about 7 a.m. next day he was suddenly seized with a shivering fit, followed by a rise of temperature to 104°. The suspicion of a general infection produced by one of the micro-organisms that had been found in the pus of the abscess was suspected, and with a view of confirming the diagnosis some blood was taken from a vein of his left arm. As it seemed probable that the infection was due to the streptococcus, the use of Marmorek's serum was begun in order not to lose time. In the first twenty-four hours 50 c.c. were injected, but the patient's condition grew worse, and his temperature remained permanently high, being always about 104°. The use of Marmorek's serum was continued during the next two days, but in spite of it the patient died from failure of the heart, unaccompanied by any localized lesion.

The micro-organism isolated from the blood was a streptococcus, which had the same microscopical character as that found in the abscess.

(6) Diseases which are Influenced by the Presence of Oral Sepsis

In this section reference will be made to conditions which, although not directly caused by oral sepsis primarily or secondarily through the intestinal tract, are nevertheless probably influenced in their course by septic conditions in the mouth. The way in which this influence is exerted is *via* the blood-stream. When the blood-stream is charged with toxins, a part of the body which is lowered in its resistance by local injury may obviously be hindered or prevented from reacting by the constant irritation of toxins brought to it by the blood-stream. Cases of phlyctenular conjunctivis, and certain forms of iritis which rapidly recover on the removal of the oral sepsis, are probably due to such irritation. Cases of alopecia areata, amenorrhœa, &c., have been recorded as due to the absorption of sepsis from the mouth.

Speaking generally, it may be said that the course of all diseases may be influenced by oral conditions. Recovery depends upon the reactive qualities of the tissue, and it is logical to suppose that such reactive qualities must depend very largely upon the quality of the substances absorbed from the whole

intestinal tract. In acute illnesses, such as the exanthematous fevers, and conditions such as septicæmia and pneumonia, the prognosis must necessarily be greatly influenced by the presence or absence of oral sepsis. Thus, it has been shown by Dr. Hunter that in scarlet fever the severity of the mouth lesion and the duration of the disease are markedly influenced by oral sepsis. Again, in diphtheria, the symptoms vary in intensity. The intensity may depend upon the relation of the individual resistance and the toxicity of the organisms in it may depend upon a secondary or superadded infection. It is clear, therefore, that with a septic mouth severe forms of this disease are more likely to occur. Further, it is probable that oral sepsis, by chronically damaging the mucous membrane of the fauces, produces a favourable medium for the growth of the diphtheria organism.

The importance of oral sepsis in connection with acute pneumonia cannot be doubted. The fevered mucous membranes, the rapid breathing, the open mouth, the frequent expectoration, are in themselves sufficient to lead to unhealthy oral conditions; but add a pre-existing oral sepsis and the condition of the patient becomes deplorable, and the prognosis infinitely less hopeful. In typhoid fever also the added sepsis must be of serious moment, and is possibly responsible for the recurring rises of temperature at times seen at the commencement of convalescence.

In common anæmias and many cases of mal-nutrition little or no improvement follows treatment by drugs should oral sepsis be in existence; indeed, the removal of the oral trouble in itself is often sufficient treatment.

It must not be forgotten that certain forms of chronic constipation are dependent upon a chronic colitis leading to excessive formation of mucus. The chronic colitis may in itself be secondary to oral sepsis and be permanently incurable without removal of the oral trouble.

To sum up, it seems to be clearly proved that oral sepsis is one of the main factors in the establishment of gastro-intestinal disease and that the absorption of toxic matter from the alimentary tract is one of the most important etiological factors in the whole realm of pathology.

With a view of relieving the text, detailed accounts of cases supporting the statements contained in this chapter have been omitted. *The following articles are given for reference*:—

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CHAPTER XXVI

Diseases arising from Reflex Irritation from the Teeth

Affections of the Nervous System—Affections of the Ear—Affections of the Eye

In past years various lesions of the eye, ear and other organs were attributed to reflex irritation from the teeth. In reading the recorded accounts of many of these cases, one is driven to the conclusion that the diagnoses were often fallacious, and that diseases which were merely coincident were frequently wrongly associated in a causal relationship. The histories of the cases, when read by the light of modern pathology, would suggest that, in the majority of the cases, the lesions attributed to the teeth were the result of septic absorption rather than reflex irritation.

(A) AFFECTIONS OF THE NERVOUS SYSTEM

Epileptic and Convulsive Seizures.[1]—It is quite possible that epilepsy may be induced by dental as by any other peripheral irritation. Dr. Brown Sequard found that, after section of one of the lateral columns of the cord anywhere between the medulla and tenth dorsal vertebra, epilepsy could be induced by very slight irritation of the fifth nerve. The following case is recorded by Dr. Bakewski[2]:—

"A young female had suffered from epileptic seizures for nine months, the fits having increased in frequency, there being several every day. The usual drugs were tried without effect. Finally, the teeth were examined and the right maxillary first molar and the left mandibular first molar were found to be carious. These were removed and the fits ceased entirely and did not return, the patient being kept under observation for six months subsequently. Upon being closely questioned, the girl remembered that before the fits commenced she had had some unpleasant sensations in the affected teeth, but nothing that could be described as pains."

[1] The cases recorded under this and subsequent headings have been introduced in order that the student may gain some idea of the evidence on which the relationship between reflex dental irritation and other diseases is based.

[2] *Journ. Brit. Dent. Assoc.*, vol. xii, p. 280.

The following case is related by Ramskill[1] :—

"A boy, aged 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 faceache, 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 recognized till some degree of inflammation arose, thus a modification of pain became associated with the aura and directed attention to it."

A case of some interest also came under the observation of Mr. Morton Smale:—

"A patient, aged 22, a male, always showed distinct signs of *petit mal* during the operation of filling, the symptoms being always more marked if an exposed nerve were touched. This patient, to the best of his recollection, had never suffered at any time with epilepsy, or had had fits of any other character."

In persons subject to epilepsy it is not uncommon for a fit to be induced by the irritation attending dental operations.

Hysteria.—Cases of hysteria supposed to arise from dental irritation have been recorded. Hysteria is such an obscure condition that it is quite conceivable that continued pain from dental trouble might act as an exciting cause in a patient predisposed to hysteria.

Chorea.—Some medical writers are of opinion that chorea may in some instances be connected with dental irritation. Chorea is a functional condition and it is quite possible that the dental lesion may induce chorea, either directly by reflex irritation or indirectly by lowering the vitality. The following case, quoted in the "American System of Dentistry," would seem to indicate that the dental trouble was intimately connected with the choreic condition. The case is related by Dr. C. N. Pierce[2] :—

"A boy, aged 9, had always been in good health until two years ago, when he was attacked with choreic movements chiefly in the muscles of the face,

[1] "*Medical Times and Gazette*, 1862, vol. ii, p. 216.

[2] Vol. iii, p. 598.

though present also in the muscles of the neck and shoulders. Owing to their local character, and the absence of the causes usually assigned for the appearance of chorea, it was thought possible that the condition of the teeth might offer some explanation of the trouble. Careful examination of the mouth revealed, in addition to considerable overcrowding of the teeth, persistence of the deciduous incisors. Upon their removal the choreic movements at once subsided. After an interval of a year there was a return of the symptoms. Examination of the teeth again showed a persistence of the deciduous molars delaying the eruption of the premolars. Removal of the offending teeth was followed by complete recovery."

Spasmodic Closure of the Jaws.—The following case was reported by Dr. Ewart:[1]—

"The patient, a man, aged 47, moderately addicted to alcohol, was suffering from an extensive chronic ulcer of the right leg. His illness began with a 'severe cold' three weeks before his admission into St. George's Hospital on September 20, 1899. The trismus set in quite suddenly during the night a week later, when he awoke in a fit of suffocation due to the closure of his lips unsupported by teeth. The same nocturnal attacks continued to occur in the hospital for five weeks. The rigidity of the jaws, of the floor of the mouth, of the platysma of the neck, and of the abdominal muscles was intensified by excitement, but there was neither opisthotonos nor any spasm of the limbs. Speech, respiration and alimentation were much impeded, leading to loss of flesh and weakness. There was a tender and slightly swollen spot on the gum, and the case was diagnosed from the first as one of reflex spasm due to periosteal irritation and tenderness at the left posterior extremity of the upper jaw, and local treatment was recommended. This was finally resorted to, after various remedies had proved ineffectual, at the end of October, and the symptoms rapidly disappeared after the tender gum had been freely incised."

This case was probably purely reflex, the absolutely edentulous and healthy condition of the gums excluding the theory that septic infection from the mouth was the cause of the spasmodic closure of the jaws.

Many cases of so-called trismus arising from the teeth are not due to spasm of the masseter muscles as is usually supposed. The closure of the jaw in most of the cases arises from infiltration of the muscles and tissues around; the interference with the movement of the jaw being due partly to mechanical impediment from the inflammatory products and partly to involuntary closing of the jaw on the part of the patient.

Paralysis of the Arm.—In the chapter on odontalgia reference was made to the occurrence of pain in the arm, which was traceable to the teeth. It is interesting to note that cases

[1] *Brit. Journ. Dent. Sci.*, January 11, 1900.

of supposed paralysis of the arm have been recorded as due to dental lesions. Salter[1] records the following:—

> "Miss B., aged 24, consulted me on October 15, 1864, respecting the left lower wisdom tooth, and the symptoms to which it had apparently given rise. The tooth had pierced the gum, but it was low down and placed horizontally, the crown pressing forwards against the second molar. The tooth was carious. From the first attempt at the eruption of this tooth there had been much pain of the ordinary kind about the angle of the jaw; latterly it had been intense, and for a fortnight there had been paralysis of the left arm; the patient complained of total inability to use the arm, to raise it or grasp with the hand; she could not employ the limb in dressing herself, and could not hold her fork at dinner. There was also a continuous pain of the whole arm resembling rheumatism. The tooth was extracted, but with extreme difficulty. As soon as the patient recovered from the pain of the operation she declared that the arm symptoms had vanished completely."

Mr. J. H. Mummery records[2] that whenever he suffered from bad pain in a left lower molar he could raise his arm only with great difficulty and experienced a sense of weight and fatigue in the arm almost amounting to pain.

In Salter's case, as in many similar records, no electrical examination of the muscles could be recorded. Before arriving at a diagnosis of paralysis it would always be well to exclude hysteria, and carefully to ascertain that the case is not one where the part is involuntarily kept inactive in order to avoid pain.

Spasm of the Sterno-mastoid (Wry-neck).—A case of spasm of the sterno-mastoid has been recorded by Hancock.[3] The patient, a woman, had suffered considerable pain in the left shoulder, apparently owing to the presence of a carious tooth on the left side of the mandible. The head was drawn down nearly to the left shoulder. On removal of the tooth the condition disappeared. In this case, as in others recorded, there was probably no true spasm of the sterno-mastoid, the head being placed involuntarily in the bent position as a result of the pain.

Tonic Spasm of the Upper Extremities.—In the following case the spasm of the muscles would seem to have been related to the pulp irritation:—

[1] "Dental Surgery and Pathology," p. 264.
[2] *Brit. Med. Journ.* September 9, 1905.
[3] *Lancet*, 1859, p. 80.

"A robust, strong man of 29, who was not in the least nervous, suffered from toothache, caused by an exposed pulp in the upper left third molar. During repeated attempts at luxation of the tooth, which was fixed very firmly, the forceps slid off and struck directly into the pulp. There was at once a tonic cramp of the flexor muscles of all fingers on both hands. Especially the left hand was closed so tightly that the patient could not open it, whilst he had some difficulty in opening the right. The flexibility of the arms was also affected. The patient, describing his condition, said he felt as though a very strong electric current passed through his head and arms, or as if the latter had pins and needles in them; a painful condition which caused the patient, usually showing great powers of endurance, to groan pitifully. Concentrated carbolic acid was applied to the pulp, whereupon the cramp gradually ceased. On the tooth being extracted the patient became normal, and could follow his business undisturbed all day long."[1]

(B) AFFECTIONS OF THE EAR

Affections of the ear due to reflex irritation from the teeth are uncommon, and in a large number of cases formerly attributed to reflex irritation from the teeth it is probable that septic absorption from the teeth only acted as an aggravation of a condition started by other causes.

Otalgia.—Otalgia is frequently traceable to teeth. Politzer states[2] that carious teeth are the most frequent causes of otalgia in children. In cases of otalgia, where there are no inflammatory or other abnormal phenomena in the ear itself to account for the trouble, the teeth should always be examined, as under such conditions the otalgia is invariably connected with the teeth. Even when there is evidence in the ear to account for the otalgia, the possibility of the teeth aggravating the pain should not be forgotton.

Deafness without any definite lesions in the ear is at times apparently traceable to reflex trouble from an unerupted third molar. In a case under my care a patient developed what she termed a "worry" in the ear, which interfered with hearing. The ear was free from organic disease, and the only possible cause in the mouth was an unerupted misplaced third molar. With the eruption and removal of this tooth the symptoms passed away. Mr. J. Howard Mummery[3] records a case of considerable deafness on the left side, which had existed for months in association with the delayed eruption of the third

[1] This case was recorded by G. Randorf in *Items of Interest*.

[2] Edition, 1909, p. 686. Translated by Messrs. Baillie and Heller.

[3] *Brit. Med. Journ.*, September 9, 1905, p, 553.

maxillary molar. The hearing was much relieved immediately on the extraction of the tooth and was fully restored the same day.

(C) AFFECTIONS OF THE EYE

Lachrymation.—Apart from an emotional flow of tears from the distressing pain of odontalgia, the eyes will occasionally become suffused with tears through sudden pain caused by biting on a sensitive tooth. This is similar to the reflex overflow of tears produced by pungent vapours, *e.g.*, strong ammonia.

Spasm of the Orbicularis palpebrarum: Blepharospasm.—Excessive blinking is a mild variety of chronic spasms of the orbicular muscle of the eyelids. Knies has seen a case of this kind disappear immediately after the removal of a painful tooth.

Blepharospasm is occasionally traceable to reflex dental irritation, and in such instances can be cured by attention to the teeth. Blepharospasm may, however, occur in elderly people with edentulous jaws. In these cases it is supposed that the osseous sclerosis present causes the spasms reflexly by the imprisonment of filaments of the dental nerve. Such cases are difficult, in fact almost impossible, to cure. The spasm involves not only the orbicularis palpebrarum, but many of the other muscles supplied by the facial nerve. It varies from slight twitching of the orbicular muscle to a violent spasmodic contortion of the whole side of the face. It is usually asymmetrical, and is seen more often in elderly females. It has no association with *tic convulsif*.

Spasmodic contraction of the internal rectus muscle is manifested by an internal or convergent strabismus. A squint not infrequently develops during the period of the eruption of the deciduous molars, and many mothers assert that the squint is due to the dental irritation. This is true only so far as the disturbance created by the eruption of the teeth acts as the determining cause of the strabismus. The fundamental cause, hypermetropia, being present, any condition which impairs the health of the child and interferes with the disestablishment of convergence (a dissociation which must inevitably take place to avoid a squint) must lead to convergent strabismus. Convulsions, measles, whooping-cough, adenoids, &c., are all in turn credited as the cause, and early dentition is perhaps as common a determining cause as any.

Spasm of Accommodation.—Spasmodic contraction of the ciliary muscle, similar to spasm of the internal rectus, seems occasionally to have a reflex dental origin. Attention to the teeth will sometimes cause a chronic ciliary spasm to relax, and a troublesome case of apparent myopia to be cured.

Paresis of the Levator Palpebræ Superioris.—Hancock[1] and Nicol[2] have each recorded a case of ptosis which disappeared after the treatment of carious teeth. In all probability, however, the ptosis in these cases was purely functional.

Paralytic Strabismus.—It is impossible for a paralytic squint to be produced reflexly from any source of irritation, though some observers think that they have seen a paralysis of an ocular muscle produced by dental irritation. Such cases are probably due to direct continuity of disease (see p. 748).

Muscular insufficiency with diplopia has been attributed to painful carious teeth.

Paresis of Accommodation. — Accommodative failure, attended by asthenopia, is recognized by many surgeons as due to diseases of the teeth. Schmidt[3] found it present seventy-two times in ninety-two cases of dental caries. It probably results, as Knies[4] suggests, from the lack of vigorous innervation on account of the distressing pain. On the other hand, Priestly Smith found unimpaired accommodation in fifteen out of sixteen cases of odontalgia.

Amaurosis and Amblyopia.—Amaurosis, or complete functional loss of sight, and amblyopia or impaired visual acuity, are two functional conditions which have over and over again been attributed to reflex dental irritation. There are a great number of such cases on record. In some of these there was probably an acute retrobulbar optic neuritis, the result of inflammation by continuity (see p. 747). In others the elements of hysteria were probably very predominant. Galezowski records a case by a lady who suffered from impaired vision upon a tooth being stopped. When the filling was removed her vision improved, but relapsed again when the tooth was re-stopped. The removal of the tooth wrought a permanent cure.

[1] *Lancet*, 1859, p. 80.
[2] *Trans. Odonto. Soc.*, November, 1895.
[3] *Arch. f. Ophthal.*, xiv, p. 107.
[4] "Relations of Diseases of the Eye to General Diseases," p. 267.

The following case of amaurosis consecutive to the extraction of a tooth is recorded by Dr. Santamaria (*La Stomatologia*, Milan, July, 1906).

The patient was a soldier who, prior to enlisting, had followed the occupation of portrait painter. Six months after his arrival at the Florence barracks he suffered from a violent attack of pulpitis in the upper right first molar, which tooth, being badly decayed, was extracted at once. A few hours after the extraction the patient again suffered from a neuralgic attack, the pain radiating from the right cheek to the eye of the same side, and from a rapid and progressive diminution in the visual power of the right eye, which very soon became amaurotic. This condition lasted five days, and, ceasing abruptly, was followed by intense amblyopia. An examination showed that the visual field had decreased both on the right and left sides, but to a greater extent on the former than on the latter, and that there was, in addition, an intense dichromatism for the blue and red primary colours. An external examination revealed nothing worthy of note; in the mouth no pathologic lesion could be seen.

The author's own conclusions regarding the peculiarities of this case are that the amblyopia was not of reflex nature; that the dichromatism was an interesting feature of the case by virtue of the previous occupation of the patient; that the amaurosis, and the dichromatism confirm the fact observed by Trombetta, viz., that the symptoms exhibited by those affected with traumatic neurosis become in preference localized in those organs which for each patient are of pre-eminent importance in his daily occupation; that the nature of the traumatism was entirely out of proportion to the severity of the consecutive neurotic manifestations; that even the most insignificant stimuli may be followed by serious and unexpected consequences in the case of neuropathic patients.

Glaucoma.—In referring to convergent strabismus it was pointed out that the irritation from eruption might in some cases be the determining cause; in like manner it is possible that odontalgia may be the determining cause of a glaucoma. If an eye is anatomically in a condition favourable for the onset of an attack of glaucoma, severe pain arising from a carious tooth may so lower the vitality of the patient that the disease may be started. Von Hippel and Grünhagen[1] consider that irritation of the fifth nerve raises the intra-ocular pressure. Priestley Smith's[2] experiments, however, seem to show that the tension is not increased in odontalgia.

[1] *Arch. f. Ophthal.*, xiv, 1, p. 107.

[2] Priestley Smith, "Glaucoma," London, 1879.

CHAPTER XXVII

The Operation of Extraction of the Teeth

The General Principles of Extractions—Extraction of Individual Teeth and Roots—Extraction of Misplaced Teeth—Extraction of Teeth under Anæsthetics—Difficulties, Complications and Sequelæ of Extraction of Teeth

THE operation of extraction is one requiring skill, judgment, experience, and an accurate anatomical knowledge of the parts involved. As with all other manipulative proceedings, success can only be obtained by actual practice.

For facility of description the operation will be considered under the following heads :—

(A) The general principles of extraction.
(B) Extraction of individual teeth and roots.
(C) Extraction of misplaced teeth.
(D) Extraction under anæsthetics.
(E) Difficulties, complications, and sequelæ.

(A) THE GENERAL PRINCIPLES OF EXTRACTION

The tooth to be removed should be carefully examined in order that the operator may form some idea of the amount of sound tissue present and the degree of force which will be necessary for the dislodgment of the tooth. In the case of roots the edges must be defined, and for this purpose a blunt probe will be found useful.

(1) Instruments

The instruments in general use for the removal of teeth are forceps and elevators.

The forceps is an amplified pair of pincers or pliers. It is made up of three parts, namely, the blades or portions beyond the joint which are applied to the tooth, the joint itself, and the handles. Forceps should be made of fine steel, light, and yet strong enough to withstand without bending any strain that it

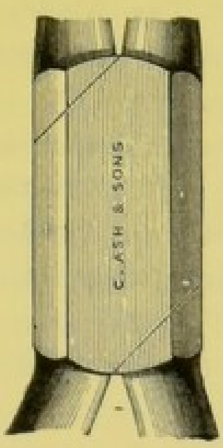

Fig. 776.[1]

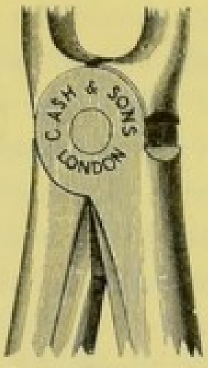

Fig. 777.

Fig. 778.

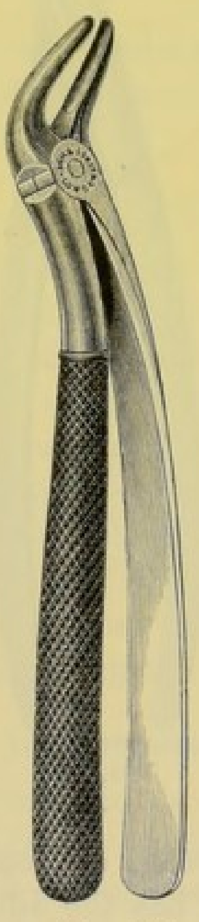

Fig. 779.

[1] For the use of the illustrations, Nos. 776 to 781, 785, 790, 791, 792, 794, 795, 796, 799, 801, 804 to 809, 812, 820, and 821, I am indebted to Messrs. Claudius Ash, Sons and Co.

may be necessary to put upon them. The blades should be shaped to fit the tooth they are intended to remove, and when applied they should be clear of the crown. On longitudinal section a blade should present a thin wedge-shaped appearance. Two kinds of joints are in general use. In the first variety one half of the forceps passes through a slot in the other half, the two being held together by a rivet passing through the centre (fig. 776). In the second variety (fig. 777) the two halves are held together side by side by a screw or pin which takes the entire strain.

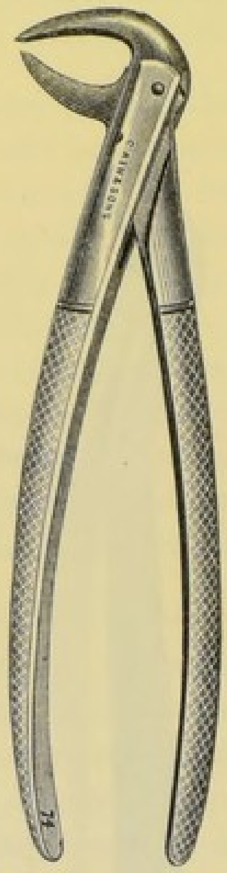

FIG. 780.

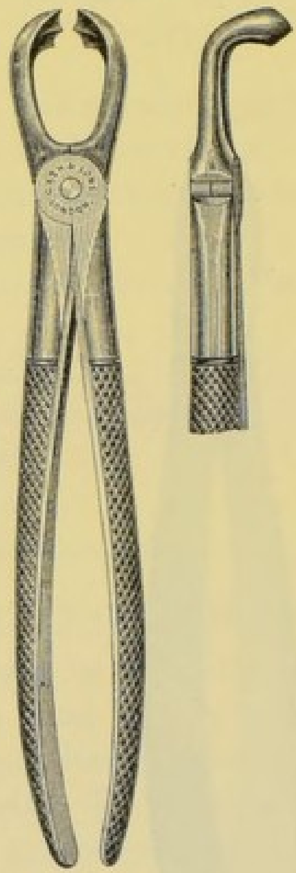

FIG. 781.

Most forceps of English manufacture are made on the latter plan, which has the advantage of permitting the instrument to be easily cleaned; it also allows a slight lateral movement of the two halves—a point of some practical importance. It is urged against this style of joint that it is weak; in practice, however, this is not found to be the case. The handles should be of a size and shape to lie comfortably in the palm of the hand, and should

be in such relation to the blades that when the latter are applied in the direction of the long axis of the tooth the handles clear the lips.

As a general rule, in forceps designed for the removal of the anterior teeth of the maxilla, the blades and handles are in the same line (fig. 778), while for the upper back teeth the handles form a curve of greater or less extent with the blades (fig. 779). In forceps for the mandibular teeth the blades are bent down from the handles to an angle of nearly ninety degrees. In one class named the "hawk's bill," when the blades are applied to the tooth the handles are at right angles to the line of the arch (fig. 780), while in other classes the handles are in line with the arch (fig. 781). Forceps with aseptic or readily cleansable joints have been introduced.

The elevator consists of two parts—the handle and the blade. The former is about 4 in. in length and of a shape suitable to allow firm grip to be obtained.

The blade is of fine steel and about 2 in. long. Elevators are of two varieties, straight and curved. In the first form the blade is thin, about one-fifth of an inch in breadth, one surface being made convex and the other flat. The point of the blade should be rounded as shown in fig. 785. In the curved variety, the terminal half-inch of the steel part of the instrument is bent at an angle with the shaft of the instrument (fig. 805). The edge of the blade of an elevator should always be kept sharp.

The screw (fig. 786) is an instrument which on rare occasions is useful for the removal of deep-seated roots.

After being used, instruments of every kind should be freed from all foreign matter and then carefully sterilized.

(2) Method of Holding Instruments

The manner of holding *forceps* is shown in figs. 782 to 784. The handles should rest comfortably in the palmar surface of the hand, and in such a manner that the end of one handle rests between the thenar and hypothenar eminences—a portion of the hand where force can be applied with the greatest advantage.

The thumb placed between the handles acts as a regulator to control the pressure of the blades upon the tooth. As a precaution it is well to have the ball of the thumb well between the

handles, so that the pressure is counteracted not only by the soft tissues, but also by the terminal bony phalanx of the thumb. If this precaution be not observed, any sudden crushing of the tooth may be accompanied by a severe and very painful contusion of the operator's thumb.

The method of holding an **elevator** is shown in fig. 787. The handle should rest comfortably in the hand, the first finger lying along the blade and being brought near the point so as to prevent the instrument slipping. When using the elevator for the removal of teeth on the right side of the mandible, the first finger should lie along the curved side of the blade, and on the flat side when extracting teeth on the left side.

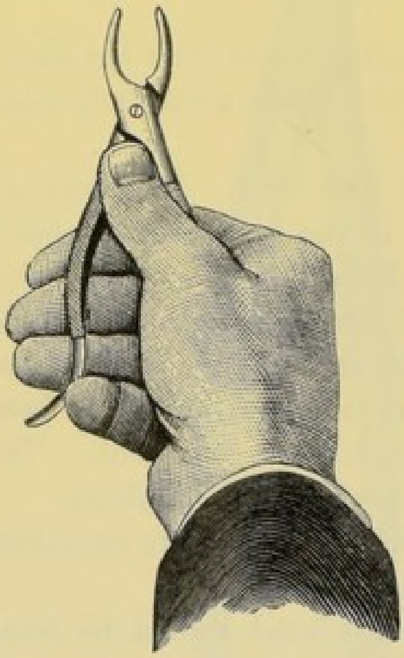

Fig. 782.—Mode of holding forceps for the removal of maxillary teeth.

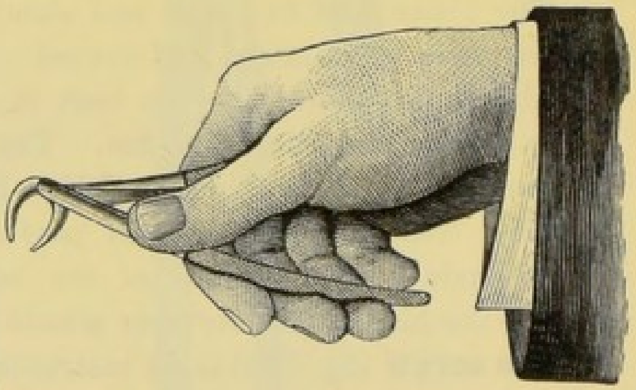

Fig. 783.—Mode of holding lower "hawk's bill" pattern forceps.

(3) Position of the Operator and the Patient

The chair should be placed before a good light, and, if a proper dental chair is not available, an ordinary armchair may be utilized. The patient should be placed in such an unconstrained position as will allow the operator to exert all necessary movements with freedom.

The operator should place himself in such a position as to be

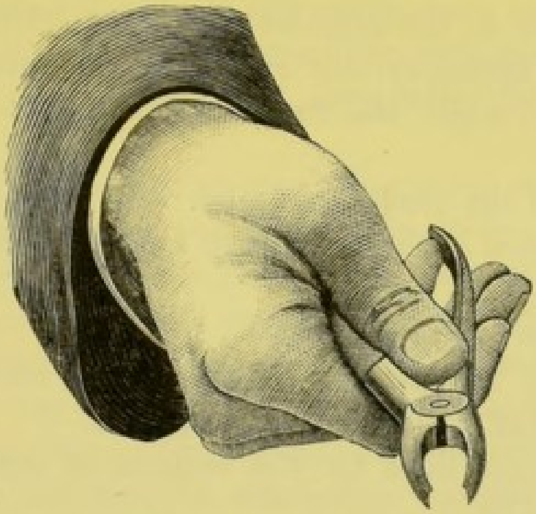

FIG. 784.—Mode of holding forceps of pattern shown in fig. 781.

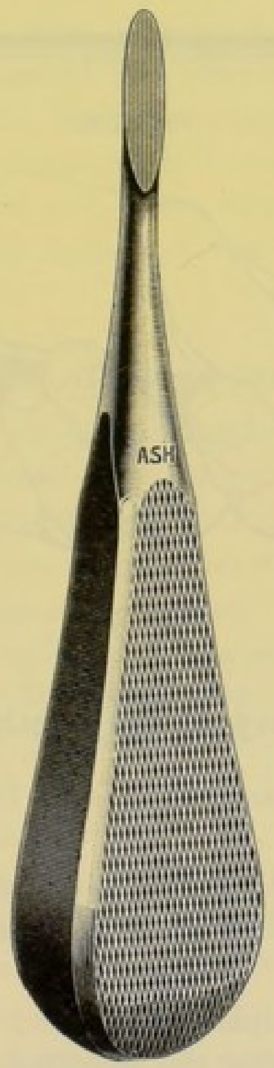

FIG. 785.

able to use force to the greatest advantage. His left arm may be utilized, if necessary, for steadying the movements of the patient's head, while the fingers of the left hand can be employed :—

(*a*) To keep the cheek and other soft parts away so as to obtain a clear view of the tooth to be extracted and its immediate neighbours.

(*b*) To support the mandible.

(*c*) To grasp the alveolar process and so allow some idea to be gained of the effect of the force employed.

The special positions for the removal of different teeth are described on p. 779.

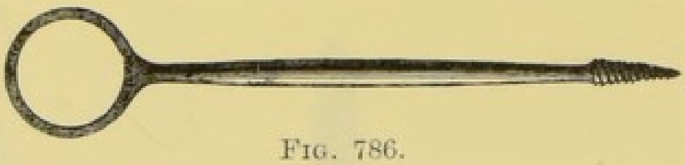

Fig. 786.

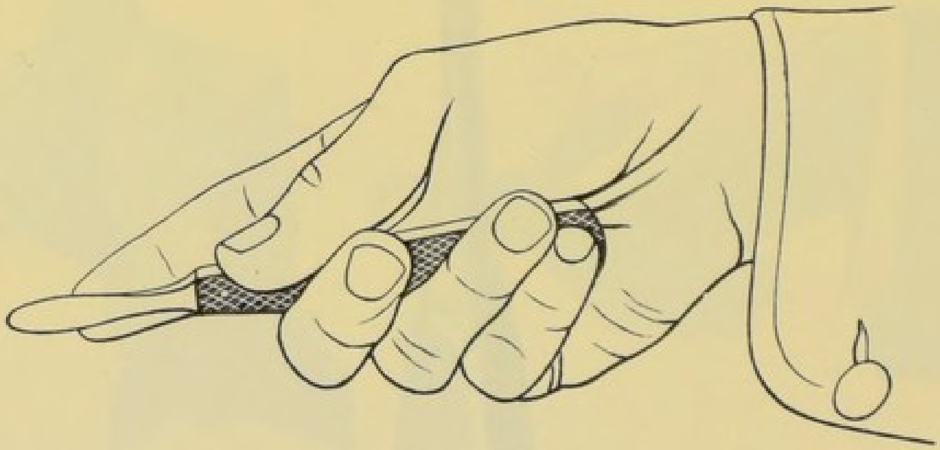

Fig. 787.

(4) Anatomy of the Teeth and Jaws

If the teeth be examined it will be noticed that they are capable of division into :—

(*a*) Teeth with single, round, tapering roots.

(*b*) Teeth with single roots which are more or less irregularly flattened or curved.

(*c*) Teeth with multiple roots.

Under (*a*) are included the maxillary incisors (deciduous and permanent) and the mandibular premolars; (*b*) the mandibular

incisors and canines (deciduous and permanent), and the maxillary canines and premolars; (*c*) the maxillary and mandibular molars (deciduous and permanent), and frequently the first maxillary premolars.

The shape of the roots, as we shall subsequently find, has an important bearing upon the manner in which force is to be applied when severing the roots from their attachments. To ensure skilful and successful operations a thorough knowledge of the alveoli of the teeth is necessary, and it is needless to say that this knowledge can only be gained by careful study of the bones (fig. 788). Some idea of the strength of different portions of the alveolar border will thus be obtained, a matter of some moment when force is being applied in the process of removing a tooth from its socket. In the maxilla the points to be specially noted are the thinness of the outer alveolar wall as compared with the inner, and the prominence of the bone in the region of the third molar. In the mandible, the outer alveolar border is, it will be seen, thinner than the inner, with the exception of that portion in the region of the third and, often, of the second, molar; at the posterior portion of the socket of the third molar the bone is moderately dense.

(5) Method of Using Instruments

The operation of tooth extraction when performed with forceps may be divided into three stages[1] :—

(*a*) Adjustment of the forceps to the tooth.

(*b*) Destruction of the membranes connecting the tooth with the socket and dilatation of the socket.

(*c*) Removal of the tooth from the socket.

In the initial stage **the first step** is the application of the blades. Care must be taken that the points pass between the gum and the tooth, and also that the blades are applied parallel with the long axis of the root.

As a rule, it is best to apply one blade first on the side of the tooth most obscured from view, and then lightly to close the other upon the opposite side. The blades should then be forcibly

[1] A description of the form of each tooth, with respect to its bearing upon the construction of forceps for its removal, will be found under the heading B.

pressed upwards or downwards, as the case may be, in the direction of the apex of the root; a slight rotary or wriggling motion will often be found of assistance in the process. This "pressing" movement should be continued until a firm hold of the root has been obtained—a matter of great importance, as the successful

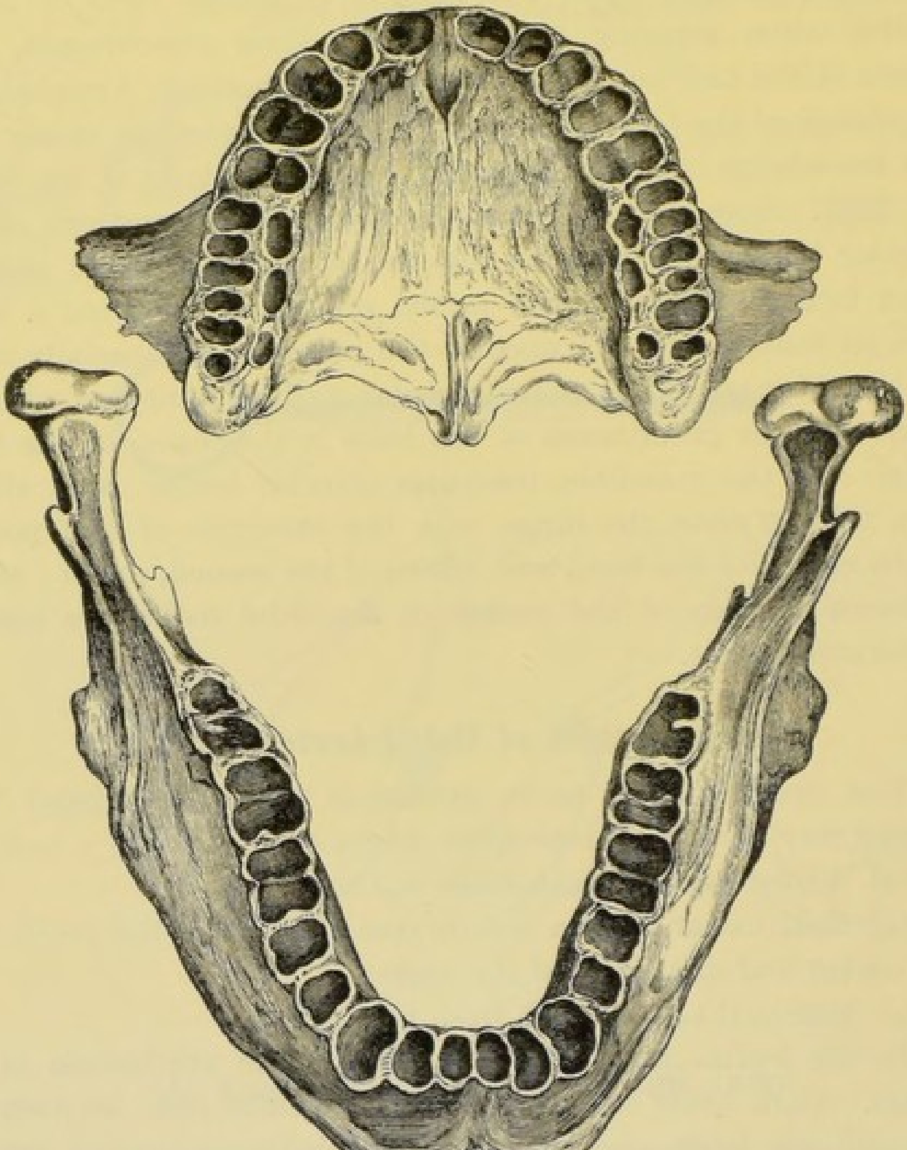

Fig. 788.[1]

removal of the tooth depends in a large measure upon the grip obtained. The handles should next be closed so as to give the blades a firm grip, and the amount of pressure applied should be such that when movement has commenced the blades do not ride

[1] From "The American System of Dentistry."

upon the surfaces of the root. The amount of pressure must of course depend upon the character of the tooth to be removed, and the resistance offered by the alveolar process. The thumb placed between the handles of the forceps, as already explained, should counteract the pressure on the root and prevent crushing.

The second stage—the destruction of the membranous attachments and dilatation of the socket—is accomplished by employing force in either a rotary or a lateral direction. The movement to be employed depends upon the form of the root or roots to be removed and the resisting strength of the surrounding hard structures. Rotary action is of course admissible only in the case of teeth possessing a single conical root.

The final stage is carried out by exerting extractive force in the direction of the long axis of the tooth, while at the same time following the line of least resistance; the latter is determined by a knowledge of the anatomy of the alveolar border and by the sensation conveyed to the hand through the forceps.

Elevators. — The removal of a tooth with a straight elevator is accomplished in the following manner:—

The blade, with the flattened surface towards the tooth to be removed, is inserted between the root and the alveolar process, the instrument being kept as far as possible parallel with the anterior surface of the crown. The blade is then forced downwards so as to reach the root at a point as low as possible; the handle of the elevator is then rotated away from the direction in which the tooth is to be removed. This has the effect of raising the tooth in its socket and at the same time displacing it in the required direction. One such movement of the instrument rarely suffices for the removal of a tooth, and a second, and sometimes a third grip, each time nearer the apex of the root, has to be obtained.

The method of using **a curved elevator** will be described in dealing with the removal of the roots of mandibular teeth.

The Screw.—Before attempting to remove a deep-seated root with the screw, a good view of the root should be obtained by pressing the overlying tissues away. A clear view of the root canal having been gained, the screw should be carefully worked into the canal, and when sufficient hold has been obtained extractive force should be applied.

(6) The Preparation of the Mouth

The tooth to be extracted should be freed from all foreign matter by the removal of any adherent salivary calculus and the thorough irrigation of the space around the tooth. For the purpose of irrigation peroxide of hydrogen is most useful, and the mouth should also be thoroughly rinsed with a suitable wash. When many teeth have to be removed at one sitting every endeavour should be made to render the mouth as aseptic as possible before operating, especially in the case of patients suffering from periodontal disease. It is a good plan to prescribe a mouth-wash to be frequently used for at least one week before removing the teeth. The patient should also irrigate the individual sockets with a suitable antiseptic. By the removal of the sepsis in the mouth the resistance of the tissues is raised and they react more readily to the injury caused by the removal of the teeth.

(7) Character of the Wound

The wound resulting from the removal of a tooth is a lacerated one, and heals by "granulation." Immediately after the operation the socket becomes filled with coagulated blood, which is eventually replaced by granulation tissue, and at a later period loose, cancellous bone is formed. Some absorption of the alveolar border always follows the removal of a tooth, the continuity in the surface of the gum being restored by ordinary cicatrical fibrous tissue.

The wound is best treated by keeping the parts carefully cleansed as far as possible from all foreign matter, and for this purpose an antiseptic mouth-wash[1] should be used several times a day. On the extraction of a maxillary tooth the discharge from the wound drains away naturally owing to the position of the orifice. The wound caused by the removal of a mandibular tooth cannot drain naturally and, should suppuration take place, the socket must be frequently syringed with some antiseptic solution, and, if necessary, packed with a suitable material.

[1] The following is a useful formula :—

℞ Liquoris potassæ .. .. ʒvi.
Acidi carbolici glacialis .. .. .. ʒiv.
Aquam .. .. ad. ℥iv.

M. One teaspoonful to be used with half a tumbler-full of warm water as a mouth-wash.

(8) Extraction During Pregnancy

In the early months of pregnancy extraction may be performed with safety. After the sixth month the removal of teeth should be avoided if possible unless they are causing severe pain which cannot be alleviated by any other means. In such cases the teeth should be removed under anæsthesia, as it is important to avoid shock as far as possible.

(9) Extraction during the Menstrual Period

If extraction is rendered necessary through acute suppuration the tooth may be removed at any time during menstruation, but otherwise it is better to wait until the end of the "period."

(10) Extraction of the Deciduous Teeth

Although the methods employed in the extraction of both deciduous and permanent teeth are alike in actual details, there are one or two points connected with the extraction of the deciduous teeth to which attention may with advantage be directed. First, when it is necessary to extract a child's tooth the child must be told. It is an unwise proceeding to deceive children in such matters or take them unawares. The confidence and consent of children can generally be gained after a little practice and by the exercise of moral suasion. It should also be remembered that anæsthetics are quite as needful for the extraction of the deciduous as the permanent teeth, the pain to a child being quite as great as to an adult.

(B) EXTRACTION OF INDIVIDUAL TEETH AND ROOTS

(1) Maxillary Teeth

For the removal of teeth in the maxilla the patient should be placed at such a level that the left arm of the operator can, if necessary, embrace the head of the patient with comfort. The operator should stand at the right side of the patient, and slightly in front, the first finger and thumb being placed on either side of the alveolar process (fig. 789). In the event of the patient becoming restless, the arm should be moved so as to encircle the head and hold it firmly.

(*a*) **Maxillary Incisors.**—The roots of both the central and lateral incisors are usually cone-shaped, the anterior surface forming the arc of a larger circle than the posterior surface. Forceps for the removal of these teeth ought therefore to have the blades made to correspond to the surfaces. The lateral incisor is smaller than the central, and has at times a root somewhat flattened. In removing maxillary incisors the posterior blade is applied first, care being taken to see that the edge of the instru-

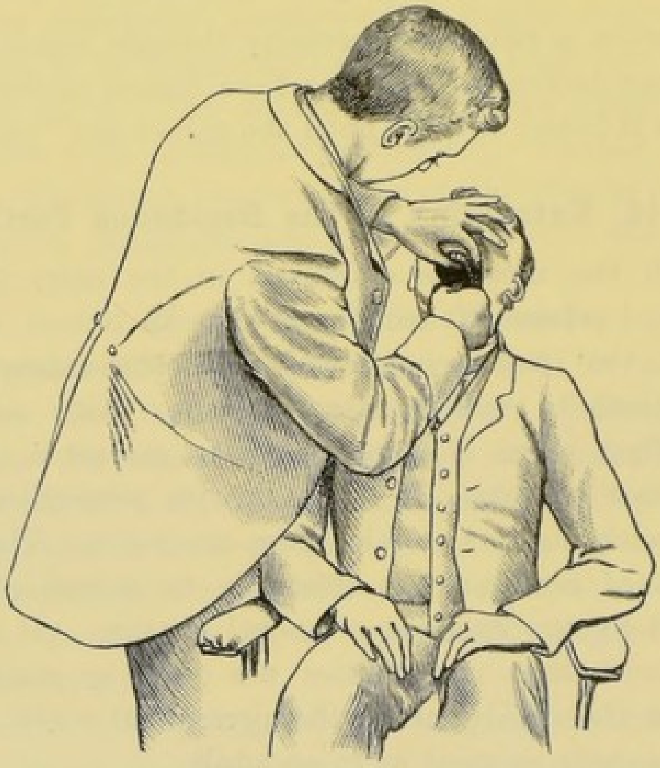

FIG. 789.

ment passes between the gum and the tooth. To dislodge these teeth a firm inward movement should be made in a direction towards the palate, this movement being followed by one in an outward direction. If this fails to dislodge the tooth from its attachments, a firm rotary motion, first to the right and then to the left, may be tried (the amount of rotation necessary being only about an eighth of the circle represented by the circumference of the root).

It is usually recommended that, in the first instance, rotation should be tried for the extraction of these teeth, but the teeth

yield more readily and with less laceration of the soft tissues if the inward movement is adopted.

The extraction of the roots of these teeth does not, as a rule, present much difficulty. When the roots are moderately sound the instrument shown in fig. 790 may be used, but where the root is much decayed and lies well below the gum margin, a rather finer pair will be found more serviceable. The manner of removal is similar to that used when the crown is standing.

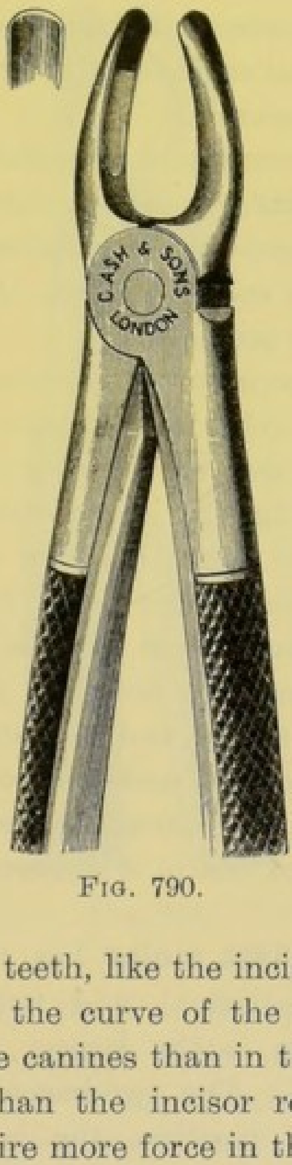

FIG. 790.

(*b*) **Canines.**—These teeth, like the incisors, are single-rooted; the difference between the curve of the anterior and posterior surfaces is greater in the canines than in the incisors. The roots, too, are much longer than the incisor roots, more firmly implanted, and hence require more force in their removal.

Forceps similar in pattern to those employed for incisors may be used, the severance of the tooth from its attachments being brought about by force applied in an inward, followed by an outward, direction. The root being more or less three-sided,

rotation cannot well be adopted. The root of a canine tooth should be removed in the same manner as the whole tooth.

(*c*) **Premolars.—The first premolar** has usually one root flattened and more or less longitudinally grooved on its mesial and distal surfaces. If this grooving is very pronounced, the result is that the root is more or less divided into two slender terminations. The existence of such bifurcation can seldom be determined before operation, and would not alter the method adopted, but the tendency to this variation should be borne in mind, and the lateral movement should be made very cautiously. The internal and external surfaces of the root are, for all practical purposes, of equal curvature.

For the removal of unerupted premolars see p. 205.

The second premolar has usually only one root, which is not so flattened in the antero-posterior diameter as in the first premolar, and the grooving and bifurcation of the root is less in the second than in the first premolar.

The blades of forceps for the premolars should be equal segments of the same circle; they should also be bent at such an angle with the handles that the handles may clear the lower lip. The forceps shown in fig. 794 is a useful pattern. In removing an upper premolar, the inner blade of the forceps should be applied first. For severing the tooth from its attachments a slight inward movement should first be made, followed by an outward. If the socket does not then yield, the inward movement may again be made, and repeated if necessary. The removal of the tooth from its socket is to be carried out by force applied in a downward and outward direction. The removal of premolar roots is carried out in a manner similar to that of the whole tooth.

(*d*) **Molars.—The first molar** has three roots, one internal towards the palate (palatine), and two external (buccal); of the three, the palatine is the largest; it is subcylindrical in form, and often curved. The two buccal roots are placed in an anterior and posterior position, the latter being in a plane internal to the anterior one; both these roots are somewhat flattened, and, of the two, the anterior is the larger. The roots of the **second molar** are similar in shape to the first, but are usually smaller.

The third molar, when normal, has three roots, but very frequently these are all fused together so as to form an abrupt tapering cone, the point of which is often curved. Owing to the disposition of the roots, different forceps will be required for the removal of upper molars on the right and left sides. Of the blades, the outer or buccal should possess two grooves, the anterior being the broader and placed in a more external plane. This blade should also have a slight projection between the

Fig. 791.

grooved surfaces to adapt itself to the space between the buccal roots. The inner or palatal blade should possess only one groove. A well-made pair of upper molar forceps should fit the neck of a first upper permanent molar perfectly. The blades should be bent at an angle with the handles, so that when in use the latter may clear the lower lip (fig. 791). The palatine blade should be applied first, and in bringing the outer blade into place the point should be kept over the groove on the

buccal side of the tooth, as this groove is a guide to the space between the outer roots. To sever these teeth from their attachments, force must be applied, first slightly inwards and then outwards, the movement being repeated if necessary, the removal of the tooth from the socket being carried out by exerting force in a downward and outward direction. Too much outward movement leads to undue bending or fracture of the external alveolar plate.

FIG. 792.

In removing the third molars it is advisable not to have the patient's mouth opened to the fullest extent, as the tension of the tissues of the cheek will thereby be lessened, thus giving a clearer view of the outer side of the tooth. The correct application of the forceps is of the utmost importance, as one is liable, unless care is taken, to include some of the soft tissue between the blades and the tooth and so cause a painful laceration. Force applied inwards, then outwards, is generally sufficient to loosen these teeth, their removal being carried out by a downward and outward movement.

Forceps similar to those in fig. 792 may be used for the removal of the third molars, but most operators use patterns the blades of which are similar segments of the same circle. **There is an abnormality of the maxillary molars** which may with advantage be mentioned here. It consists in the posterior buccal root being situated in a plane much internal to the anterior root—in other words, it is an exaggeration of the normal arrangement. Such teeth have been **termed** by Mr. Booth Pearsall "**oblique-rooted**" (fig. 793). This abnormality is met with most frequently in the third molar, sometimes in the second, rarely in the first. The difficulty encountered in extracting these teeth is that the outer blade of the forceps is apt to slip round. Oblique-rooted teeth can at times be diagnosed by noting an undue prominence of the alveolar process over the anterior buccal root; such teeth are best removed with forceps similar to that shown in fig. 792.

a *b* *c* *d*

FIG. 793.—(*a*) normal maxillary first permanent molar; (*b*) oblique-rooted maxillary first permanent molar; (*c*) normal maxillary second permanent molar; (*d*) oblique-rooted second permanent molar.

In cases where a portion of the crown remains and the decay extends well below the gum on either the palatal or buccal side, ordinary molar forceps should be discarded and root forceps employed; useful patterns are shown in figs. 794 and 795. The removal of teeth in this condition is carried out as follows: It will be supposed that the decay extends deeply on the palatine side. One blade of the forceps should be first applied to the buccal side of the tooth and to the root which is considered the stronger; the inner blade should then be applied to the palatine root, care being taken to insinuate it between the alveolus and the root. The forceps should be pushed well upwards until a firm hold of the root is obtained. A firm inward movement should then be made, as this will allow the inner blade to pass

still higher up the palatine root and ensure steadiness should the blades tend to ride upon the surface of the root. An outward movement should next be made, but to nothing like so great a degree as that used in extracting molars with the whole of the crown standing. This inward and outward movement is to be repeated until the tooth is free, the force being principally applied in the inward direction.

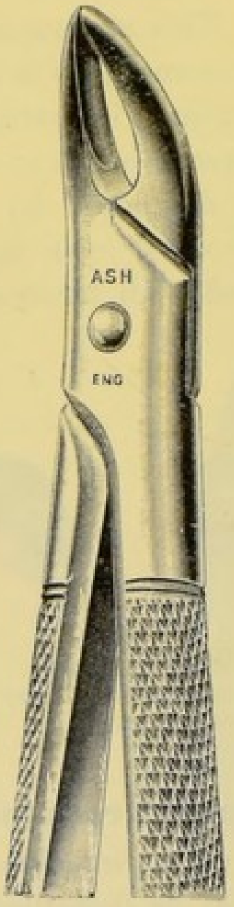

FIG. 794.

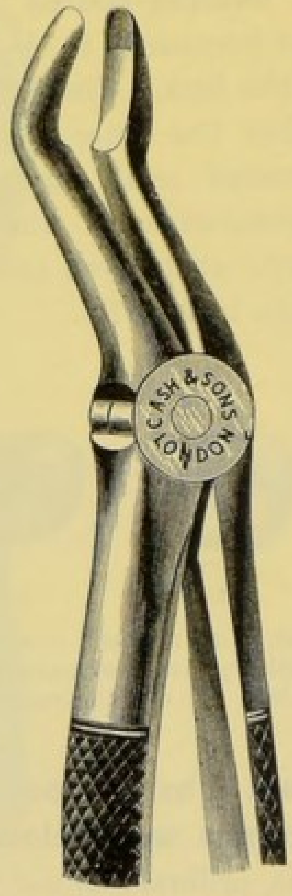

FIG. 795.—For the removal of roots towards the back ofthe mouth.

When the more extensive decay has taken place on the buccal side the order of procedure is slightly different. The first blade to be applied should be the palatine, the outer blade being closed upon whichever of the buccal roots is considered the stronger. The extractive force should be applied first outwards and then inwards, these movements being repeated if necessary, the principal force being outwards, as the object in view is to prevent the instrument slipping off the more decayed side.

When a molar is so decayed that very little of the crown remains, but all the roots are still united, root forceps should be used. In such a case the inner blade is to be applied to the palatine root first, the outer blade being closed upon the stronger of the buccal roots. Inward, followed by outward, movement should be employed, the point to bear in mind being to use force towards the side of the tooth which is considered the weaker. In the majority of such cases the three roots come away together, but even if this does not happen, one or perhaps two will be removed, and the remainder can subsequently be removed without much difficulty.

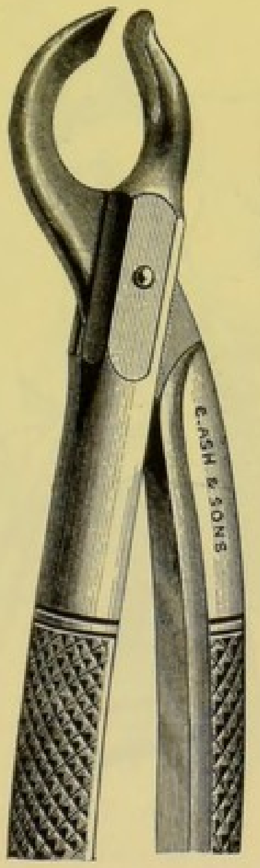

FIG. 796.

In cases where the resistance presented by the roots is very great, and an unsuccessful attempt at removal has been made with ordinary root forceps, an instrument with a buccal blade similar to that shown in fig. 796 may be used. The inner blade is applied first, the outer being inserted, if possible, into the space between the buccal roots. A firm hold of the roots having

been gained, extraction should be attempted by force applied in an inward and outward direction; this failing, sufficient pressure should be put upon the handles to split the roots asunder. The sharp outer blade of the forceps will then pass between the buccal roots on to the palatine root, which can thus readily be brought away. A pair of ordinary upper root forceps should be employed to remove the buccal roots.

If all three roots of a molar are separate, a slight rotary movement will usually suffice for their removal.

In any case where there is danger of a molar fracturing, root forceps should be used in preference to ordinary forceps.

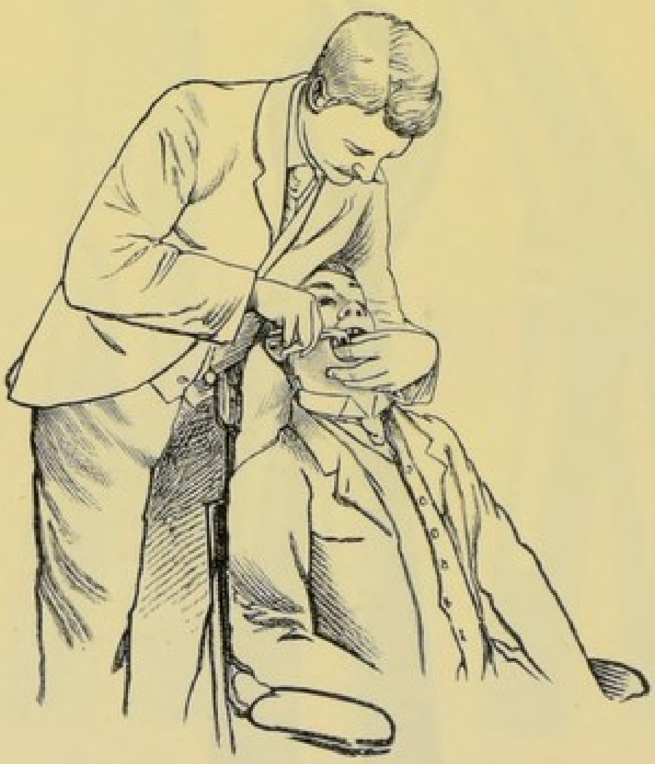

Fig. 797.

(2) Mandibular Teeth

For the removal of mandibular teeth the patient should be placed on a low level, the head being kept a little forward and the chin depressed. The position of the operator will depend upon the tooth to be removed and the instrument to be used. With teeth on the right side, when hawk's bill pattern forceps or elevators are used, the operator should stand behind and to the

right of the patient, the left arm being brought round the patient's head. The thumb of the left hand should be placed on the inside and the first finger on the outer side of the alveolar process of the tooth to be removed, and the three remaining fingers under and supporting the chin. In placing the fingers in the mouth, care should be taken to keep the wrist well down so as not to impede the entrance of light (fig. 797).

FIG. 798.

When removing the anterior teeth or those on the left side of the mouth, the operator should stand on the right side and slightly in front of the patient. The left hand should be placed as follows: the second finger on the lingual side, and the first on the labial side of the alveolar process of the tooth to be extracted, the thumb being placed under the chin (fig. 798). When employing forceps of the straight pattern shown in fig. 781· the operator

should stand as shown in fig. 798, but it will be found difficult to place the fingers of the left hand on either side of the alveolus; indeed, they can only be used with advantage for retracting the cheek and supporting the mandible.

In removing teeth from the mandible, the operator should be careful to guard against the sudden separation of the tooth from its attachments when raising the tooth from its socket, as, unless the instrument is well under control, damage may be caused to the upper teeth.

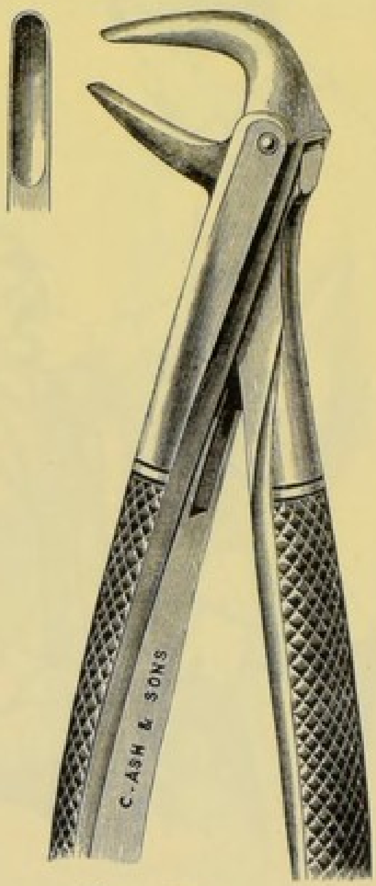

Fig. 799.

(a) Incisors.—These teeth have each a single root, which is much flattened laterally. For their removal, forceps similar to those shown in fig. 799 should be used, the blades being equal segments of the same circle. The lingual blade should be applied first, the loosening movement being made by taking the tooth slightly inwards and then outwards, the final extractive force being upwards and outwards.

The removal of mandibular incisor roots is carried out in a similar manner.

(**b**) **Canines.**—The mandibular canines have normally one root, which is flattened laterally. It is stronger and longer than the incisor roots. The removal of a mandibular canine is carried out in a manner similar to that employed for the removal of a mandibular incisor, but as the canines present more resistance than the incisors greater force is usually required.

(**c**) **Premolars.**—The lower premolars have normally one root, which is conical in shape. In the first premolar the conical shape of the root is not so marked as in the second, the outer aspect being the arc of rather a larger circle than the posterior. Forceps similar to those shown in fig. 799 may be used, the blades being practically equal in size and shape. The lingual blade of the instrument should be applied first, the tooth being severed from its attachments by a slight rotatory movement around the long axis of the tooth, first in one direction, then in the other; should this not suffice, a slight inward followed by an outward movement may be tried, the tooth being raised from its socket by force applied in an upward and slightly outward direction.

The roots of mandibular premolars should be removed in a manner similar to that required for the extraction of the whole tooth. When the root lies much below the level of the gum, the extraction is often troublesome owing to the difficulty in gaining a hold with the blades of the forceps; in such cases, if an attempt with forceps has failed, the straight elevator may be employed.

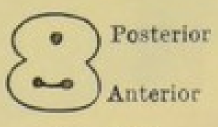

FIG. 800.

(**d**) **Molars.**—Mandibular molars have two roots, placed anteriorly and posteriorly. The roots are much flattened, with a tendency to curve backwards, the curving being well marked in the second and still more so in the third molar; a fusion of the two roots is at times met with in the second and, frequently, in the third molar. A section of a lower molar at the neck shows both the buccal and lingual surfaces to be composed of two segments of a circle touching each other at one extremity, the

anterior segment being slightly the larger (fig. 800). Each blade of the forceps used for these teeth should possess two grooves separated by a projection which fits into the division between the anterior and posterior roots; for all practical purposes the blades may be made of the same size, so that one instrument will suffice for both sides of the jaw. The instrument best adapted for the removal of these teeth is shown in fig. 801, though some operators prefer the shape illustrated in fig. 802.

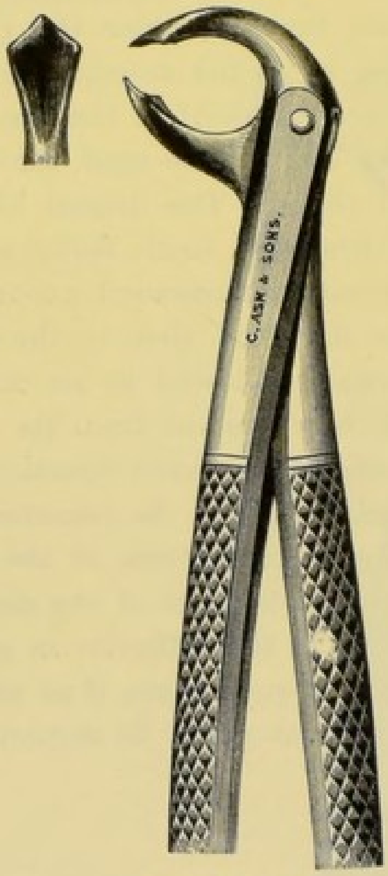

Fig. 801.

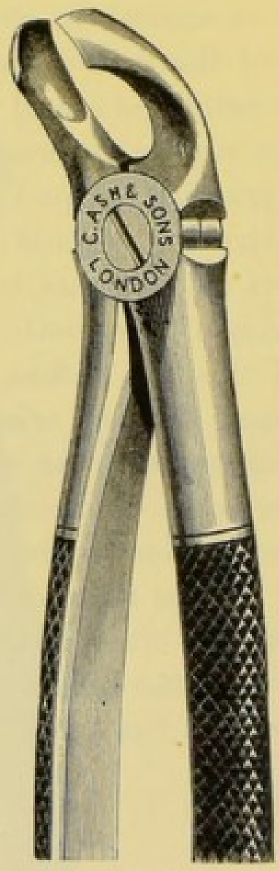

Fig. 802.

The advantages of the former over the latter may be briefly summed up as follows: (1) A clear view of the tooth and its surroundings can be obtained during the whole period of removal; (2) force can be applied with greater advantage; (3) the alveolar process can be easily embraced by the fingers, or by the finger and thumb of the left hand.

One disadvantage of shape fig. 801 is the difficulty of employing much inward movement, and therefore, for teeth lying inwards,

that is, with the crown directed towards the tongue, hawk's bill-shaped forceps cannot be easily used. Another disadvantage is that the extent of inward movement is limited by the proximity of the maxillary teeth, and, in case of trismus, it is often better to use straight forceps.

In removing mandibular molars with forceps, the inner blade should be applied first and then the outer, care being taken to get the points of the blades between the interspaces of the roots. For severing these teeth from their attachments, a slight inward movement should be first made, followed by one well outwards, this inward and outward movement being repeated if necessary.

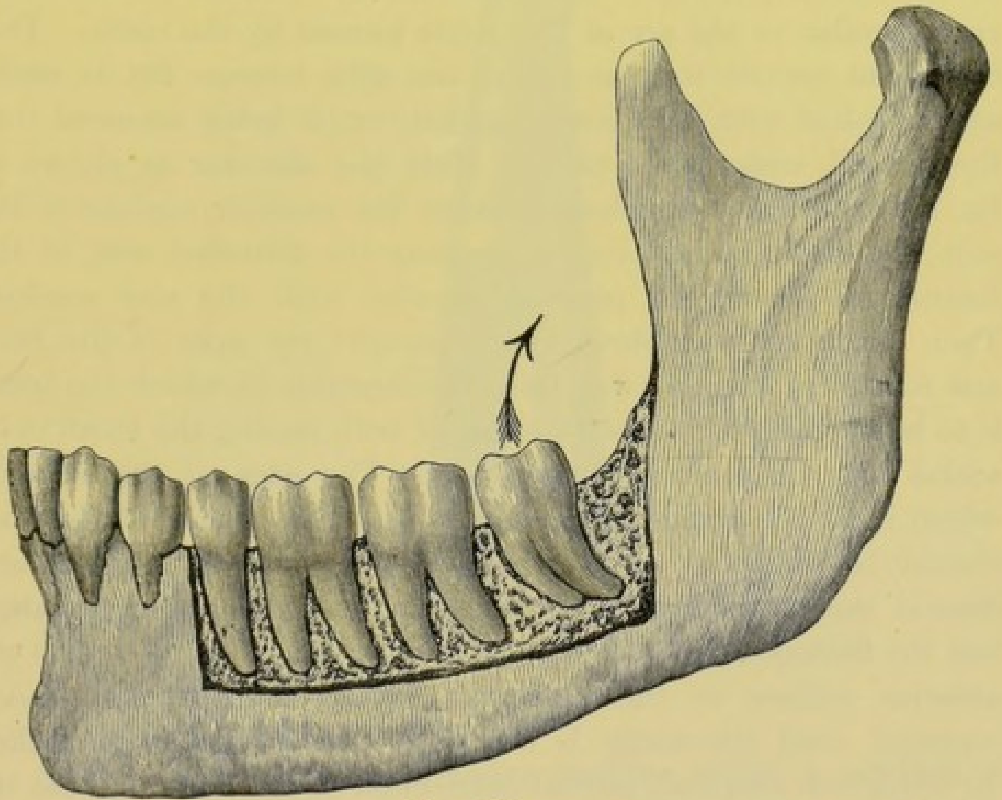

FIG. 803.

The removal of the tooth from its socket is carried out by force used in an upward and outward direction. The upward force exerted upon lower teeth should always be well under control, as, not infrequently, the resistance is very suddenly overcome, and if such precaution is not taken there is danger of striking the upper teeth with considerable force. As previously pointed out, the roots of these teeth are at times curved a little backwards,

so that it is often needful, in removing the teeth from their sockets, to twist the forceps in a curved direction backwards.

In the **removal of the second molar,** too much outward movement is to be avoided, as the outer alveolar process is often very dense.

The third molar is best removed with a straight elevator. A glance at the illustration of this tooth (fig. 803) will show that the roots have a well-marked curve backwards, in addition to which the bone forming the socket of this tooth is stronger than is the case with the anterior molars. The removal of the third molar has therefore to be accomplished by using force in a direction upwards and backwards, in other words, in a curve similar to the arc of the circle formed by the roots. This movement cannot well be carried out with forceps, but is easily accomplished with the elevator as follows (it being assumed that the second molar is in place): Hold the elevator as shown in fig. 787, and insert the blade between the anterior surface of the root and the alveolar process, keeping the flattened side of the instrument as far as possible parallel with the root surface. Then force the blade downwards towards the apex of the root, and rotate the handle away from the direction in which the tooth is to be moved. This has the effect of both raising the tooth in its socket and displacing it backwards. The edge of the elevator which is to be brought into contact with the surface of the root should be sharp so as to cut somewhat into the cementum. Should this prove insufficient the handle should again be raised and the flattened end of the instrument brought parallel with the anterior surface of the root, the extractive movement being repeated until the tooth is completely raised from its socket. In using the elevator, special care must be taken to protect the tongue with the thumb or the fingers of the left hand, so as to provide against the instrument slipping and penetrating the tongue.

With the third lower molar there is a tendency for the gum to adhere tenaciously to the posterior aspect of the neck of the tooth. When this happens it is better simply to raise the tooth from its socket with the elevator or forceps, as the case may be, and then cut the gum away with a curved pair of scissors. By this method a severe laceration of the gum may at times be avoided.

When the third molar is isolated owing to the absence of the second molar, the elevator may still be employed for its removal, the first finger of the left hand being used as a fulcrum on the right side and the thumb on the left side. In such cases, however, many operators prefer to use ordinary lower molar forceps.

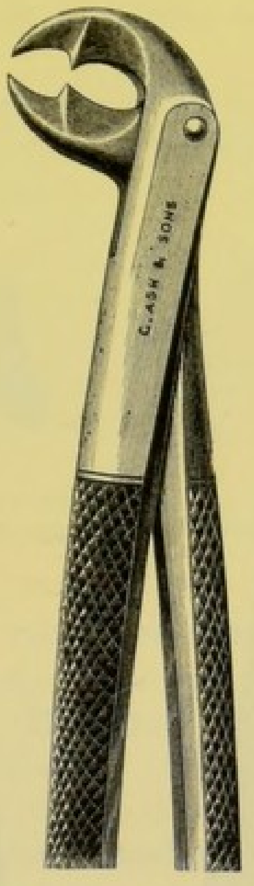

FIG. 804.

The removal of mandibular molars when a portion of the crown is standing, but the caries has progressed below the gum on either the buccal or lingual aspect, is carried out with root forceps of shape shown in fig. 799. A similar condition in maxillary molars and the method of their removal was referred to on p. 785. The principles enumerated there apply to the removal of the lower molars, and it is not therefore necessary to repeat them. The main points to bear in mind are to apply the blades of the forceps to the stronger root, and to use the principal force in the direction of the weaker wall.

Where the roots of molars are still united, root forceps should be used, the blade being first applied to the lingual surface of the stronger root. A firm hold having been obtained, the root may be removed by employing force in the same way as with ordinary molar forceps. Both roots will usually come away

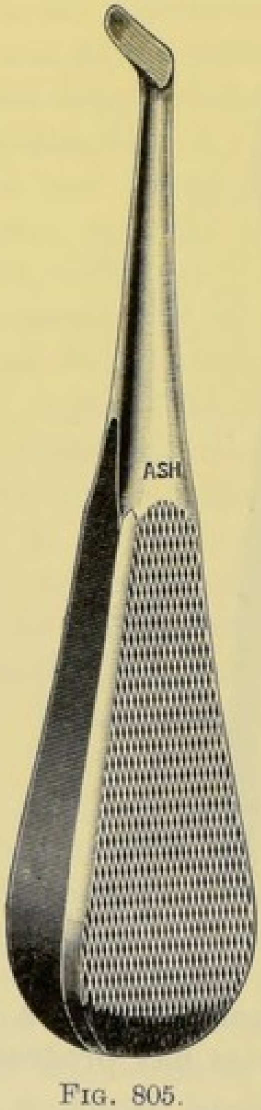

Fig. 805.

Fig. 806.

together. If, however, only one root is extracted, the remaining one can easily be removed either with the same forceps or with a curved elevator (figs. 805 and 806). The curved elevator should be insinuated between the root and the alveolar process so as to force the tooth into the empty socket, or the elevator may be placed in the empty socket and the root elevated by forcing the point through the septum of bone.

With roots of mandibular molars which present great resistance, forceps with cutting blades may be used (fig. 804). The blades are inserted on the lingual and buccal aspects of the arch in such a manner that the points pass into the space between the roots. The handles are then closed and an attempt is made to remove the roots in the ordinary way, but should this prove unsuccessful the handles must be forcibly closed so as to divide the roots, which can then, as a rule, be removed with ordinary root forceps.

The advantage of splitting roots in a case similar to that shown in fig. 807 is apparent, as each root can then be removed in the line of its inclination.

a *b*

FIG. 807.—(*a*) lower molar with divergent roots; (*b*) the dotted lines show the direction in which the roots can be removed if the tooth is divided as suggested in the text.

In cases where the roots are separated their removal is carried out with root forceps, an inward and outward movement being usually sufficient. **The roots of third molars** are best removed with a straight elevator. The *modus operandi* is similar to that used in extracting the whole tooth.

At times the mandibular molar teeth are tilted so that the crown surfaces stand towards the tongue. Under such conditions their removal is best carried out with instruments of the pattern shown in fig. 781, as the handles of forceps of the hawk's-bill pattern would come in contact with the upper teeth, and thus impede the inward movement which is so necessary for the removal of teeth in this position.

(3) Deciduous Teeth

For the removal of maxillary incisors and canines, a small pair of straight forceps of the pattern shown in fig. 808 should be used. The first deciduous molars are best removed with a pair of forceps like fig. 809.

The mandibular incisors and canines require a small pair of hawk's bill forceps similar to the shape shown in fig. 799. For

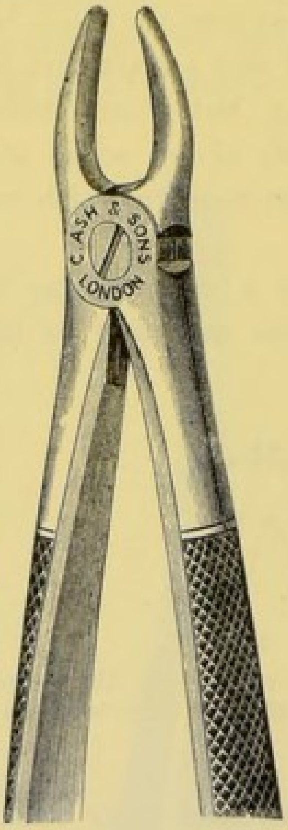

Fig. 808.

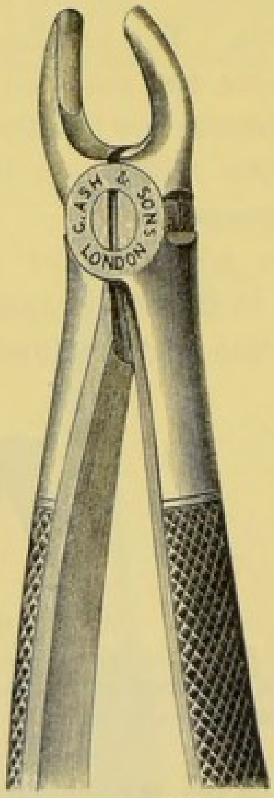

Fig. 809.

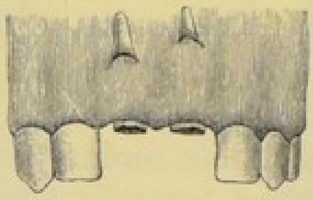

Fig. 810.[1]

the deciduous molars a small pair of forceps similar to that illustrated in fig. 801 should be used.

In removing deciduous teeth, care must be taken not to drive the forceps too high up, or the permanent teeth may be injured, and this danger should be specially guarded against in the case of the deciduous molars, as the roots of these teeth practically embrace the crowns of the premolars.

Roots in the condition shown in fig. 810 are best removed

[1] From "Dental Surgery and Pathology," by A. Coleman.

with an elevator as follows: The thumb of the right hand being placed on an adjacent tooth so as to gain a hold, the point of the elevator should be placed below the end of the root and pressure applied. In a few cases it may be necessary to cut the gum with a lancet before using the elevator. For the small pieces of the deciduous teeth which persist and become wedged in between the permanent teeth, the small curved elevators will be found useful.

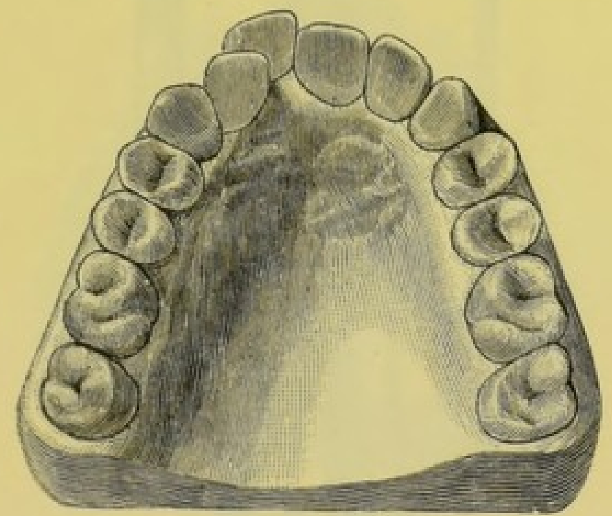

FIG. 811.

(C) THE EXTRACTION OF MISPLACED TEETH

The extraction of a misplaced or impacted tooth is perhaps the best test of the skill of an operator, and although it is impossible to give a complete list of the various mal-positions met with, those most commonly seen will be mentioned, and the usual method of removing such teeth indicated.

(1) Maxillary Teeth

(*a*) **Central Incisors.**—The extraction of an irregularly placed incisor such as is shown in fig. 811, which is the seat of intractable chronic periodontitis, is best carried out with an instrument similar to that shown in fig. 812, the fine inner blade being applied on the palatal side and the broad blade on the labial. Extractive force should be applied principally in the outward direction, and if this is not sufficient slight rotary movement should be tried. In cases where there is less room

between the approximal teeth, the projecting tooth may be removed with a pair of straight forceps (fig. 790), the blades being applied to the mesial and distal aspects of the root. The blades should not be driven very far up, and the loosening of the tooth should be accomplished by slight rotary motion, but care should be taken to avoid loosening the approximal teeth.

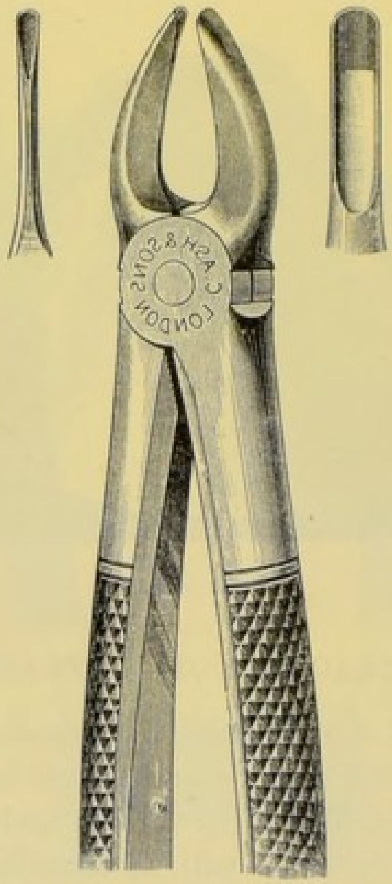

FIG. 812.

(*b*) **Lateral incisors** lying internal to the arch, as shown in fig. 813, can be removed with the forceps shown in fig. 812, by placing the fine blade on the labial and the broad blade on the palatal side of the tooth. Extractive movement should be made inwards, followed by very slight outward movement ; this failing, rotation should be tried, but, as pointed out on a previous page, this form of movement is not so suitable for lateral incisors as for centrals.

(*c*) **Canines** placed high in the arch, as shown in fig. 814,

may be extracted with a straight pair of forceps (fig. 790), the blades being placed on the mesial and labial aspects of the root. Extraction of such teeth is very difficult. Slight but firm rotation may first be tried; if this fails to loosen the tooth, slight lateral movement may be attempted, the force being applied towards, and then away from, the median line of the mouth.

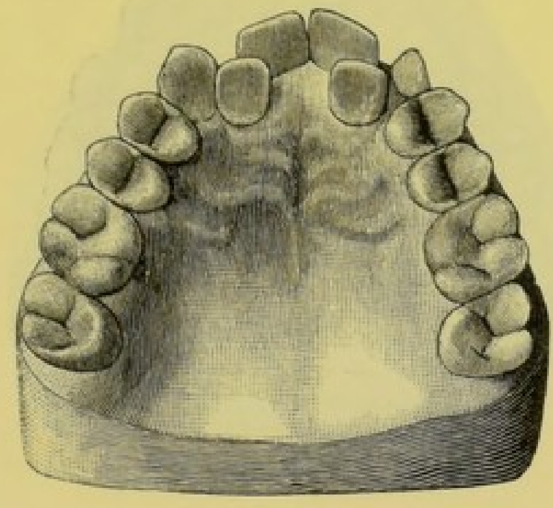

FIG. 813.

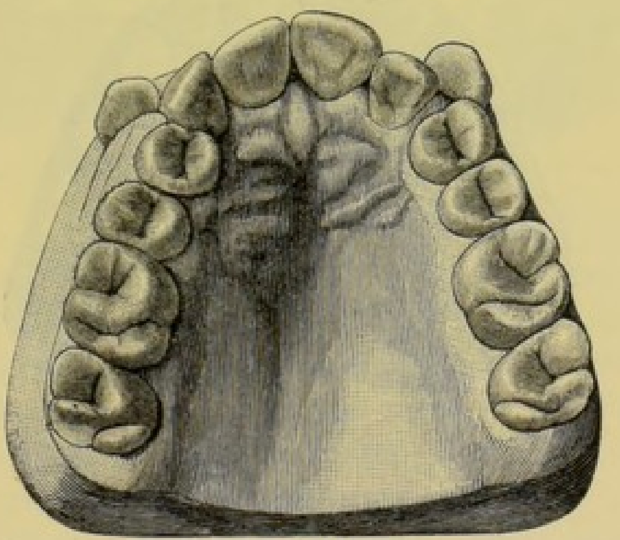

FIG. 814.

(*d*) **Premolars** misplaced, as shown in fig. 815, can be removed with forceps similar to those in fig. 794, the blades being applied on the anterior and posterior aspects of the tooth. Force should be applied in a backward and forward direction, the movements being repeated alternately until the tooth is

loosened in its socket. A premolar placed as shown in fig. 816 can be removed with forceps similar in form to those depicted in fig. 794, with the outer blade strong but narrow. The extractive movement should be made mainly in an inward direction.

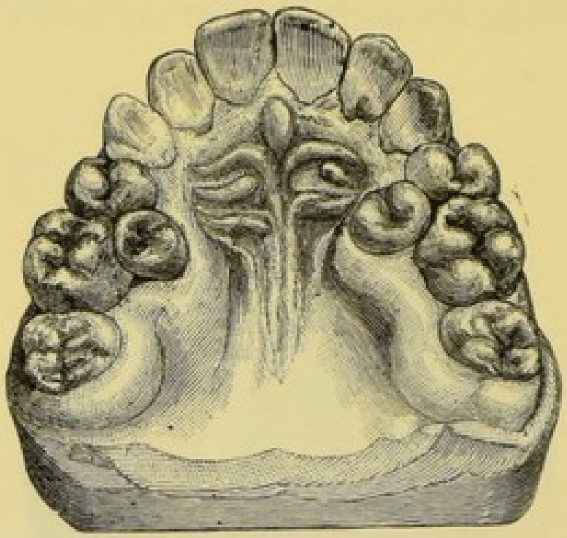

FIG. 815.

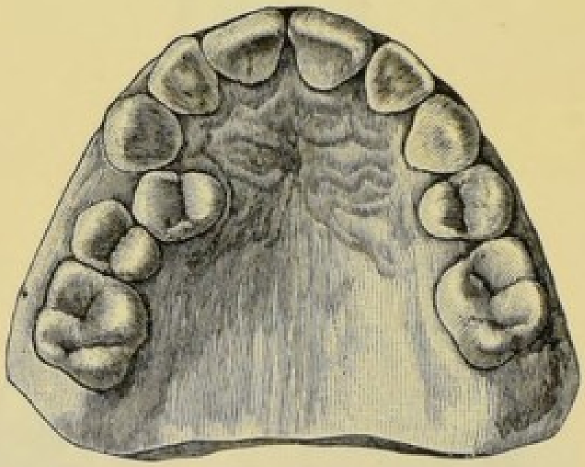

FIG. 816.

(2) Mandibular Teeth

(*a*) **Central incisors** misplaced as shown in fig. 817 may be removed with ordinary lower root forceps (hawk's bill pattern), the blades being placed on the mesial and distal surfaces of the root, and movement applied in a direction to and away from the median line of the mouth. When the crowding is not severe (fig. 818) forceps of the hawk's bill pattern with a strong but narrow inner blade should be used (fig. 820), and the principal

extractive movement made in an outward direction. For an incisor placed as shown in fig. 817, the narrow blade should be the outer one (fig. 821), and the principal force should be applied in an inward direction.

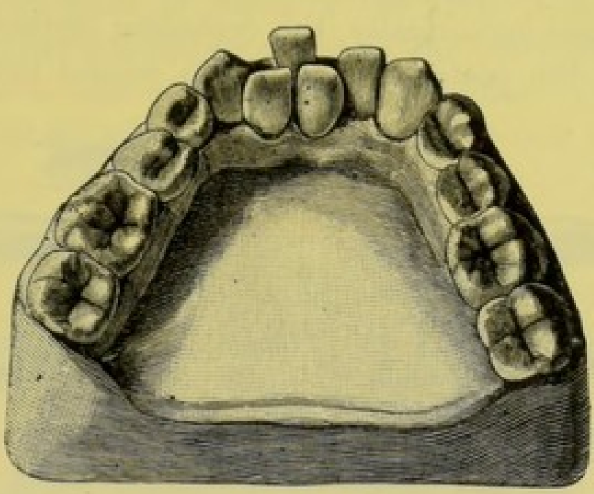

FIG. 817.

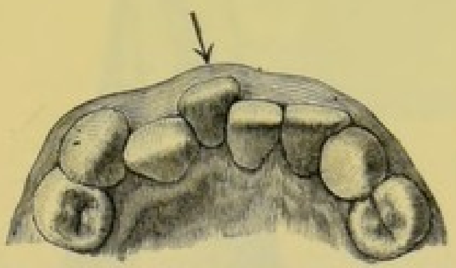

FIG. 818.

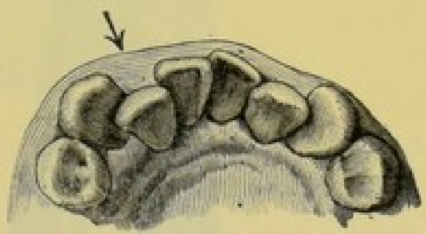

FIG. 819.

(*b*) **Premolars** placed as shown in fig. 822 are most difficult to remove. One of the most useful instruments for their extraction is a pair of upper root forceps (Read's pattern, fig. 794), which should be held so that the curve of the blades is downwards. The blades should grasp the root on its anterior and posterior surfaces. Slight rotary movement may first be attempted, followed by lateral motion. These movements may be persevered with until the tooth is found to yield. Too much haste may lead to a fracture which would be extremely difficult to deal with.

In cases where the crowding is not very marked and the tooth is more in the normal line of the arch, a forceps with a narrow outer blade will suffice (fig. 821). Extractive force should be

used principally towards the median line of the mouth, and this may be combined with slight rotary movement.

(*c*) **Third molars** when **partially erupted or misplaced** are amongst the most difficult teeth to extract. The position of the misplaced tooth may amount only to a slight tilt forwards, or it may be placed horizontally, the occluding surface of the crown impinging on the posterior root of the second molar. In some

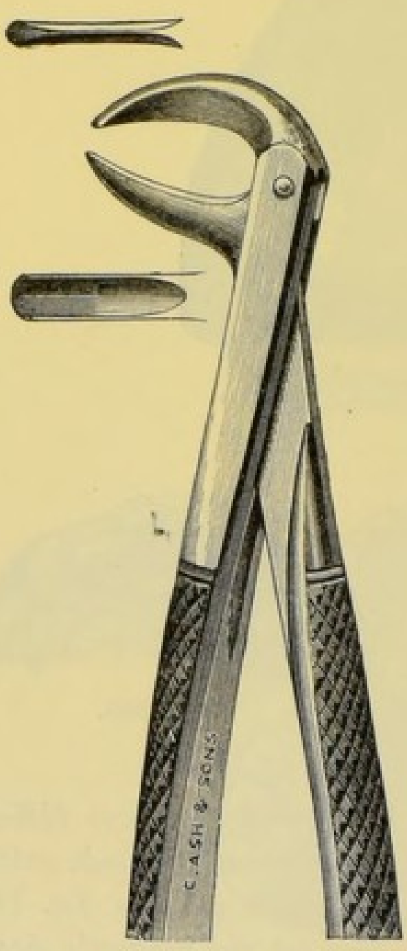

Fig. 820.

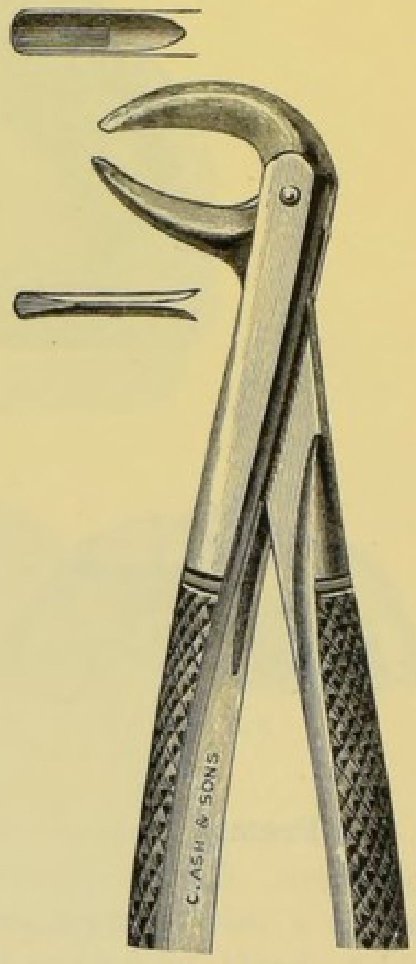

Fig. 821.

instances the teeth may be so placed that the occluding surface looks downwards and inwards. If we examine specimens showing misplaced mandibular molars (see figs. 248 to 250), some points come out very clearly : (1) That the roots of these teeth are to a greater or lesser extent covered by the ascending ramus of the mandible ; (2) that the root of the tooth is in close proximity to the mandibular canal ; and (3) the small amount of bone existing at the posterior aspect of the second molar.

In all cases where there is reason to expect difficulty in removing third molars, a radiograph should be obtained in order to ascertain the relation of the tooth to its surroundings.

When the tooth is in a normal direction, but retarded in erupting through want of room in the arch, it is a good plan, before attempting removal, to cut away the overlying gum and so obtain as clear a view of the tooth as possible. In cases where the tooth is slightly tilted, the curved elevator will often be found

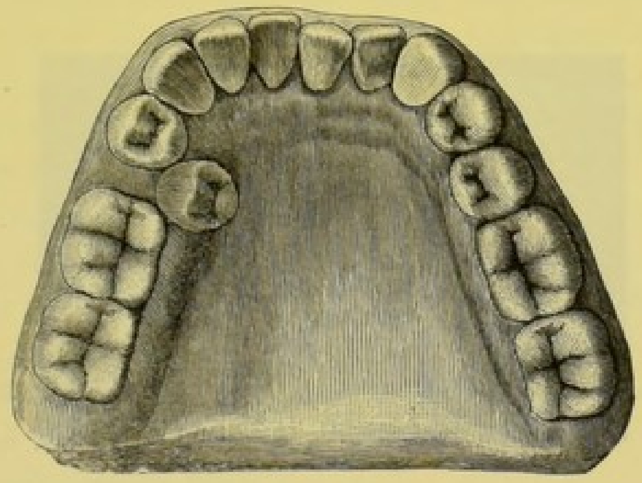

FIG. 822.

a useful instrument for removal; the blade of this instrument can usually be inserted under the crown and the tooth prised upwards. In cases where the tooth is firmly embedded in the bone, the muco-periosteum covering the alveolar process should be raised, and the bone surrounding the tooth cut away before attempting removal. The wound left after the removal of the tooth should be packed and syringed regularly until healing is complete. Attempts to remove such teeth by placing a curved elevator under them and forcibly prising upwards invariably lead to failure, and may, if too much force is used, lead to fracture of the jaw (see p. 816).

(3) **Embedded Roots.**—Roots occasionally become embedded and impacted, a good sample of this is shown in fig. 823. The radiograph depicts a second lower premolar impacted between the first premolar and first molars. In cases of this character it is always advisable to obtain a radiograph, and a careful study of it

will often be of considerable assistance in deciding upon the method to pursue in attempting removal of these roots. For example, the radiograph seen in fig. 823 shows that the embedded root lies close to the first molar and is separated by a considerable interval from the first premolar. The best instrument for the removal of these roots is a straight elevator, the roots being forced towards the direction of least resistance. In the case illustrated above the elevator should be inserted between the root and the first molar, and the root elevated towards the first premolar.

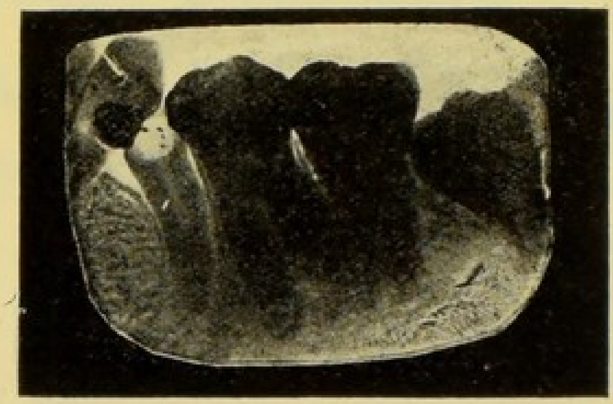

Fig. 823.

Roots lying well below the surface of the bone can often be quite easily removed by means of the screw (fig. 786). The overlying soft tissues should be forced away by "packing" and the screw worked into the pulp canal of the root until a secure hold is obtained, and then extractive movements applied.

(D) THE EXTRACTION OF THE TEETH UNDER ANÆSTHETICS

The anæsthetics used during the extraction of teeth may be divided into two classes, viz., general and local.

(1) General Anæsthetics

It is not proposed to make any allusions to the methods of administering general anæsthetics, as they hardly fall within the scope of this volume. There are, however, a few points which the operator should bear in mind when employing anæsthetics, and which may with advantage be briefly dwelt upon, but before considering them a word or two may not be out of place with

regard to the choice of anæsthetics. In dental practice the agents generally used are nitrous oxide alone or in combination with air or oxygen, ethyl chloride, ether and chloroform.

Choice of Anæsthetics.—In the very large majority of operations **nitrous oxide** should be chosen in preference to ether or chloroform, as it possesses the great advantage over them of being practically safe. In addition, the administration of nitrous oxide occupies a shorter period, and the recovery is rapid and complete. Within the last few years combinations of nitrous oxide with oxygen and with air have been introduced by Dr. Hewitt and Mr. Rowell, respectively, and both combinations possess advantages over nitrous oxide used alone.

The advantages of nitrous oxide and oxygen over nitrous oxide alone are:—

(*a*) The anæsthesia is quieter.

(*b*) The mucous membranes of the mouth do not become congested to the same extent, and the operator therefore gains a clearer view of the tooth.

The advantages of nitrous oxide with air over nitrous oxide alone are somewhat similar to those of nitrous oxide and oxygen, though less marked.

The administration of nitrous oxide by means of **the "nasal apparatus"** has been extensively used during recent years. By this means the anæsthesia can be prolonged indefinitely. This method has advantages over such anæsthetics as ethyl chloride and ether, but considerable experience and skill is required in its use; too often an asphyxial rather than a true anæsthetic state is produced. For operations requiring one to two minutes' anæsthesia, ethyl chloride is a most valuable agent, and is especially useful as an anæsthetic for children when it is necessary to remove several teeth.

The practice of constantly using methods requiring long anæsthesia has had the effect of making operators slower in their work. With the original methods of administering nitrous oxide the practitioner realized the value of every second of the anæsthesia and time was not needlessly wasted.

For operations requiring a long anæsthesia, such as the extraction of a difficult third molar, ether should be used, the administration being commenced with nitrous oxide. In such

cases many operators prefer to use chloroform, but the regular employment of this agent in dental surgery is to be deprecated, and the cases are rare indeed in which it is actually necessary. A very careful inquiry into this most important subject has been made by Dr. Hewitt, and the results of his work will be found in an exhaustive paper published in the *Journal of the British Dental Association* for November, 1896, which is well worthy the perusal of all those who are in the habit of administering chloroform.

Whenever a general anæsthetic is given for the removal of teeth two persons should always be present, one to confine his attention solely to the administration of the anæsthetic, the other to the removal of the teeth, as it is impossible for one person to operate and at the same time observe the condition of the patient during the anæsthetic period. This rule should be strictly adhered to.

Position of the Patient.—For extraction under nitrous oxide and to a great extent under ether, the positions of the patients should differ but little, if at all, from those already advocated, except that the head should not be placed so far back. Before administering any anæsthetic any removable **artificial teeth** that may be in the mouth **should be removed.** The operator should always decide beforehand exactly what he intends to do, and it is very inadvisable to attempt too much. Care should be taken to avoid pricking the gum during the examination of any roots which it is proposed to extract. **The prop should be placed on sound firm teeth** in such a position that the operator can work without being hindered by it, and the preparation being complete a final view of the mouth should be taken. **Where several teeth have to be extracted** at one sitting, their order of removal should be decided upon before the operation is commenced, and if any particular tooth is causing pain it should be extracted first. As far as possible the **order of removal** should be arranged so that changes of instruments are reduced to a minimum. As a rule lower teeth should be extracted before upper teeth, because if the latter are removed first the blood may pass down and so obscure the lower ones. For the same reason roots should be removed before whole teeth. **Each tooth or root must be cleared from the mouth before**

any attempt is made to remove another, except in cases where the gum is thoroughly adherent, when the tooth or root may be left in the mouth and freed from the gum when the patient has recovered. With teeth which have a liability to slip from between the blades of the forceps, it is well as a precaution to keep the finger of the left hand behind the blades to prevent the tooth passing backwards in the event of its slipping out.

In cases where several teeth have to be removed on both sides of the mouth, it will be found useful to remove the upper and lower teeth on one side first, and then cover the wounds with pledgets of wool, which should be held in place with the "Mason" gag. By this means the hæmorrhage is held in check during the operation on the opposite side of the mouth.

In extensive dental operations there is a tendency for the student to operate with blood flowing freely over the roots that require extraction. Such a practice invariably leads to undue laceration of the gums, and considerably retards the healing of the wounds.

(2) Local Anæsthetics

(*a*) **Infiltration Anæsthesia.**—The usual drugs used for this purpose are cocaine, eucaine, stovaine, and novocaine.

Cocaine.—This drug is an alkaloid obtained from coca leaves. Cocaine can be made synthetically. Hypodermic solutions of the hydrochloride should be made with *sterile* salt solution (·6 per cent.), not with distilled water. Cocaine solutions cannot be sterilized by boiling, as decomposition takes place. Not more than half a grain should be employed for the removal of a tooth, and even then in some cases untoward symptoms may appear.

Eucaine Hydrochloride.—Beta eucaine hydrochloride, a salt of benzoyl-vinyl-diaceton-alkamine, is obtained synthetically. It is soluble about 1 in 30 of water, and solutions may be boiled without decomposing the salt. Normal salt solution recommended as the solvent. Eucaine lactate is more soluble, dissolving 1 in 5 of water, is equally stable, and is frequently used. A good deal of information regarding this drug will be found in the *Brit. Med. Journ.*, 1904, vol. ii, p. 1862, the formula recommended being beta eucaine hydrochloride ·2; sodium chloride ·8; adrenalin solution (1 in 1,000) ·65; sterile distilled water to produce 100 c.c.

Stovaine.—The hydrochloride of alphadimethyl-amino-propanol benzoate. Occurs as a white, inodorous, crystalline powder, soluble about 4 in 5 of water, 1 in 4 of rectified spirit. According to the *Brit. Med. Journ.*, 1905, vol. ii, p. 95, a 5 per cent. solution is equal to a 10 per cent. solution of cocaine hydrochloride. Injections are recommended to be made in isotonic fluid, such as normal salt solution.

Novocaine.—Para-aminobenzoyl-diethylaminopethanol hydrochloride. A white, crystalline, odourless powder, freely soluble in distilled water. Solutions may be sterilized by boiling without decomposition.

The administration of local anæsthetics may be followed by certain toxic effects. The following toxic effects of cocaine are cited by Dr. Hewitt: "Headache; vertigo, pallor; a cold, moist skin; a feeble, slow or rapid pulse, becoming imperceptible in grave cases; incoherence of speech, nausea, vomiting, unconsciousness, trismus, and other muscular spasms, epileptiform attacks; dilated or unequal pupils, and disturbances of respiration culminating in dyspnœa and asphyxia." The treatment of cocaine poisoning should be directed first to restoring the circulation by the administration of a rapidly acting stimulant, such as sal-volatile, brandy, or the hypodermic injection of ether. The patient should be placed in the horizontal position, and the respiration watched; should the respiration show signs of failing, artificial means must be immediately resorted to.

The Technique of Administration. — The subcutaneous administration of any drug must be carried out with proper aseptic precautions. The mouth should be thoroughly rinsed with a carbolic mouth-wash, and the parts where the injection is to be made carefully cleansed with peroxide of hydrogen. The syringe used should be sterilized and the solution injected at the temperature of the body. Dr. Pare,[1] who has had considerable experience with the use of novocaine, adopts the following plan:—

"If the patient is hypersensitive, a pledget of cotton-wool soaked in a 10 per cent. solution of novocaine, applied to the gum for about two minutes, may be used to obviate even the inconvenience of the initial prick. The needle should be inserted $\frac{1}{8}$ in. from the gum margin, and not high up in the sulcus, between the teeth not over the roots, and at right angles to the plane of the tooth, so that the point of the needle impinges on the alveolar process. It is almost useless when the fluid passes up between the gum and the alveolar process, causing bullæ in the sulcus. If the needle impinges on the bone it should be withdrawn and inserted at another spot. It is curious how short a distance the needle will go into the gum in one spot, whereas in another only $\frac{1}{20}$ in. distant it will go in up to the nozzle.

[1] "Further Experience with Novocaine," *Dental Record*, July, 1908, p. 353.

One injection is first made. The injection is made in two, three, but never more than four places for one tooth. After about 2 or 3 minims of the fluid have passed into the part, a pause is made for half a minute, and when the tissues in the immediate neighbourhood have become anæsthetic, the needle is farther insinuated and another few minims injected, to be followed by a further pause. When the desired position for the injection is attained, the contents of the syringe are allowed to pass slowly into the tissues. The whole procedure should occupy from five to ten minutes. Success as measured by absence of pain depends almost entirely upon the slowness with which the injection is performed. As the fluid permeates, the gum becomes blanched owing to the local constricting action of the suprarenin on the blood-vessels. This phenomenon affords the index to successful injection; it shows that the injected fluid has not escaped through adjoining sockets, nor become unduly diffused; the anæsthetic has been restricted to the desired sphere of action, but if the blanching immediately disappears on the removal of the needle it is a failure."

In cases where the alveolar process is thin, Dr. Pare passes the needle up between the gum and the bone, keeping as near the latter as possible, and allows ten minutes to elapse before operating. In some cases where the tooth is loose or the gum detached, the needle (a long one) should be passed between the tooth and the bone. Dr. Pare recommends that a 4 per cent. solution of novocaine should be used.

The injection of cocaine, eucaine, and stovaine may be carried out on similar lines.

Local and General Disturbances.—The local disturbances following the subcutaneous injection of drugs are frequently the direct result of neglect of aseptic precautions, but this is not always the case. The wounds do not react so readily as when no local injection has been used, and this is probably due to the lowering of the resistance of the tissues by the drugs. Local anæsthesia must be used with great caution where the tissues around the teeth are infected, as the act of injecting the drug will tend to disseminate the infection and may thus lead to serious complications and death.[1] A case of this character is

[1] *Semaine Médicale*, January 17, 1906.

reported by Maragliano.[1] Under local anæsthesia, a tooth was removed for periodontal disease, and the operation was followed by an increase in the local infection and, subsequently general infection, death occurring eight days after the injection. In another case in which 30 minims of "alvatunder" was used death immediately followed the removal of nine teeth. The *post mortem* showed fatty degeneration of the heart.

In using local anæsthetics where there is suppuration Dr. Pare recommends that the injection should be on the side of the gum remote to the swelling. If it is necessary to inject on the side of the swelling care must be taken to avoid the suppurating area.

(*b*) **Freezing Agents.**—This group includes such preparations as **chloride of ethyl, coryl** (a mixture of chloride of ethyl and chloride of methyl in such proportions that the mixture boils at 0° C.), and **anestyle.** Generally speaking, the anæsthesia produced is by no means satisfactory. To use them to the greatest advantage attention must be given to the following points :—

(i.) The gums must be well dried and, as far as possible, all the neighbouring regions, such as the cheeks and tongue, protected by napkins or other suitable material.

(ii.) The gums must be thoroughly frozen before the operation is commenced.

(iii.) The extraction must be carried out as quickly as is consistent with thoroughness.

(iv.) If possible, the spray should be continued during the operation.

(v.) Too great a jet should not be used.

Freezing agents can be employed much better for front than for back teeth, in fact it is often difficult to freeze the gums at all satisfactorily at the back of the mouth.

(E) DIFFICULTIES, COMPLICATIONS, AND SEQUELÆ OF EXTRACTION OF THE TEETH

Like all other surgical operations, the extraction of teeth is at times attended with certain difficulties, complications and sequelæ, which, for the sake of convenience, will be considered under the following headings :—

[1] *Brit. Med. Journ.*, January 11, 1908.

(1) Difficulties, complications and sequelæ connected with the teeth themselves.

(2) Difficulties, complications and sequelæ connected with the jaws.

(3) Difficulties, complications and sequelæ connected with the soft parts.

(4) Difficulties, complications and sequelæ arising during extraction under anæsthetics.

(5) Miscellaneous complications, difficulties and sequelæ.

(1) Difficulties, Complications and Sequelæ connected with the Teeth themselves

(*a*) **Undue Resistance of the Tooth and Alveolar Process.**—A tooth may offer considerable resistance to removal. This is naturally, though by no means always, met with in persons of strong physique. Isolated teeth are always more firmly fixed than those in series; this is accounted for by a consolidation of the bone around them. Experience will act as a guide, and after a little observation it is to a certain extent possible to recognize such teeth. Should undue resistance be met with, steady attempts to move the tooth slightly in different directions should be made and persevered with; if this precaution is not taken and too much force is used in any one direction, fracture of the tooth or alveolar process is sure to result. It may even be found impossible to remove the tooth, and in that case it is best to dismiss the patient and make a fresh attempt two or three days later; the teeth will then probably be loose, as a result of the inflammatory process which has been set up by the previous attempt at extraction, and can be easily removed.

The causes of undue resistance are:—

(i.) Abnormal density of the alveolar process.

(ii.) Divergent and twisted roots.

(iii.) Alteration in the shapes of the roots brought about by periodontal inflammation.

(*b*) **Fracture of the Tooth.**—The principal causes of this accident are:—

(i.) The use of badly fitting forceps.

(ii.) The use of unnecessary or wrongly applied force in attempting to loosen the tooth in its socket.

A tooth having been fractured, the patient should be made to rinse the mouth until the bleeding has ceased; the socket should be dried with cotton-wool, and the position and edge of the root defined with a probe before an attempt is made to remove the fractured portion. It is neglect of these steps that so often leads to failure to remove the remaining portion of a fractured root. Too many attempts to remove a fractured root should not be made; if a second endeavour prove fruitless, the patient should be dismissed and a fresh attempt, if necessary, made after a period of one or two days, as the tooth will probably then be looser; moreover, the hæmorrhage will have ceased and it will be possible to obtain a clearer view of the root. Before dismissing the patient, however, an anodyne mouth-wash should be prescribed, and the pulp, if exposed, touched with a strong escharotic. The lower third of a root may generally be left without fear of unpleasant consequences; but it is always advisable to inform the patient when any portion of a tooth is allowed to remain in the jaw, as such knowledge may be of assistance should any trouble arise at a subsequent date.

(*c*) **Crowded and Irregular Teeth.**—The removal of these has already been referred to on p. 805.

(*d*) **The Removal of the Wrong Tooth.**—Should the operator accidentally remove the wrong tooth, it must be immediately replaced and, if necessary, secured with a ligature. If the pulp subsequently shows signs of degeneration or inflammation, it should be removed and the canal treated and filled.

(*e*) **Dislocation of a Neighbouring Tooth.**—This accident, which is generally due to a crowded arrangement of the teeth, seems to occur most frequently with the removal of the first permanent mandibular molar, the neighbouring tooth usually involved being the second premolar, which is simultaneously dislocated from its socket. To avoid this contingency the thumb should be placed on the tooth which shows a tendency to move, and only as much force exerted in the removal of the tooth which is being extracted as can be controlled by the thumb. If a neighbouring tooth is removed, it must be replaced and treated in the manner described above.

(*f*) **Removal of an Unerupted Premolar.**—This may be

an avoidable or an unavoidable accident. At times the developing premolar is so firmly embraced by the roots of the deciduous molar that during the extraction of the latter tooth the premolar is removed; such an accident cannot be avoided. It is an avoidable accident when it occurs through using too much force in the extraction of the roots of a deciduous molar.

(*g*) **Breaking One Tooth in Extracting Another.**—In the extraction of mandibular teeth with hawk's bill forceps the maxillary teeth may be fractured. This accident is generally due to inexperience, and arises from the tooth leaving its socket suddenly owing to the extracting force being used in an upward rather than an outward direction. It may, however, occur when a lower tooth has been more than normally resistant. It is well, therefore, for the operator to be on guard by keeping the thumb or a finger of the left hand over the joint of the forceps. An adjacent tooth may also be fractured in using the elevator.

(2) Difficulties, Complications and Sequelæ connected with the Jaws

(*a*) **Fracture.**—The fracture and removal of a **small piece of the alveolar process** is not an infrequent accident, but the result is not serious. It is sometimes unavoidable, but at other times is due to placing the blades of the forceps on the outer side of the bone instead of between the bone and the root of the tooth.

Extensive fracture is sometimes seen; for instance, in a case that came under notice at the Dental Hospital of London, an unqualified person in removing the first mandibular right permanent molar fractured the bone in a horizontal direction, so that the second and first premolars with the canine were completely separated from the body of the bone. Mr. Salter[1] gives an account of an extensive fracture of the jaw in the case of a lady, aged 35. The fracture occurred in connection with the removal of the maxillary central incisors. The right central incisor required some considerable force for its removal, and, when it came away, the whole of the front of the alveolus was firmly

[1] "Dental Pathology and Surgery," p. 340.

attached to the root. In removing the left central incisor a similar accident occurred. On examination of the parts the mass of bone corresponding to the intermaxillary bone was found to be merely held in place by the soft tissues. "A vertical fracture extended from the side of the canine up to the root of the nose, then nearly horizontally across to the opposite side, being connected there with another vertical fracture. The lesion passed completely through the jaw from before backwards, and there was a wound in the palate three-quarters of an inch from the alveolar border, through which was considerable hæmorrhage." A still more severe example of fracture during extraction of teeth is recorded by Mr. Cattlin,[1] where, in an attempt to remove a third maxillary molar with an elevator, the tuberosity of the maxilla, a portion of the floor of the antrum and part of the sphenoid were fractured. Fracture of the maxillary tuberosity may occur during the removal of the third molar, and Mr. Nicol[2] records such on accident during the removal of the second permanent molar. In a case recorded by Mr. L. Matheson,[3] a transverse fracture of the maxilla occurred in a line between the first and second permanent molars during the removal of the first-named tooth. Direct transverse fracture of the horizontal ramus of the mandible due to extraction of the teeth has also been recorded. In a case recorded by J. H. Badcock[4] a fracture involving the ascending ramus occurred during an attempt to remove a misplaced third molar.

Treatment.—In fracture of small portions of the alveolar process no special treatment is called for except that all loose fragments should be removed. When the fracture is of a more extensive character, the fragments must be retained in position by a suitable form of splint, a description of which will be found in the chapter dealing with fractures of the jaws.

(*b*) **Necrosis** of the alveolar process may result from extraction and is generally caused by undue violence or some septic process occurring in the wound. For treatment see chapter XXX.

[1] *Trans. Odonto. Soc.*, vol. iii, p. 138.
[2] *Ibid.*, vol. xxviii, p. 3.
[3] *Journ. Brit. Dent. Assoc*, vol. xiv, p. 727.
[4] *Trans. Odont. Soc.*, vol. xxxv., p. 229.

(*c*) **Dislocation of the temporo-mandibular articulation.**—The use of too much force in extracting a mandibular tooth may lead to unilateral or bilateral dislocation of the temporo-mandibular articulation, if the force is not counteracted. This accident may also be brought about by forcing the mouth open too much with a Mason's gag during the administration of an anæsthetic. It may likewise occur without the employment of undue force in cases where dislocation has previously occurred. (For treatment see p. 858).

(*d*) **Opening of the Antrum.**—The antrum may be opened by the removal of the upper premolars or molars. This accident may be due to a portion of the floor of the cavity adhering to the teeth, or it may be due to the fact that the root of the tooth has only been separated from the antral cavity by its lining membrane which has been torn away during extraction. The condition is recognized by epistaxis and by fluid passing from the mouth into the nasal fossa *via* the antrum. The condition usually does not call for treatment unless the opening persists, which is extremely rare.

(*e*) **Forcing a Root into the Antrum.**—This occurs mostly in connection with the extraction of the second maxillary premolar root and buccal roots of the first permanent molar. **If a root** has been dislocated into the antral cavity but **still partly remains in its socket,** the best course to pursue is to leave it alone and not to attempt removal, as the attempt might only result in complete dislocation of the root into the antrum. The socket should be kept quite clean by the continual use of antiseptic washes. As a rule the root gives rise to no subsequent trouble. **When a root has been forced completely into the antrum,** the opening into the latter should be enlarged and the antral cavity thoroughly syringed. For this purpose it is well to use an aural syringe of 5 or 6 oz. capacity. The *rationale* of this form of treatment is that the root may pass out with the return current from the antrum. If this treatment fails, an attempt may be made to remove the root with a little scoop of gutta-percha fixed on to a flexible wire. Should this procedure prove unsuccessful, free access to the cavity must be gained by an opening through the canine fossa.

(*f*) **Forcing a Tooth into an Abscess Cavity.**—This accident requires similar treatment to the accident just described in connection with the antrum.

(*g*) **Trismus.**—Inability to open the mouth obviously renders extraction of the teeth more difficult than usual. When, however, the closure is the result of inflammatory trouble in connection with the lower molars, an anæsthetic should be given and the mouth opened forcibly with a Mason's gag. If the trismus is the result of tonic contraction of the muscles closing the jaw, ether should be used in order to overcome the resistance of the muscles, as nitrous oxide would not have the desired effect.

(3) Difficulties, Complications and Sequelæ in Connection with the Soft Tissues

(*a*) **Extensive Laceration of the Gum.**—The soft tissues naturally suffer when a tooth has been difficult to remove, and may be severely lacerated when the gum is more than usually adherent to a tooth. This complication is most frequently seen in the removal of the mandibular third molar, but it is also sometimes met with in the removal of loose teeth. When the gum is found to be more than usually adherent, the tooth should be left in the socket until the gum attachment has been divided with a pair of scissors or a lancet. Continued attempts to remove the tooth with the forceps before the gum has been detached will only lead to increased laceration. In all cases where the gums have been badly lacerated, an anodyne mouth-wash should be prescribed.

(*b*) **Wounding the Tongue.**—This is most likely to occur under nitrous oxide, as the tongue during anæsthesia is generally swollen, and is, moreover, not under the control of the patient. Wounding the tongue is nearly always due to carelessness in using the elevator. **When the tongue is much lacerated,** the overhanging portions should be trimmed off with scissors and the surface kept clean with antiseptic mouth-washes.

If the tongue is punctured and the wound does not involve a large branch of the lingual artery, but yet bleeds freely, the tongue should be drawn forward; if this does not prove successful the insertion of a stitch will generally cause the hæmorrhage to cease.

If the tongue is punctured and a large branch of the lingual artery is involved, the finger should be placed on the back of the tongue and the organ drawn forward; this compresses the lingual artery against the hyoid bone. The bleeding point must then be sought for, and, if found, an attempt made to twist the wounded vessel. If this fails, cauterization may be tried, and, as a last resource, if cauterization does not stop the bleeding, the lingual artery must be tied.

(*c*) **Bruising the Lower Lips.**—This may occur in the removal of premolars and molars, and is due to having the mouth insufficiently opened, and using forceps of too straight a pattern.

(*d*) **Injury of the Mandibular Nerve.**—The mandibular nerve may be injured during the removal of the mandibular molars and premolars. Loss of sensation over the parts supplied by the nerve, with dribbling saliva, generally follows the accident. Sensation is, however, usually restored, and in cases of laceration the nerve generally unites. Mr. Sewill records a case in which "the roots of a lower wisdom tooth contained a groove and a foramen through which the inferior dental nerve had evidently passed." A similar case has been reported by Mr. R. H. Cumine. Removal of a mandibular third molar was followed by profuse hæmorrhage for ten minutes, and a fearful paroxysm which lasted without intermission for about eight hours. Seven months after the extraction the patient had not recovered.

(*e*) **Suppuration in the Tooth Socket.**—Suppuration in the wound, resulting from extraction, is invariably due to neglect of proper after-treatment. It is more liable to occur where the tissues in the vicinity of the tooth have been lowered in their vitality, for example, in cases of chronic periodontitis or where there is a lowered general vitality, as seen in such conditions as diabetes, chronic nephritis, tuberculosis.

Suppuration of the wound may be due to direct infection either from septic foci in the mouth or the inhalation of air laden with infectious organisms. Cases arising from the latter cause are frequently met with in those constantly working in hospital.

In those cases **where the pus is putrid** and there is reason to suspect infection, the socket should be thoroughly syringed with some antiseptic, such as hyd. perchlor. 1 in 1,000, carbolic acid

1 in 40; following this the parts should be carefully dried with cotton-wool. A small piece of chloride of zinc should then be introduced and allowed to dissolve in the socket, which must be subsequently kept aseptic by constant irrigation with some antiseptic solution. Suppuration occurs more frequently in the mandible than in the maxilla, the drainage of the latter being more easily effected owing to the dependent position of the sockets. In many cases it will be found necessary to plug the socket with iodoform gauze; this prevents the accumulation of *débris*, which would act as an irritant. In cases **of suppuration occurring in patients of diminished vitality** a tonic form of treatment should be prescribed; the dressing in the socket should be removed two or three times a day and the socket syringed.

Care must be exercised in applying escharotics to sockets to which the nerve may be in close proximity; this is especially necessary in dealing with impacted lower third molars. Two cases illustrating this point have come under my notice. In the first a mandibular second premolar with a long-standing chronic abscess had been removed. The patient complained of pain, the socket was syringed out and a small piece of chloride of zinc inserted. Intense agonizing pain followed, which all local anodynes failed to relieve. In the second case an impacted right lower third molar had been removed. The socket suppurated, and the pain, although severe, was not intense. Treatment similar to that used in the first case was adopted, with similar results. In all cases where it is possible that the trunk of the nerve may be in close proximity to the socket, a non-irritating antiseptic injection should be used and the socket plugged with cotton-wool dipped in tincture of opium. It is advisable to inform the patient of the possibility of pain following the extraction of a tooth, especially after periodontitis, and in all cases after extraction a mouth-wash should be prescribed; for even if there is no pain, it will prevent the discharge from the sockets of the teeth undergoing putrefactive changes.

(*f*) **Hæmorrhage following tooth extraction** is a most important complication, and one which needs prompt treatment. Hæmorrhage is predisposed to by a diathesis known as **hæmophilia.** Of its pathology but little seems to be definitely known.

The blood in this condition is said by Walsham to be deficient in fibrin. Hæmorrhage may occur in people not predisposed to the above-named diathesis; in some instances it is probably due to pathological changes in the artery supplying the tooth, these changes being frequently induced by inflammation around the apex of the root, the vessel becoming adherent to its bony surrounding, and thus being prevented from contracting. Another condition, which may have a practical bearing, is the occurrence of hæmorrhage during the menstrual period. The removal of teeth during the menstrual period should be avoided, as there is a greater liability to hæmorrhage at this period. An interesting case bearing on this point has been reported by Dr. Dorn[1]:—

"The patient was 20 years of age, of weakly build. Dr. Dorn had previously extracted a tooth, and no undue amount of bleeding followed. On May 5, about 7 o'clock in the evening, he extracted a lower molar, no unusual force was needed, the gum was not torn, and when the patient left the bleeding had ceased. About 11 o'clock the following morning the patient returned with profuse hæmorrhage, the mouth being full of clots, and the blood still oozing away. The bleeding, she said, commenced about three hours after going home and had not ceased since, though cold alum and vinegar had been applied. Dr. Dorn plugged the socket with iodoform gauze, covering it with a pad of 'Stent.' The following morning he removed the dressing and believing that the hæmorrhage had permanently ceased, he dismissed the patient. About 6 the same evening the bleeding recommenced and the dressings were reapplied as before. A couple of days after the dressings were again removed and the wound healed in the usual way.

"Her periods were usually regular; she menstruated in April and again in June, but in May menstruation, which should have occurred at the period of the above-mentioned hæmorrhage, was absent. Curiously, a similar occurrence had coincided with severe hæmorrhage from the nose a couple of years previously. Dr. Dorn regards the case as one of vicarious menstruation."[2]

Hæmorrhage is generally divided into three stages—primary, intermediate and secondary. In the mouth we often find the primary running into the intermediate.

The treatment of primary hæmorrhage, or that occurring at the time of the operation, is not of serious import. If it is at all sharp, a useful plan is to give the patient some tincture of

[1] *Dental Record*, 1897, p. 351.

[2] An interesting paper on the subject of extraction during the menstrual period was published in the *Deutsche Monatsschrift für Zahnheilkunde*, May, 1897.

hamamelis in the water used for rinsing the mouth. At the same time, calcium lactate (15 gr.) should be administered, and the patient ordered to take a similar quantity every three hours until the hæmorrhage ceases. The socket should also be loosely plugged with cotton-wool dipped in some styptic, such as gallic acid.

Intermediate and secondary hæmorrhage is more serious and generally sets in at night. When a case of intermediate hæmorrhage is first seen, two important points should be ascertained before treatment :—

(1) Whether the bleeding emanates from the gums or the socket of the tooth.

(2) Whether the blood shows a tendency to coagulate.

The latter point will act as a guide in the choice of drugs for internal administration.

In hæmorrhage from the gum, search should be made for any small vessels that may be the cause of it, and if found they should be twisted or compressed. If the vessel is only partially divided it should be completely severed, as this will probably allow contraction to take place. If the bleeding is capillary in character, a pad of gutta-percha, lined with lint, dipped in some styptic and applied with firm pressure, is usually sufficient to stop it.[1] A method which is efficacious is as follows: With a curved needle in a holder, threads of horsehair are passed through the gum from one side to the other (one usually being sufficient). The ends are then tied tightly, the effect being to exert pressure on the gum and at the same time retain the clot in position.

When the hæmorrhage proceeds from the socket the following mode of procedure is adopted: Some small cone-shaped pieces of non-absorbent cotton-wool are prepared (each about $\frac{1}{3}$ to $\frac{1}{2}$ in. long and $\frac{1}{4}$ in. broad at the base), also a pad of lint and a four-tailed bandage, a syringe, a pair of conveying forceps, some cold water and the chosen styptic are likewise placed ready for use. The socket is first freed from clot, then syringed, then dried out with a pledget of cotton-wool,

[1] Perchloride of iron should be avoided as a styptic; it nearly always contains some free acid, and is therefore detrimental to the teeth; in addition to this it leads to extensive clotting in the veins, as well as to a certain amount of sloughing of the gums.

and directly afterwards one of the cone-shaped pieces of cotton-wool dipped in the styptic (the most useful being tannin) is placed in the socket and forced to the apex with a fair amount of pressure; the hæmorrhage is arrested far more by pressure than by the styptic. More pledgets of wool are inserted until the socket is quite full; a plug of lint is then placed over all and kept in position by antagonism with the opposing teeth, a four-tailed bandage being used for this purpose.

An excellent method of keeping the plug in the socket, if the approximal teeth are standing, is to wedge a piece of wood between them. Excellent as this plan is, however, if the hæmorrhage is at all sharp it is better to use the four-tailed bandage to make more certain of retaining the plug in position. The number of pledgets of wool inserted in the socket should be counted.

In addition to plugging the socket, hæmostatics should be administered.

The general directions to be given to the patient, though apparently trivial, are most important and should never be omitted. The patient should be advised to go home very quietly, to avoid all forms of excitement, to assume the sitting position usual during the day, and to use a high pillow at night. The patient should be fed through a bent tube and all fluids should be given cold.

In cases where there is a thin watery blood and no tendency to coagulate it may reasonably be assumed that the cause of the hæmorrhage lies in the blood, and calcium lactate in 15 gr. doses will be found useful, but **when the blood shows marked tendency to coagulate** in the mouth, as often happens, and the bleeding still continues, such drugs as ergot[1] are indicated; in this latter condition it may be assumed that the cause of hæmorrhage lies in want of contractility of the vessel wall, and ergot causes contraction of unstriped muscular tissue.

The patient should be seen within twenty-four hours after treatment, and if the bleeding has ceased the plugs may be

[1] ℞ Ext. ergotæ liquidi .. .. ♏xx.
Acidi sulphurici diluti .. .. .. ♏x.
Aquam rosæ .. .. ad. ℥i.
Mitte ℥viii.
M. Two tablespoonfuls every three hours until the hæmorrhage ceases.

removed and an antiseptic mouth-wash prescribed. This course is not recommended when the hæmorrhage has been severe; under such circumstances the plugs should be allowed to work themselves out. If the hæmorrhage has not then ceased, the socket should be replugged tighter than before with a plug of wool wrapped in non-absorbent cotton-wool. Should this prove of no avail the actual cautery may be tried; if this fails, and the bleeding is from the mandible, the canal should be trephined and a plug of ivory inserted, so as to compress the artery against the inner plate of the bone. In uncontrollable hæmorrhage from the maxilla, digital pressure on the common carotid opposite the transverse process of the sixth cervical vertebra may be tried; should this fail to stop the hæmorrhage, ligature of that vessel must be resorted to. In one case of hæmorrhage from the region of the third right lower molar Mr. Boyd divided the lip in the medium line and reflected the cheek from the jaw. The mandibular canal was then laid open by excising the outer plate of the bone, and the bleeding was arrested by plugging the mesial and distal ends of the canal.

In extreme cases with signs of collapse normal saline solution must be infused into the median basilic vein. Cases of death from hæmorrhage following tooth extraction have been reported.

In patients predisposed to hæmorrhage extraction should be avoided if possible; but if the removal of the tooth be absolutely necessary, prophylactic treatment should be pursued for five or six days previous to the operation, by the administration of calcium lactate in doses of 10 to 15 gr. three times a day. A new styptic consisting of fibrin ferment, 1 to 10, to which 1 per cent. of calcium chloride has been added, is said by Walsham to act only on the blood, not on the tissues, and to be perfectly aseptic. It was found to be effectual in arresting hæmorrhage after the division of all the veins except the common jugular in a dog's neck. The tooth should be extracted in the early morning, so as to have the whole day for treatment, should hæmorrhage occur. Some hæmostatic should be administered at the time of the operation and the socket plugged at once as a preventive measure, for, be it remembered, it is far easier to prevent the hæmorrhage occurring than to arrest it when once it has

commenced. The subsequent treatment will consist in the continued administration of hæmostatic drugs. In regard to the use of ergot during gestation, Dr. Routh is of the opinion that liquid extract of ergot in 10 to 15-minim doses three times a day will do no harm in pregnancy of any date. Larger doses should be avoided, as they unquestionably increase the duration of the intermittent uterine contractions, and might thus expel the contents if there were a tendency to abortion from uterine action as the primary cause.

(*g*) **Injury of the Arteries in the Neighbourhood of the Teeth.**—Wound of the lingual artery has been referred to under the heading of Injuries to the Tongue. **Laceration of the ranine, anterior and posterior palatine** arteries may also occur. Such accidents are usually the result of the forceps slipping and are therefore avoidable.

Treatment consists in pressure or in twisting or in tying the the divided vessel. In the case of the **anterior or posterior palatine artery** it may be found necessary to plug the foramina which give passage to these vessels.

(*h*) **Pain following Tooth Extraction.**—The causes giving rise to pain following the extraction of a tooth are:—

(i..) **Incomplete extraction of the tooth,** more especially when the remaining portion contains an exposed pulp.

(ii.) **Too Rapid Healing of the Orifice of the Socket.**—It sometimes happens that the margins of the wound left after extraction unite very early, and when this occurs the discharges which naturally come away from the granulating surface at the base of the socket have no exit; the consequence is that they are retained and increase the inflammatory reaction in the surrounding tissues.

(iii.) **Suppuration in the Tooth Socket.**—(See p. 819.)

(iv.) **Extensive laceration of the hard and soft tissues** in the neighbourhood of the socket; and

(v.) **Necrosis of the socket of the tooth,** are also fruitful sources of pain following tooth extraction.

(vi.) **The Presence in the Wound of a Foreign Body.**—A curious example of this came under notice a few years ago. A patient applied for the extraction of the left first permanent molar During the operation a portion of one of the cusps disappeared;

a search was made for it, but as it was not found the natural supposition was that it had been removed in rinsing the mouth. The patient for the next three weeks complained of slight pain in the socket, for which remedies were tried but proved of little use. Eventually the patient discovered the cusp on the top of the granulation tissue which had filled up the socket. In another case of the same character which came under notice the offending material was a piece of an amalgam filling. A fractured blade of forceps may likewise act as the offending body.

(vii.) **Injury to the Nerve.**—Direct injury to the trunk of the nerve is more likely to occur during extraction of the lower third molar than with any other tooth. It is more than probable that many obscure cases of pain following tooth extraction are due to exposure and irritation of the nerve at the apex of the socket. An interesting case of this character was reported by Mr. Storer Bennett. The patient, a lady aged 23, had had the third maxillary molar dislocated through the use of a Mason's gag, and as it was considered hopeless to restore the dislocated tooth it was extracted without difficulty. The socket, in spite of treatment, remained painful for the next twelve days, but in the meanwhile granulated healthily, except at its apex, where by the aid of a mirror and probe a spot about the size of a pin's head was noticed, which caused the greatest agony on being touched. Incision of the nerve produced permanent relief.

Treatment.—The treatment of cases where pain follows tooth extraction must obviously depend in a great measure on the cause. A thorough examination of the socket should be made with probe and mirror. **When due to incomplete extraction** another attempt, if considered advisable, may be made to remove the tooth. This proving unsuccessful, the socket should be swabbed with an anodyne drug, and, if there is an exposed pulp in the remaining portion of the tooth, the pulp should be touched with strong carbolic acid. The patient should also be advised to use poppy-head fomentations.

Where **the orifice of the socket heals too rapidly,** the freshly healed surfaces must be separated, the socket syringed out, and a small tent of lint allowed to remain in the orifice for about twelve hours. An antiseptic mouth-wash should also be prescribed.

In pain due to necrosis of the socket, deodorant antiseptic injections must be used, while in extensive laceration of the soft and hard parts, an anodyne mouth-wash[1] may be tried. In all **obscure cases** some local anodyne, such as tincture of opium or cocaine, should be applied to the socket, and a mouth-wash having similar properties should at the same time be prescribed.

(*i*) **Traumatic Emphysema.**—A case in which traumatic emphysema followed tooth extraction is recorded by A. Turnbull.[2] A bugler immediately after having an upper premolar removed blew his bugle, with the result that the face became considerably swollen, due to the passage of air through the empty tooth socket into the cellular tissues.

(4) Difficulties, Complications and Sequelæ arising during Extraction under Anæsthetics

(*a*) **Tongue Slipping Back.**—During extraction under anæsthetics the tongue, not being under control, may slip over the larynx, or may be forcibly pushed back by the fingers of the operator. Symptoms of difficult breathing or even arrest of respiration will follow this accident. It is not sufficient merely to watch the chest walls, as respiratory movement may continue without air entering the lungs. **Treatment** consists in pulling the tongue forcibly forward with a suitable instrument and forcibly extending the head on the spinal column. Pushing the mandible forward with the thumbs behind the angles will usually suffice.

(*b*) **Forcing out a Tooth with a Prop or a Mouth-opener.**—This accident may arise from resting a prop upon teeth which are loose, or from placing it in such a position that undue leverage is brought to bear on the teeth. It is an accident most likely to occur when the prop is fixed upon the front teeth and the mouth opened to its widest extent. Under such conditions undue leverage at right angles to the long axis of the tooth is brought

[1] ℞ Zinci sulphatis .. .. gr. viii.
Zinci chloridi .. .. gr. vi.
Morphinæ acetatis .. .. gr. ii.
Aquam .. .. ad. ℥viii.
M. Fiat lotio.
To be used with an equal quantity of water as a mouth-wash.

[2] *Brit. Med. Journ.*, May 5, 1900, p. 1131.

to bear upon the palatal surfaces of the upper teeth, and they are consequently forced outwards.

With a mouth-opener the accident is due to clumsiness; great care should therefore be exercised when using this very powerful instrument. If a tooth is forced out it should, if possible, be immediately replaced.

(*c*) **Passage of a Foreign Body through the Isthmus of the Fauces.**—A foreign body, such as a tooth, a broken piece of forceps, or a prop, passing through the isthmus of the fauces may become impacted in either the air or food passages.

(i.) In the air passages it may lodge (*a*) over the entrance of the larynx, (*b*) in the larynx, (*c*) in the trachea or bronchus.

(ii.) In the food passages it may lodge (*a*) in the pharynx, (*b*) in the œsophagus, (*c*) at the pyloric opening of the stomach.

(i.) **In the Air Passages.**—Should the foreign body lodge **over the entrance of or in the larynx,** the patient will be seized with a violent fit of coughing which may expel it; but should this not happen, symptoms of asphyxia will supervene. With regard to treatment: the head should immediately be brought forward and the finger inserted along the side of the mouth into the pharynx, and then given a forward sweeping movement; by this means the foreign body if lodged at the back of the tongue, will probably be removed.

This failing, the patient must, if possible, be inverted and a forcible slap given on the back. If the foreign body is not dislodged by this method, laryngotomy should immediately be performed. There must be no hesitation about the performance of this operation and it must be carried out promptly, for the longer it is delayed the less becomes the chance of saving the life of the patient.

A foreign body in the trachea or bronchus usually gives rise to a violent fit of coughing, with signs of impending asphyxia. These signs pass away, to be followed at intervals by fresh attacks of coughing, and eventually by symptoms of collapse of the lung or lungs. In a case recorded by Sir William MacCormac,[1] during the removal of a maxillary premolar the palatine blade of the forceps snapped off close to the joint

[1] *Journ. Brit. Dent. Assoc.*, vol. vii, p. 32.

and disappeared. The patient immediately suffered from great dyspnœa and appeared to be dying. The symptoms passed away, and for the following six weeks the patient's condition gave no great cause for anxiety, although she suffered from a constant hacking cough accompanied by bloody expectoration. Seven weeks after the accident she was admitted into St. Thomas's Hospital, the foreign body was with difficulty removed from the right bronchus, and the patient made an excellent recovery.

When there is a suspicion that a tooth may have passed into a bronchus, prompt measures must be taken. In the first place an examination must be made with X-rays and this, even if negative in character, should be followed by a thorough examination of the chest by auscultation and percussion. In the event of the foreign body being lodged in a bronchus, immediate steps should be taken to remove it, and although in the past this was an extremely difficult undertaking, the introduction of the bronchoscope has rendered the removal of such foreign bodies very much easier.

(ii.) **In the Food Passages.—A foreign body impacted in the pharynx** will give rise to pain, symptoms of dysphagia and dyspnœa. A hacking cough is generally present. Should a foreign body be suspected in the pharynx, its presence can usually be ascertained by digital exploration; this failing, the cavity should be examined by the aid of a laryngoscope.

An attempt should first be made to remove the body with the fingers: and if this is unsuccessful pharyngeal forceps must be called into use. In some cases, where the impaction is very firm, it may be necessary to perform pharyngotomy.

A foreign body in the œsophagus will cause dysphagia, and will probably give rise to constant pain; if it is situated in the upper part it will in all probability give rise to dyspnœa. On applying the stethoscope over the region of the œsophagus, a gurgling sound will be heard when the patient swallows fluids. The presence of a foreign body may be definitely ascertained by the use of the X-rays.

If impacted in the upper part of the œsophagus an attempt may be made to remove the impacted body with forceps; this failing, œsophagotomy must be performed.

If lodged near the cardiac end of the œsophagus an attempt may be made with a bougie to push the foreign body into the stomach ; this failing, gastrotomy should be performed.

If a foreign body becomes impacted at the pyloric opening of the stomach, it will give rise to gastric dilatation. Under such circumstances, the stomach must be emptied of its contents, and gastrotomy then performed.

(5) Miscellaneous Difficulties, Complications and Sequelæ

(*a*) **Uterine Pain.**—A case is quoted by Mr. Sercombe where extraction of a tooth was followed by paroxysmal uterine pain, followed by the cure of an obstinate leucorrhœa.[1]

(*b*) **Menorrhagia** (Profuse Menstruation).—A case is recorded, in which a married woman aged 25, unipara, was seized with violent bleeding from the uterus after the removal of teeth under chloroform anæsthesia. Packing the uterus with tampons saturated with various solutions, and the administration of ergot and strychnine, were tried without success. Finally the uterus was curetted and packed, the hæmorrhage ceasing at the end of twenty-four hours. An examination of the scrapings from the uterus showed the presence of chronic follicular endometritis. Menorrhagia is liable to occur with such local conditions as endometritis, and it is possible that the extraction of the teeth, similar to any other operation combined with the chloroform anæsthesia, may have indirectly determined the menorrhagia. The lesson to be learnt from the case, however, is the necessity of avoiding dental operations as far as possible during the menstrual period.

(*c*) **Shock.**—The fact that **tooth extraction is a surgical operation** and may be followed by shock is often overlooked. As a rule, the amount of shock which follows is practically *nil*, but at times, especially in the weak, it may be well marked. The effects of shock are not taken sufficiently into account when a question arises as to the number of teeth to be extracted at one sitting. It should clearly be borne in mind that a strong,

[1] A. Anorifrieff, *New York and Philadelphia Medical Journal*, April 22, 1905 ; translated from *Roussky Vratch*, February 26, 1905.

able-bodied person can bear more severe operations than one of weaker physique.

(*d*) **Syncope at the time of the operation** sometimes occurs. In these circumstances, the operator should immediately desist until recovery ensues. Fainting is best treated by bending the head down towards the knees, at the same time loosening anything tight about the neck and waist, and applying ordinary salts of ammonia to the nose. **In severe cases** the patient should be removed from the chair and laid on the floor, and the chest should be exposed and flipped with a towel dipped in cold water. **In more severe cases** it may be necessary to inject ether or some other stimulant, such as brandy. **Fatal syncope** following tooth extraction has occurred. In one case recorded,[1] the patient was a female, and an attempt was made to remove a tooth, but owing to alarming syncope the operation was abandoned. A second attempt was about to be made when fatal syncope ensued. *Post-mortem* examination showed nothing beyond a slight amount of cerebral congestion.[2]

(*e*) **Epilepsy.**—In persons predisposed to epilepsy an attack often commences immediately after the extraction of a tooth. In the event of a fit occurring, the patient should be removed from the chair and placed on the floor, the clothes being at the same time loosened, and a wedge of wood or some suitable material placed between the teeth to prevent injury to the tongue.

(*f*) **Hysteria.** — Manifestations of this disorder at times follow tooth extraction, but do not call for any special treatment beyond that usually adopted for this disorder.

(*g*) **Septic and Infective Sequelæ.**—Scattered through dental literature will be found a large number of records of septic and infective diseases which have followed the extraction of teeth. In many of these cases it would be difficult to say that the infection was traceable to the operation ; in a number of them the actual cause was due to the neglected condition of the tooth which called for extraction. Infection can, however, at times undoubtedly be traced to the operation, and once again attention is drawn to the urgent necessity of adopting aseptic

[1] *Journ. Brit. Dent. Assoc.*, vol. vii, p. 32.

[2] See also case recorded in *Journ. Brit. Dent. Assoc.*, vol. xvii, p. 385.

precautions. Suppuration of the socket and its appropriate treatment has already been dwelt upon, p. 819. Cases of syphilis acquired through the use of infected forceps are recorded. The treatment of these conditions hardly lies within the scope of this work.

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CHAPTER XXVIII

Replantation, Transplantation and Implantation of the Teeth

Replantation is an operation of replacing in its socket a tooth which has been partially or completely dislocated.

Transplantation is the operation of transferring a tooth from its own socket to that of another tooth. The transference may take place in the same mouth, or the tooth may be extracted from the mouth of one person and transferred to that of another.

Implantation is an operation of forming an artificial socket in the bone for the introduction of a natural tooth.

Of these three operations, the only one which is performed to any extent in this country is replantation, the other two being of questionable utility.

(A) REPLANTATION

Replantation should be performed only in cases of traumatic dislocation.

The operation consists in gently rinsing the tooth in a solution of some antiseptic, and replacing it in the socket with firm pressure, the alveolar process being moulded around it with the fingers. The tooth may be kept in place by a tin splint similar to that recommended on p. 174. If the patient is not seen for some hours after the accident, the pulp must be removed, and the canal filled before the tooth is replaced.

The union after replantation is brought about through the periodontal membrane. In cases where the tooth is living and is immediately replaced, the vitality of the pulp is sometimes re-established. Magitot, who has recorded a large number of cases of replantation, maintains that the operation cannot be successful unless there is a complete ring of healthy membrane on the tooth.

The results of replantation depend upon the nature of the condition for which the operation is undertaken. If the tooth is immediately replaced a successful result may be hoped for; but if replacement is delayed the prognosis is naturally not so good.

(B) TRANSPLANTATION

There are three distinct objections to this operation: (1) The liability to failure; (2) the risk of inoculation; (3) the moral objection. Failure of the operation may be due to (*a*) want of adaptability of the tooth to its new socket; (*b*) morbid conditions of the new socket. The risk of inoculation is a strong argument against this operation—a case of transmitted syphilis has been recorded within recent times. The moral objection to the operation is also weighty, as the teeth to be transplanted are usually obtained from the poorer classes. All circumstances considered, transplantation of a tooth from one patient to another is to be condemned. The transplanation of a tooth from one socket to another in the same mouth is occasionally useful, as, for example, in the transfer of a healthy lateral incisor which has erupted internal to the arch to the socket of an unsavable central incisor. The method recommended for carrying out transplantation is as follows: The patient to receive the transplanted tooth is first operated upon, as little injury as possible being inflicted, and the bleeding from the socket arrested as far as possible. The tooth to be transplanted is next removed from the other patient and immediately transferred to the vacant socket and forced well into place.

Union in transplantation may be a process similar to that which takes place in replantation, or the process may be entirely different and similar to that which occurs in implantation, viz., absorption of portions of the root first taking place. In these excavations, bony tissue is formed continuous with the alveolar process, the tooth thus becoming anchylosed to the jaw. In other cases, it seems possible that there is only a fibrous union.

(C) IMPLANTATION

Implantation is an operation of more recent date than either replantation or transplantation, and is probably less justifiable even than transplantation. Dr. Younger, who was the first to perform this operation, is very particular in the choice of his

patients, selecting only young and healthy subjects. The tooth to be implanted should possess a healthy periodontal membrane.

The method of procedure is as follows: A crucial incision is made over the situation intended for the implanted tooth; the flaps of periosteum are then dissected up, and, by means of specially designed trephines and burrs, a fresh socket is made. The socket is then syringed so as to remove all *débris*, and the bleeding is then arrested, the tooth being fixed into place and, if necessary, secured with ligatures or other suitable means. Some operators force the tooth into place with a hammer; in this way the tooth is firmly fixed and ligatures are not required. Dr. Younger does not always use freshly extracted teeth to perform implantation, but in some cases employs dry teeth.

The union taking place after implantation is probably similar to that following many cases of transplantation. Dr. Amoedo advocates slight decalcification of the roots previous to implanting. The root is placed in a 10 per cent. solution of hydrochloric acid for from three to four hours until the surface of the cementum is slightly softened, the acid being afterwards neutralized with ammonia. The results obtained from implantation are not encouraging, and do not justify the operation.

CHAPTER XXIX

Fractures and Dislocation of the Jaws

Fracture of the Mandible—Causes—Varieties—Symptoms—Displacements — Complications — Ununited Fractures — Treatment—Types of Splints—Mal-union—Fracture of the Maxilla —Dislocation of the Temporo-mandibular Articulation

In dealing with this subject it will be convenient to consider it under three heads:—

(1) Fracture of the mandible.
(2) Fracture of the maxilla.
(3) Dislocation of the temporo-mandibular articulation.

(1) FRACTURE OF THE MANDIBLE

Fractures occur more frequently in the mandible than in the maxilla, and this is probably due to the mandible being in a position more exposed to injury.

(*a*) **Causes.**—Fractures are mostly the results of kicks, a blow of the fist, a fall (especially on the chin), or gunshot injuries. Undue violence in the extraction of teeth may fracture the jaw, but a direct transverse fracture is rarely caused in this way (see p. 816). Fracture of the alveolar process during extraction is of common occurrence, but as it leads to nothing more serious than the exfoliation of the portion fractured, it is of little importance. Some rare causes of fracture, as, for example, a fit of coughing, are recorded in "Gross's Surgery," p. 964. In rare instances a blow may cause a fracture of the jaw in such a way that portions of the tooth are situated in either fragment.

(*b*) **Varieties.**—Fractures of the ascending ramus are usually simple, those of the horizontal ramus always compound. The bone is usually fractured in one place, but double or triple fractures are not uncommon. In the cases of gunshot wounds and similar severe injuries, the fracture is comminuted.

(*c*) **Position.**—The position of the fracture will depend, firstly, on the situation in which the blow is received; and, secondly, on the presence of any weak spot in the bone such as might be caused by loss of teeth at certain points. Fractures are far more common in the horizontal than in the ascending ramus. Hamilton records fifty-two cases of fracture of the horizontal ramus out of a total of fifty-five fractures of the mandible. The most common situation of fracture is the **neighbourhood of the canine tooth** on the side nearest to the premolar, the explanation generally accepted being that the depth of the canine socket weakens the bone at this spot. The region of the **mental foramen, symphysis** in the young, and the **last molar,** are other common positions of fracture. **Fractures of the ascending ramus** are generally the result of great violence, and **may occur in almost any situation,** the angle and condyloid process being frequent seats of the injury, and, more rarely, the apex of the coronoid process.

(*d*) **Direction.**—The direction of the line of fracture in the horizontal ramus is usually **oblique,** though, when occurring at the symphysis, it may be quite **vertical.** It is sometimes **horizontal,** involving the alveolar process of several teeth, and a severe case of this character is mentioned by Tomes,[1] in which a fracture, running level with the apices of the teeth, and carrying the premolars, canines and incisors, had occurred in an attempt by a chemist to extract a right mandibular first molar.[1]

(*e*) **Symptoms.**—The symptoms are generally well marked when the fracture occurs in the horizontal ramus; but in the ascending ramus the symptoms are often obscure. In both, the patient usually complains of pain on opening the mouth. In the former, there will be distinct crepitus, mobility in the continuity of the part, and frequently, alteration in the line of the teeth, due to displacement. There is often more or less salivation and, in some cases, when the displacement is great, an inability to close the mouth.

(*f*) **Displacement.**—The displacement will vary according to the character and situation of the fracture, and will be slight in some cases and well marked in others.

[1] "Dental Surgery." Third Edition, p. 623.

In the region of the canine, the displacement is produced by the action of the muscles and the obliquity of the fracture. The direction of the fracture is usually from within, outwards and forwards, so that on the lesser fragment there is a greater extent of the outer than the inner plate of the bone. This is diagrammatically shown in fig. 824. The displacement in such a case is brought about as follows :—

The left external pterygoid will tend to force the smaller fragment towards the right, and the right external pterygoid tend to draw the greater fragment to the left side. If the line of

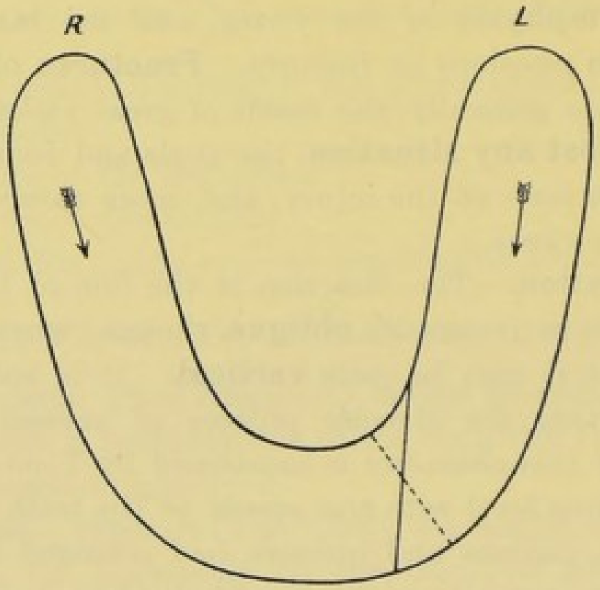

Fig. 824.—The arrows indicate the direction of force exerted by the external pterygoids.

fracture be directly transverse, as shown by the dotted lines, the force of the two external pterygoids would be equalized ; but as the line of fracture is usually oblique, the tendency of the external pterygoids will be to cause the lesser fragment to slide over the greater. The lesser fragment will also be drawn up by the muscles which close the jaw, because they are unopposed by any depressors of the jaw ; the latter muscles are all attached to the greater fragment and depress that fragment, the right and left depressors combined exerting more force than the counteracting right elevators.

In double fractures through the canine regions, with the

lines of fracture taking oblique directions, the following displacement may occur: the central fragment has attached to it the digastrics, the genio-hyoids, and the genio-hyo-glossi; the action of these will be to depress the fragment, and at the same time cause it to fall over towards the tongue. The elevators of the mandible are attached to the lateral fragments, and draw them slightly upwards. The left external pterygoid will tend to draw the left fragment to the right side and the right external pterygoid the right fragment to the left side, with the result that the lateral fragments are drawn towards the median line and tend to increase the inward displacement of the central fragment. In reducing fractures of this kind the foregoing facts should be kept clearly in mind.

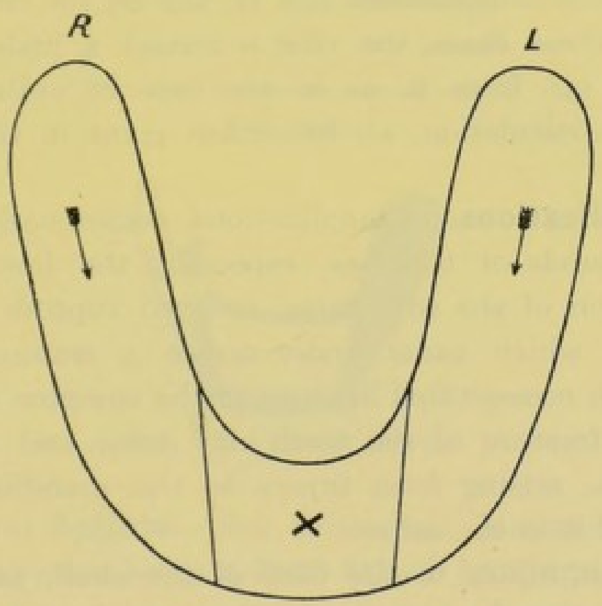

FIG. 825.—(X) central fragment to which the depressors of the mandible are attached. The arrows indicate the direction of force exerted by the external pterygoids.

With **fractures in the region of the last molar,** the direction of the fracture is often transverse. The lesser fragment will be drawn upwards by the elevators of the mandible of that side and towards the median line by the external pterygoid. The greater fragment is drawn down by the depressors of the mandible and towards the injured side by the external pterygoid.

Fractures of the ascending ramus are generally accom-

panied by much swelling, but present little displacement. Pain is, as a rule, referred to the fractured part, and by passing the finger of one hand well back in the fauces and applying the other outside, crepitus may generally be obtained. In severe cases, the upper fragment may be tilted forward by the action of the temporal muscle.

In **fractures about the angle of the jaw,** the pain is often referred to the third molar or mental foramen, and, when the soft parts are much swollen, the fracture may easily be overlooked altogether.

Fractures of the condyle are generally accompanied by some pain and a difficulty in moving the affected side, while crepitus may be apparent to the patient. The condyle may be drawn forward on the eminentia articularis by the external pterygoid muscle, and this displacement can be felt by the finger inside the mouth. In these cases, the chin is turned a little towards the injured side, not from it, as in the case of unilateral dislocation of the articulation, an important point in the differential diagnosis.

(*g*) **Complications.**—Complications occasionally arise, such as severe wounds of the face, especially the lips, hæmorrhage from laceration of the soft parts, or even rupture of an artery. In one case which came under notice, a traumatic aneurism formed, which necessitated ligature of the common carotid. Dislocation and fracture of the teeth may occur, and also paralysis and neuralgia, arising from injury to the mandibular nerve or implication of it in the callus.

Dislocation, injury to the base of the skull, and necrosis of the ends of the fragments, leading to abscess and salivary fistula, may be complications.

(*h*) **Un-united Fractures.**—Fractured jaws generally require a splint to retain the fragments in position for about six weeks, and as a rule respond readily to treatment. Occasionally union is delayed, or does not take place, the causes being practically the same as those which lead to un-united fractures in other parts of the body. In the mandible, necrosis is the principal cause of non-union, the disease producing a considerable space between the fractured ends. Other causes are exceptional difficulty in treatment, the slipping of a tooth or some foreign body between

the fragments, and want of rest due to a badly arranged splint. Suppuration in the region of the fractured ends is at times due to the presence of septic roots. With un-united fractures, either a "**false joint**" is formed, or "**fibrous union**" takes place between the fractured ends.

(*j*) **Treatment.**—Before applying splints, either externally or interdentally, for the treatment of fractures, the mouth should be rendered as aseptic as possible by the removal of all septic teeth and salivary calculus on the teeth. Failure of fractured jaws to unite can frequently be traced to the septic condition of the teeth and contiguous parts.

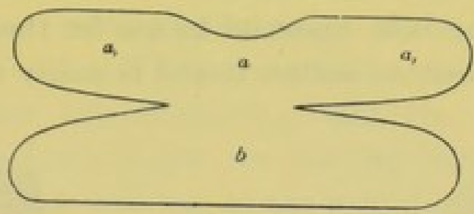

FIG. 826.

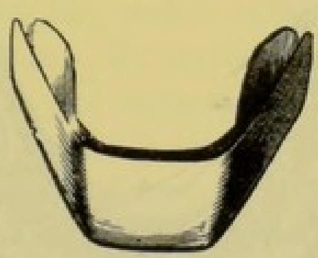

FIG. 827.—From Heath.

(i.) **External Splints.**—For treatment, various methods are adopted, the simplest being **a four-tailed bandage**, and to this a splint of gutta-percha forms a valuable adjunct. The splint should be lined with chamois leather, and several holes should be made to allow of evaporation. The parts should also be sprinkled with some dusting powder, to prevent decomposition. To make the splint, a piece of gutta-percha is cut similar in shape to that shown in fig. 826. This is softened in hot water, and the part (*a*) is placed under the chin, the two ends (*a*,) being bent upwards over the ascending ramus; the portion (*b*) is then bent round as shown in fig. 827.

The gutta-percha splint and bandage are useful as temporary measures during the manufacture of an interdental splint.

The objections to the bandage and its adjuncts are these :—

(*a*) To apply them, it is necessary to bind the mandible tightly against the maxilla, and accordingly prevent mastication, &c.

(*b*) Any tendency to displacement is not overcome.

(*c*) In oblique fractures, a bandage causes the fragments to overlap by the pressure applied from without, and so increase the displacement.

(ii.) **Interdental splints.**—To make an interdental splint, the first step is to obtain impressions of the maxillary and mandibular teeth. This is not always a simple operation, and at times it is necessary to take the impression of the mandibular teeth in half trays. Wax is the best material to use for these impressions, as it requires little heat to soften it and is easily removed from the

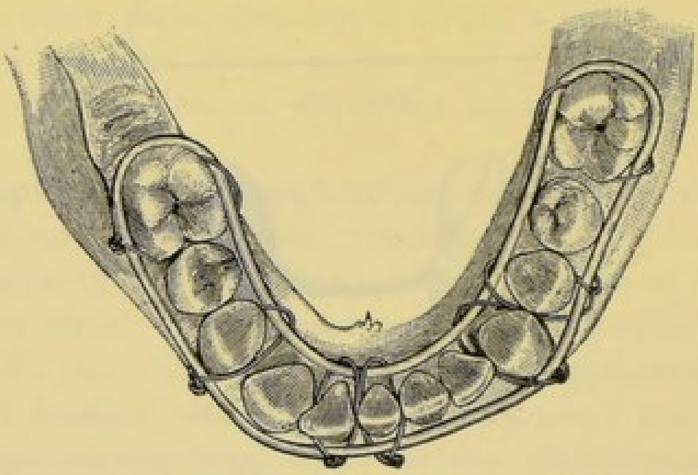

FIG. 828.—Hammond splint. The fracture is supposed to be between the central and lateral incisors upon the right side of the figure.

mouth. If wax is not to hand, composition may be substituted. It is advisable not to allow the material used to become hard before removing it from the mouth. When the models have been cast, the lower one should be divided at the line of fracture, and the fragments pieced together so that the bite can be carefully adjusted to the upper teeth. By this means the original contour of the lower teeth is obtained. The fragments are then united in their new positions and the splint made to the corrected model.

(*a*) **The Hammond or interdental wire splint** (fig. 828) is an excellent contrivance in suitable cases. It is made by bending

soft iron wire and adapting it as accurately as possible to the model, the wire running on the lingual and labial sides of the teeth, the ends being joined by soft solder. Some prefer to fit the wires to the mouth, but, unless great haste is necessary, this seems a needless and painful proceeding.

When the splint has been prepared, the fragments are brought into position, and the splint placed over them, the teeth being fixed to the splint by means of ordinary iron binding wire. The method of passing the wire is as follows: The end of the piece to be passed should be cut obliquely and given a slight upward curve, and inserted from without over the top of the outer bar, a downward direction being maintained in order that it may be passed under the inner bar; with the forefinger of the left hand the point must be felt for and the wire returned over the inner bar and brought out under the outer one, and the two ends twisted together and bent down under the bar (fig. 828). The reason for passing the wire over the bar at the outset is that if it be passed under the outside bar, in returning, the wire will have to be passed under the inner bar, which is by no means as easy as returning it over the bar. By giving the wire a slight upward curve as suggested, it is not only easier to pass, but the risk of pricking the side of the tongue is lessened. To prevent traumatic inoculation by pricking the finger with the wire, Mr. Newland Pedley has devised two pairs of forceps with suitable curvatures and also a spoon-shaped spatula. The latter protects the mucous membrane of the mouth, reflects light and assists in directing the tip of the wire upwards. The teeth should be free from calculus before the splint is applied. When other teeth are available those adjacent to the fracture should not be wired. It is well to ligature on both sides the two teeth next to the one adjacent to the fracture and, after that, each alternate tooth (see fig. 828). After the splint is applied, the patient should be seen within a week, as the wires generally require tightening. An antiseptic mouth-wash should be prescribed and its frequent use insisted upon.

A modification of this splint has been suggested by Mr. Pedley and is extremely useful where the lesion is anterior and the displacement is not great. To quote Mr. Pedley's words:[1] "The

[1] *Trans. Odonto. Soc.*, vol. xvii, p. 16.

main strand is not passed behind the last tooth, but between two teeth on each side of jaw in the following manner: The point of the wire is sharpened by being divided obliquely with cutting pliers, and passed into the cavity of the mouth between the premolars or the more posterior teeth, and is brought out again by being pressed from the lingual surface between two teeth on the opposite side of the jaw. The intervening portion now lying on the tongue is manipulated into close contact with the lingual surfaces of the necks of the teeth. The wire is then carried across the labial surfaces of the teeth, and its ends twisted

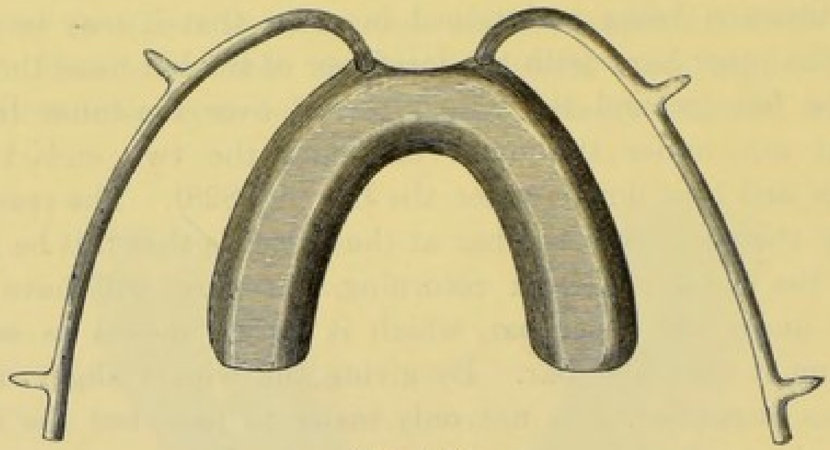

FIG. 829.

loosely together. It is not desirable to twist up the main strand very tightly at first, for so doing would impede the passage of the binding wires, and tend to drag away the strand from the lingual surface of the teeth. The binding wires are passed in the usual way, and twisted together loosely at first. Finally, all the wires are twisted tight, a few turns being given first to one and then another; the ends are cut short and tucked under the splint to avoid excoriation of the mucous membrane. Rarely should a binding wire be attached to a tooth immediately contiguous to the line of fracture." A useful way of fastening the ends of the main strand is to pass the main wire through a piece of closely fitting metal tube and give the ends a turn in the opposite direction.

A small but useful **modification of the Hammond splint** has been suggested and used by Mr. H. Lloyd Williams for the treatment of fractures far back in the mandible, when only one tooth is standing in the smaller fragment. The splint is made in

the usual way, except that it fits loosely round the tooth in the smaller fragment. A vulcanite cap exactly fitting the single tooth is then fixed to the splint, the top of the cap being filed off so as to allow the cusps of the tooth to articulate correctly with its antagonist. The splint is bound in the usual way to the larger fragment, the weight of which is sufficient to keep the lesser fragment in position. In seven cases treated in this manner Mr. Lloyd Williams obtained successful results in six.

(*b*) **The Hayward splint** (fig. 829), sometimes known as a Kingsley, consists of a vulcanite cap fitting the teeth; into the sides iron wires are fixed in such a way that, when in position,

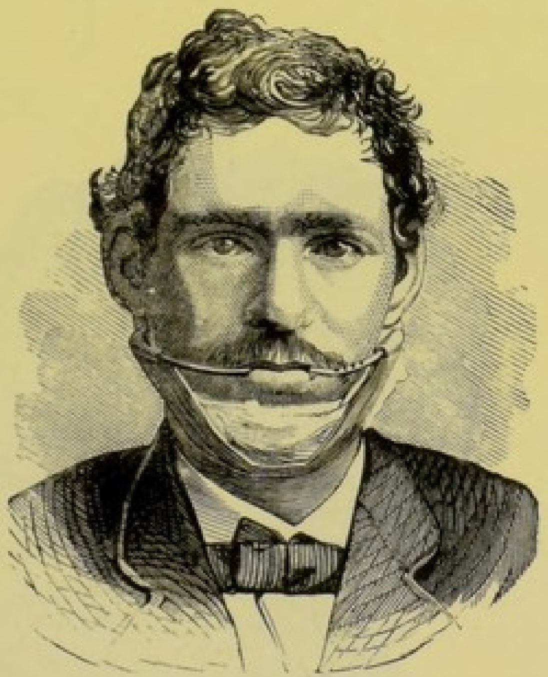

Fig. 831.

the wires lie outside the mouth. The wire should be about one-eighth of an inch in thickness, should curve well up as it emerges from the mouth to avoid rubbing the lips, and should terminate at the posterior border of the ascending ramus. It is well to solder on two points, one towards the front and another towards the back of the wire, the front attachment preventing the bandage slipping forward (a constant trouble), while the back one is useful for fixing the bandage when pressure about the angle is required. These splints are generally made to fit a little loosely,

and are then filled with a thin layer of gutta-percha. A perfect fit is thus ensured. The splint should be made to articulate accurately with the upper teeth. When ready for insertion, the gutta-percha should be thoroughly softened, the displacement reduced as much as possible and the splint forced into position.

A compress of some kind is then placed under the chin and the whole fixed with a figure-of-eight bandage (fig. 830). In applying the bandage, care must be taken to avoid its slipping too much forward. With children, if the operation is likely to prove at all painful, it is as well to administer an anæsthetic. The mandible in this class of splint is fixed between the vulcanite cap inside and the bandage outside the mouth.

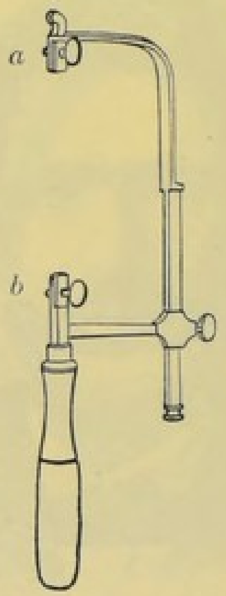

Fig. 831.[1]

The wire wings are considered an objection to this splint because they prevent the patient lying on the side and thus cause discomfort. The modification shown in figs. 831 to 834 overcomes this objection. The splint is constructed from an ordinary fret-saw frame (fig. 831). The handles and the parts marked *a* and *b* are removed. To the lower part of the frame a revolving brass chin-piece is attached, and the top part of the frame is bent and split as shown in fig. 832, and the vulcanite cap

[1] For the loan of figs. 831 to 834 I am indebted to the publishers of Richardson's "Mechanical Dentistry."

attached to it (fig. 833). The appliance in position is shown in fig. 834; the chin-piece before being applied should be padded with some soft material.

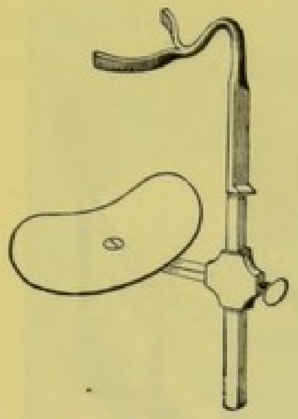

Fig. 832.

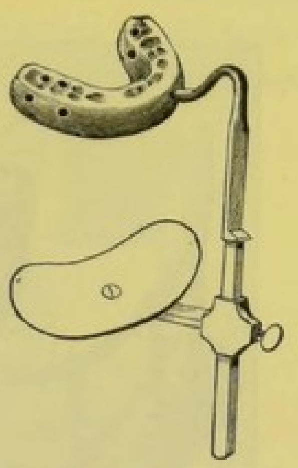

Fig. 833.

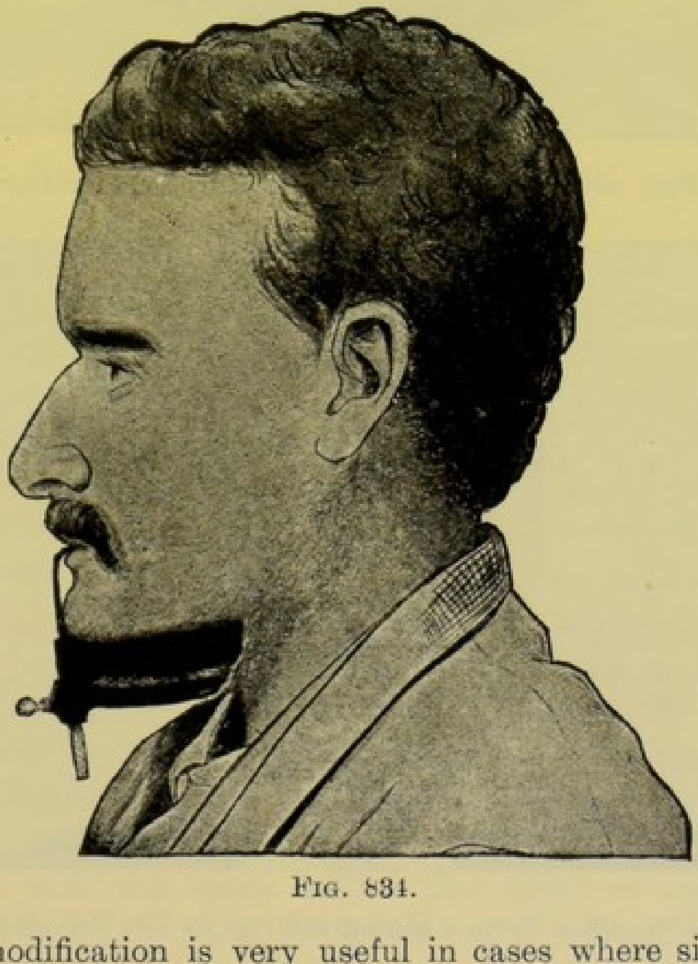

Fig. 834.

This modification is very useful in cases where sinuses exist in the lower part of the face, as they can be treated without interfering with the action of the splint. If sinuses exist under

the mandible, the brass chin-piece can easily be arranged so as to permit treatment.

In some **fractures**, especially **in the region of the molars,**

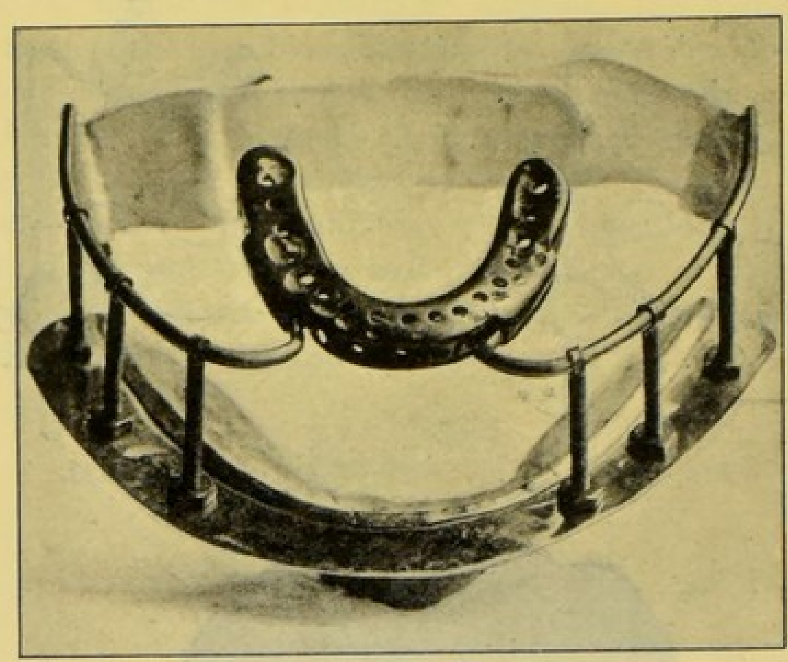

FIG. 835.—From a photograph lent by Dr. Moriarty.

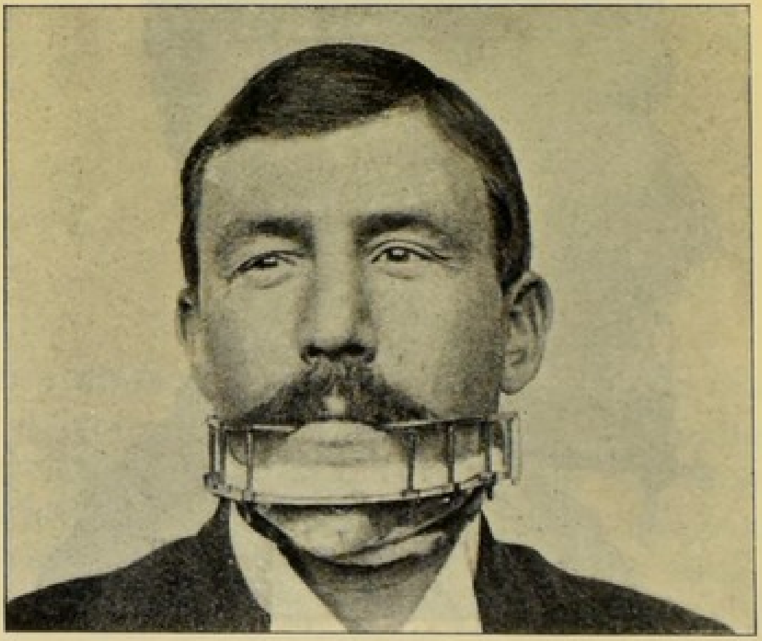

FIG. 836.—From a photograph lent by Dr. Moriarty.

it is difficult at times to keep the parts in position with a Hayward splint or the modification just referred to. In such cases, the form of splint shown in figs. 835, 836, and suggested by Dr.

Moriarty,[1] would probably prove valuable, as it exerts the requisite pressure on the posterior fragment, and this is at times difficult to obtain with the forms just described. The metal chin-piece moulded to the contour of the jaw is attached to the bars of the vulcanite splint by screw-bolts, which permit the amount of pressure to be adjusted to a nicety.

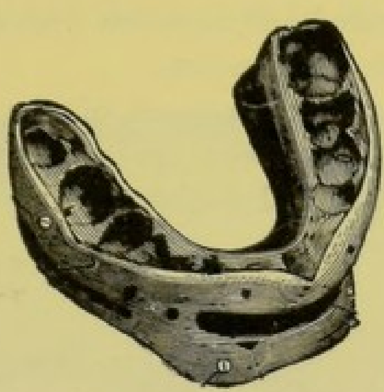

FIG. 837.

(*c*) **The Gunning splint** (fig. 837) consists of vulcanite caps joined together by supports, and constructed to fit both the maxillary and the mandibular teeth. These caps can be filled with gutta-percha as described above. When the splint is in position a four-tailed bandage is applied. With this type of splint the fractured jaw is fixed between the bandage outside and the cranium, the splint keeping the part in position and also transmitting the force to the maxilla.

(*d*) **The Hern splint,** a modification of the Gunning, consists of a vulcanite cap covering the teeth and alveolar border of the mandible. Blocks or pillars are built up on the upper surface of the splint, these pillars containing indentations corresponding with the upper teeth (fig. 838). In cases where the occlusion and articulation is difficult to obtain, or doubtful when obtained, the pillars or blocks are built of vulcanite so as to form shallow troughs or cavities into which gutta-percha is placed for articulation with the upper teeth. The splint is applied in a similar way to the Gunning, but instead of a four-tailed bandage Mr. Hern prefers a skull and chin cap, connecting bands between

[1] *Dental Cosmos*, March, 1898, p. 242.

the two being arranged in a manner similar to the arrangement of the tails of a four-tailed bandage. The bands are made of elastic, which gives constant pressure and counteracts the tendency of the fragments to displacement downwards.

The advantages of this modification of the Gunning splint are :—

(1) The upper teeth are not covered, and so can be kept clean.

(2) It can be adjusted and removed with greater facility.

(3) It is much less cumbersome.

(4) It allows of the adjustment of the articulation of the maxillary teeth after it has been applied, as the vulcanite surface can be cut with the dental engine, or the gutta-percha in the troughs added to or removed.

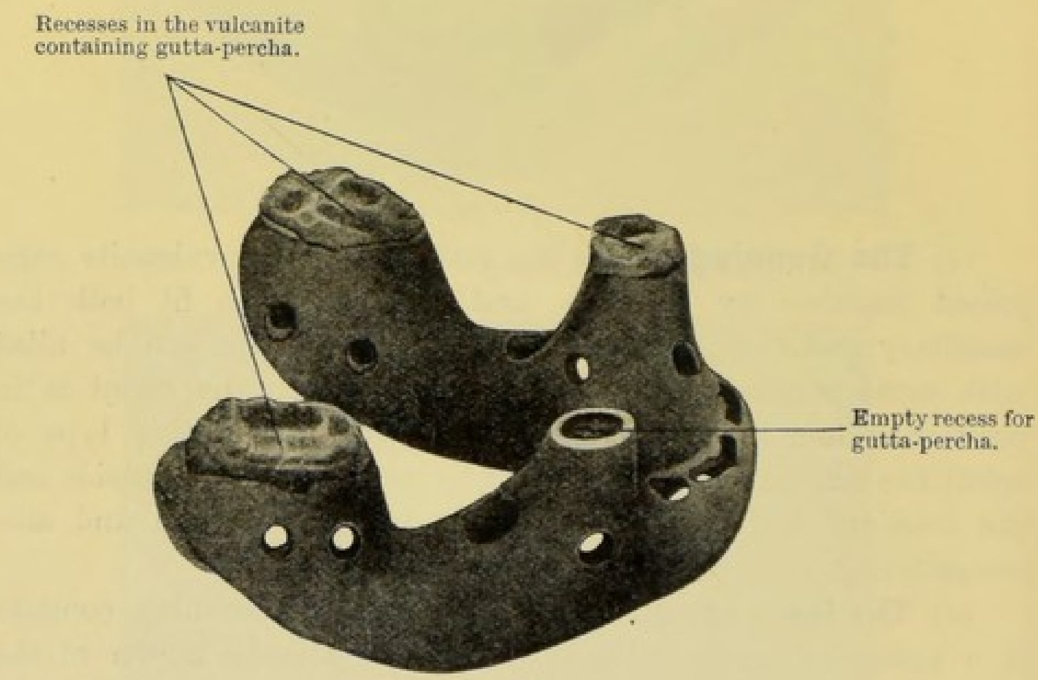

Fig. 838.

The Payne Splint.—A useful form of splint has been suggested by J. Lewin Payne.[1] A silver wire framework is fitted to the necks of the upper and lower teeth on the labial and lingual aspects, the wire being carried as far round the arch as it is convenient to carry the splint. The ends of each half of the framework are soldered together and, at suitable intervals, transverse bars (c) are fixed. Two to three bars are necessary ; they not

[1] *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. ii, p. 161.

only strengthen the arch but also prevent the splint from slipping to the gum. The two arches are then united by rods on the labial and lingual sides (see fig. 839). The splint is ligatured to the teeth in a way similar to that suggested in adjusting the Hammond splint. The advantages claimed are :—

(1) The fragments can be held firmly in position.

(2) The mouth can easily be kept clean.

(3) The condition of the jaw can be observed.

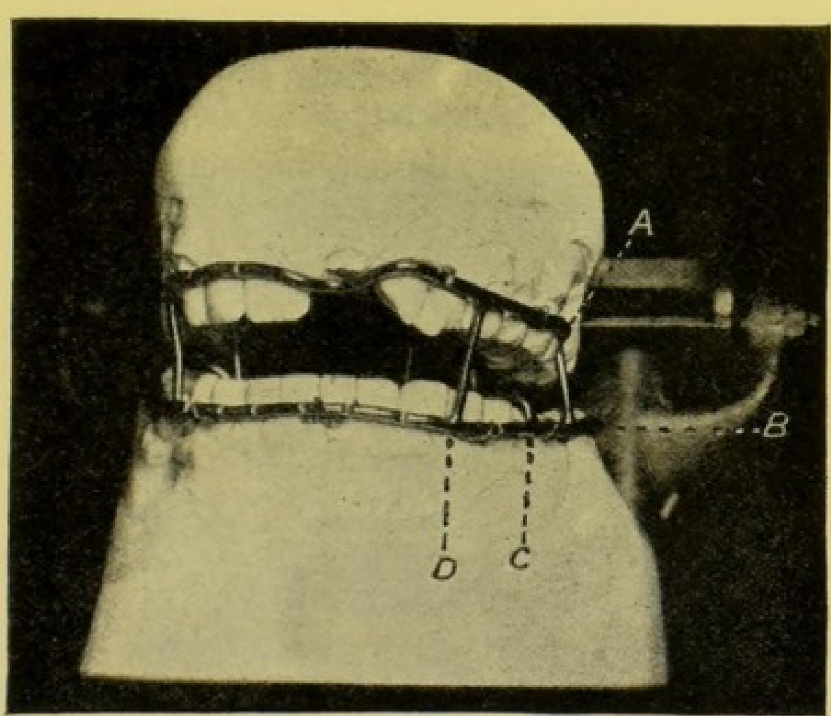

FIG. 839.[1]—The cradle splint adapted to models of a case of fractured mandible.

In cases of resection of the jaw for malignant disease, the insertion of a splint of this type shortly after the operation counteracts the tendency to deformity and hastens the healing of the wound. The splint can only be used where five or six teeth remain in both arches.

In transverse fractures of the horizontal ramus in the region of the incisors, with little displacement, Dr. Moriarty states he has obtained excellent results from a simple splint of the character

[1] From *Proc. Roy. Soc. Med.*

shown in fig. 840. The splint consists of a metal cap accurately fitted and cemented to the teeth.

The choice of splint will depend to a great extent upon the requirements of each individual case. **Where the teeth are firm and each fragment contains a few, a Hammond splint is undoubtedly best.** Its advantages are :—

(1) The small amount of inconvenience to the patient in the way of mechanical contrivances.

(2) The fragments can be kept perfectly rigid.

(3) The non-interference with speech and mastication.

(4) The ease with which the parts can be kept clean, and therefore the small risk of suppuration.

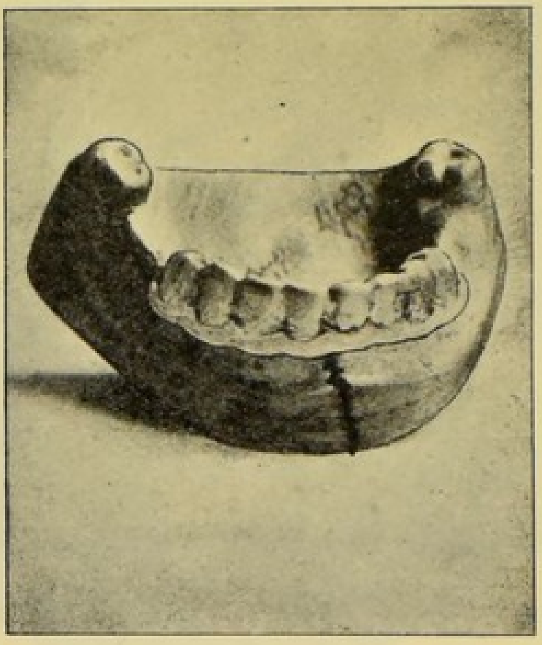

Fig. 840.[1]

Its use is contra-indicated :—

(1) When there is much downward displacement, specially if the teeth are very short or loose ; and

(2) In children, unless the deciduous teeth are firm.

The Hayward type of splint is indicated in:—

(1) Cases where there is much downward displacement and the teeth are very short or loose.

(2) Children in whom the deciduous teeth are not sufficiently firm to form a *point d'appui*.

[1] From a photograph lent by Dr. Moriarty.

(3) Where only a few firm teeth are present or the smaller fragment only contains one or two firm teeth.

The Payne type of splint may be used in cases where the fracture is behind the last standing tooth and sufficient teeth are present for the attachment of ligatures.

The most suitable cases for a Hern splint are :—

(1) Fractures where the mandible is edentulous.

(2) Where the fracture is behind the last standing tooth, or in the ascending ramus.

It is necessary for the use of this splint that a few firm teeth should be present in the maxilla.

The Gunning splint is indicated where the maxilla and mandible are fractured or where the maxilla is edentulous.

Among the **disadvantages of the Hern and Gunning splints** may be mentioned :—

(1) The closure of the mouth, interfering with speech and mastication.

(2) The dribbling away of saliva.

(3) The great fatigue from propping open the mandible.

(4) The difficulty of keeping the mouth and splint clean.

(iii.) **Treatment by Wiring.**—Suturing the fractured ends by means of wires has been advocated by several surgeons. Mr. T. S. Carter has devised some neat instruments for performing the operation, and, in a communication to the *Lancet* (June 16, 1900), describes the method he adopts. It is as follows: A piece of silver-plated copper wire, No. 19, R.W.G., is taken and filed away for the distance of nearly an inch, the wire being reduced by nearly half its thickness. To make it more ductile it is passed slowly through the flame of a spirit lamp, making it a dull red for a length of about 6 in. With the patient under ether the lip is drawn down, and with a sterilized bayonet-shaped drill in the motor a hole is slowly bored through the bone posterior to the fracture and between the teeth. In this position the mandibular nerve will be avoided. The hole should be drilled not less than a quarter of an inch from the fracture. While drilling with the right hand a spoon is held on the lingual side so as to guard the tongue from the drill as it emerges from the foramen. Having withdrawn the drill, the plated wire is pushed through from without and, by means of forceps, drawn well into the mouth.

A difficulty sometimes arises in returning the silver wire, as it is not easy to find the return passage by simply probing for it. Having, however, drilled the hole on the other side of the fracture, a pliable copper needle may be pushed through from without and bent at a suitable angle to allow of its being readily threaded with the plated suture wire. Where the point of the wire has been filed, it may be bent so as to form a hook, and if the needle is then withdrawn, the wire will follow.

It is well to drill the hole in the depressed fragment on a lower level than the one in the other fragment, so that there may be a lifting tendency and greater resistance to the relapse in position. The wires are then twisted until the ends of the bone are drawn tightly together. This can be accomplished by means of a specially devised key. To prevent the key from cutting the wire, it is necessary not to push it nearer to the bone than, say, half or three-quarters of an inch before the first turn is given. Having severed the twisted wire with side cutters, an end is left projecting about half an inch long. To prevent this from cutting, it is covered with a short piece of india-rubber tubing of the calibre of a crow's quill and turned down flat. Mr. Carter finds annealed silver-plated copper wire has more resistance than solid silver wire.

In the treatment of horizontal fractures involving the alveolar process of two or three teeth, a cap of gutta-percha or vulcanite is quite sufficient, or the fragment may be wired to adjacent teeth. In more severe cases a Hammond splint (or a modification of it) is perhaps the best.

Fractures about the angle may be treated with an outside gutta-percha splint made in such a way that it passes back and catches the angle. The splint can be kept in position with a four-tailed bandage, but whatever method of bandaging is used, endeavour must be made to get firm pressure over the part of the splint covering the angle, as this will assist in keeping the parts at rest by preventing the splint from shifting. It is generally found that after a period of a week it is necessary to remodel the splint. Almost invariably there is a considerable swelling about the parts, and, as this subsides, the splint naturally requires readjustment.

Fractures of the ascending ramus, condyle or coronoid

process are best treated by merely keeping the mandible fixed. A four-tailed bandage is generally advised, but the method suggested by Angle and shown in fig. 841 seems likely to give far better results. Teeth in the maxilla and mandible are banded. To the bands, studs are attached and wires passed around the upper and lower sides in a figure-of-eight manner.

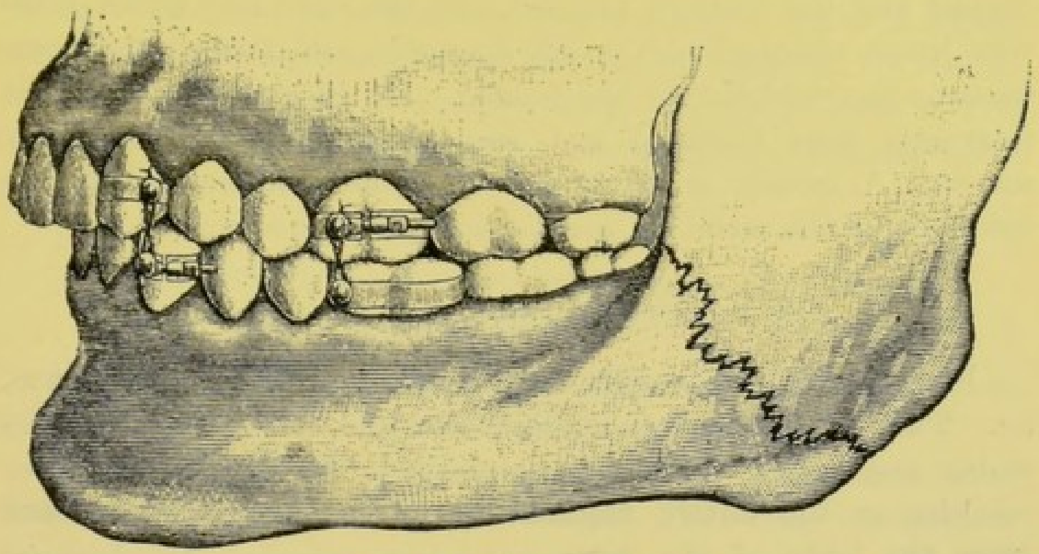

FIG. 841.—From Angle.

Mal-union.—To obtain union of a fractured jaw without a certain amount of disorganization of the occlusion is not always easy, especially in cases where the interdental wire splint cannot be used. In cases where the occlusion is only slightly deranged, the simple operation of "cutting in the bite" will often be found sufficient to correct the mal-occlusion. Where, however, considerable disturbance has resulted, extraction of certain teeth may be necessary. At times, the deformity resulting from mal-union may be so marked as to call for more serious surgical interference. A case of this character is recorded by Mr. S. Boyd,[1] and seems an instructive example illustrating the deformity and the difficulties of treatment. The patient, a man, fell about 50 ft. and smashed the jaw in the region of the right canine. For six months every means short of wiring was tried and, when seen, the left fragment had been drawn backwards and had united to the right

[1] *Trans. Odonto. Soc.*, June 24, 1901, p. 226

fragment in such a way that the right canine and incisors lay behind the right premolars. The teeth met at the back on the left side, but in front a considerable space existed, and there was marked deformity of the face. In the floor of the mouth was a long, fixed, bony mass. A scar extended along the lower border of the jaw from the level of the right angle of the mouth to 1 in. behind the vertical line through the left angle. The scar was opened and the fracture exposed, and the right mylohyoid ridge was found attached to the left fragment and formed the bony mass on the right side of the tongue. By careful dissection, the fragments were liberated and secured in correct position by screws. A certain amount of improvement followed, but the deformity of the mandible was not completely overcome.

(2) FRACTURE OF THE MAXILLA

Fractures of the maxilla arise generally from severe violence, &c. They are frequently comminuted, adjacent bones such as the malar and nasal being often implicated. Transverse fractures resulting in the **entire separation of the alveolar process from the body of the bone** have been recorded, the fracture sometimes communicating with both antra and the nasal fossæ. In a case under the care of Messrs. Ackery and Paterson,[1] the fracture (caused by a severe blow on the left side of the face) commenced to the left of the infra-orbital plate, and, passing downwards, ended on the opposite side about half an inch above the alveolar border. The whole maxilla could be moved *en masse* in a downward direction, and also laterally to the right, as if hinged above the alveolar border on the right side. In a case which came under my notice, the whole of the maxilla and the nasal bones seemed to have been wrenched from their attachments. The accident was caused by a lift striking the patient across the bridge of the nose.

Separation of the two halves of the maxilla in the median line has been recorded. Lastly, **fracture of portions of the alveolar process and of the tuberosity** occasionally occurs during the extraction of teeth.

The **complications** encountered are, to a great extent, similar

[1] *Trans. Odonto. Soc.*, vol. xxii, N.S., p. 65.

to those in the mandible, but the hæmorrhage is generally more severe. At times the infra-orbital nerve is permanently injured.

The **treatment of fractured maxilla** does not differ in principle from the treatment of fractured mandible. Teeth, unless loose, should be retained, and the same course should be pursued with fragments of bone, since the parts are so vascular that there is every chance of good repair taking place. In cases involving the alveolar plate of several teeth a Hammond splint is applicable. In extensive fractures similar to that recorded by Messrs. Ackery and Paterson, a Gunning splint should be used. With fractures of the mandible, as well as the maxilla, a Gunning splint is essential.

(3) DISLOCATION OF THE TEMPORO-MANDIBULAR ARTICULATION

Dislocation of the temporo-mandibular articulation may be unilateral or bilateral, the latter being more common.

(1) Causes.—This accident may be due to a violent blow, or it may be caused by the simple actions of yawning, vomiting, or

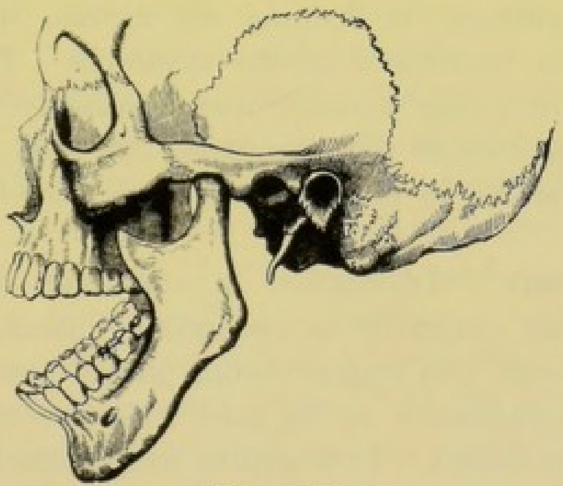

Fig. 842.

shouting. The dislocation may also arise in an attempt to introduce large substances into the mouth or during the extraction of the lower teeth, if the mandible is not supported during the operation. The unilateral variety is generally due to violence.

(2) Morbid Anatomy.—In dislocation the condyles of the mandible slip over the eminentia articularis (fig. 842); im-

mediately following this the masseter and internal pterygoid muscles contract, drawing the jaw forwards and upwards. The capsular ligament is stretched, but is seldom torn.

(3) **Symptoms.**—**In bilateral dislocation** the mouth remains open and is rigid, so that the lips cannot be closed and the saliva dribbles away. If the region of the condyle be examined, a hollow will be felt behind the condyle and a prominence will be noticed immediately above the zygoma; according to Mr. Christopher Heath, the prominence is probably due to spasmodic contraction of the temporal muscle.

In unilateral dislocation the mouth is open and fixed, a hollow being apparent behind the condyle dislocated. The chin is drawn to the side opposite to the dislocation, and this symptom distinguishes it from fracture of the neck of the condyle, where the chin is drawn to the affected side. The dislocation may be overlooked and become permanent unless operative treatment is pursued.

A condition somewhat connected with the accident under consideration is "**sub-luxation.**" This was first described by Sir Astley Cooper, and is an affection in which the patient complains of a constant clicking on opening the mouth, with occasional difficulty in the movement of the mandible. This condition, usually found in young women, was previously thought to be due to a lax condition of the ligaments, but it is now generally considered to be due to changes in the joint, the result of osteoarthritis.

(4) **Treatment.** — Dislocation of the jaw, when of quite recent occurrence, can easily be reduced by placing the thumbs on the molar teeth, the fingers being placed beneath the chin. A downward movement is to be used with the thumbs and an upward with the fingers. It is well to wrap some lint or a towel round the thumbs to prevent them being injured. If necessary, the leverage can be increased by placing corks or some similar wedge between the molars. In old-standing or difficult cases ether should be given, as it will bring about muscular relaxation. After reduction, a four-tailed bandage should be worn for one or two weeks, the mandible being used as little as possible. Patients accustomed to repeated dislocations should be advised to use an elastic support.

CHAPTER XXX

Necrosis of the Jaws

Causes—Signs and Symptoms—Diagnosis—Treatment

NECROSIS affecting the jaws may be limited to a small fragment of the alveolar process, or may involve the greater part of the bone. Necrosis is more common in the mandible than in the maxilla, on account of the exposed position of the former, its smaller blood supply and the fact that it is composed mainly of compact tissue.

(A) CAUSES

(*a*) **Bacterial Poisons**.—In the majority of cases, necrosis of the jaws is the result of septic or infective processes arising in connection with the teeth. The *infection may reach the bone via the teeth* or their sockets, and examples of this are met with in the necrosis which occasionally follows septic periodontitis. The necrosis may be limited to the alveolar process, or may involve the body of the bone (fig. 843). How severe a condition can arise will be seen from the following case reported by Mr. Dolamore.[1] It occurred in a little boy, aged 4, and arose in the region of the left mandibular deciduous molars. A general supporting treatment was carried out with the local use of antiseptic and deodorant mouth-washes. At the end of ten months the necrosed bone was removed, and the extent of the disease can be gleaned from fig. 844. The radiograph seen in fig. 845 shows the extent to which new bone had been formed from the periosteum.

A case is reported by Mr. Breward Neale,[2] in which an extensive necrosis of the mandible was attributed to a dental operation.

"The patient, a medical man, consulted a dental practitioner

[1] *Journ. Brit. Dent. Assoc.*, vol. xxi, p. 3.
[2] *Trans. Odonto. Soc.*, vol. xxxii, p. 146.

on account of great pain from a mandibular right canine in which the pulp was exposed. At the first visit the pulp was dressed with a devitalizing agent; at the second visit a portion of the pulp was extirpated; at the third visit the root and crown were filled, but a flexible drill was broken in the canal. The position

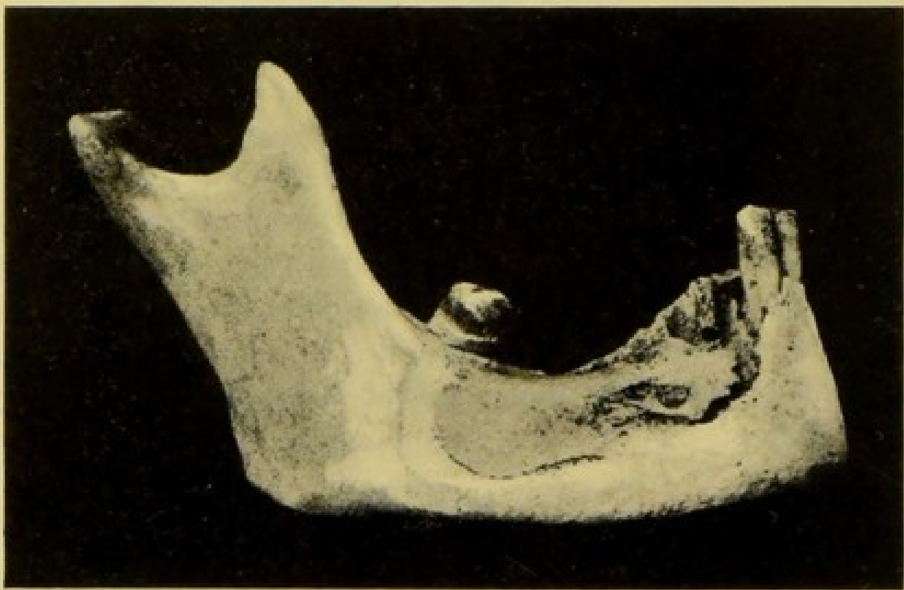

FIG. 843.—Necrosis of the mandible involving the body of the bone. The necrosis was due to sepsis in connection with the canine.

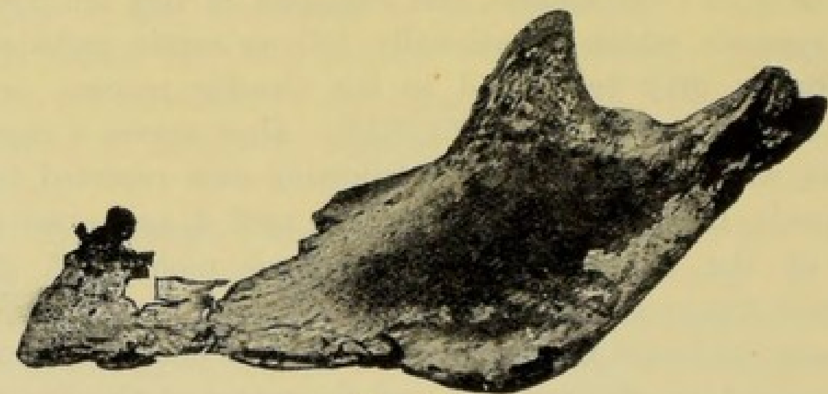

FIG. 844.[1]

of affairs was made clear to the patient, and he went away. On the fourth day he experienced great pain, and he attended and asked for the tooth to be removed, but as it was thought possible to save the tooth an opening was made through the alveolus with a view of relieving the pain. The patient attended the next day, again hoping to have the troublesome tooth removed, but the

[1] From *Journ. Brit. Dent. Assoc.*

practitioner still thought removal of the root unnecessary, and excised the crown. On the sixth day, however, the root was extracted, but no relief following, the case passed into the hands of his surgical colleagues."

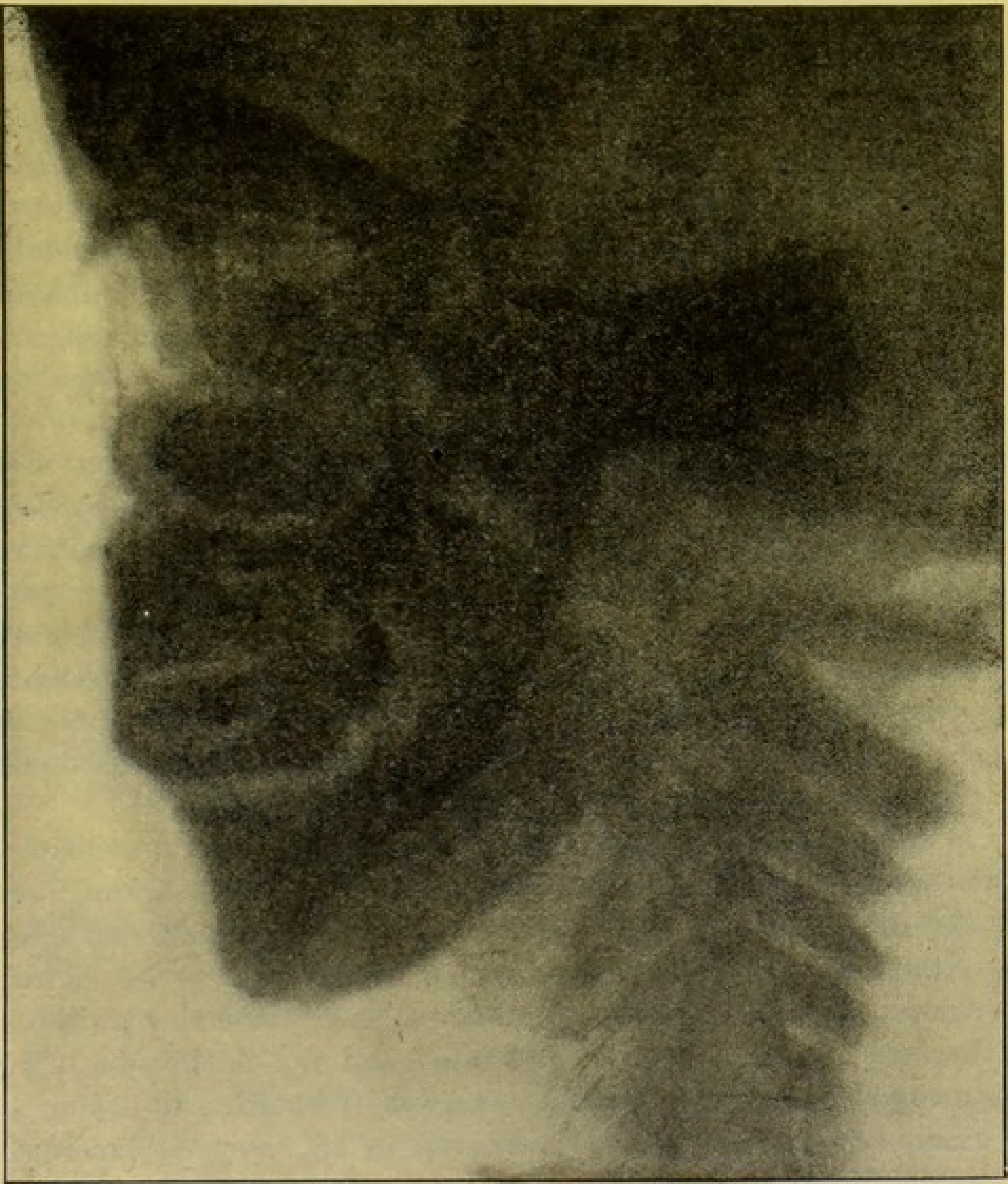

FIG. 845.[1]

The patient then went into hospital. The pain and swelling increased and the submaxillary and submental regions became swollen and brawny. Free incisions to the bone gave little relief. The condition became very grave, the whole mandible becoming

[1] From *Journ. Brit. Dent. Assoc.*

involved as far as the angle and the outline of the neck being obliterated. The patient fortunately recovered, but, at different times, forty-nine sequestra were removed. The average size of the larger sequestra was 1 in. long, $\frac{1}{4}$ in. wide and $\frac{1}{16}$ in. thick.

In children, whose resistance has been lowered by bad hygiene or acute illness, *the infection may reach the bone via the gum.* The necrosis seen in gangrenous stomatitis is an example of this mode of infection.

A third way in which the *bacterial toxins may reach the bone is by the blood-stream.* Mr. Fairbank considers that infection through the blood-stream is more common than is generally supposed; the region of the angle and the ascending ramus are the parts usually affected. The clinical condition is similar to "acute necrosis" of the long bones. Mr. Fairbank quotes the following case as typical of this type of infection: "A boy was brought to the Children's Hospital, Great Ormond Street, with a brawny swelling over the lower border of his mandible opposite the molar region. Each of the two deciduous molars on that side had a small carious cavity, though there was no sign of periodontitis, and the gums were normal. The swelling was incised through the skin and pus evacuated from beneath the periosteum of the jaw. One of the molars was removed, as it was possibly the cause of the trouble. Except for the superficial caries, the tooth was absolutely normal, and the pulp was healthy."

The necrosis, occurring as a sequela of the exanthematous fevers, is probably due to bacterial infection invading the bone from the mouth or the blood, and is in no way a specific effect of the fevers. The septic condition of the mouth present during the acute stages of the exanthematous fevers, combined with the lowered resistance of the individual, and the liability to injury in the process of cleaning the gums and the throat, all favour the occurrence of necrosis. Dr. Austen,[1] in an extended experience at the Western Fever Hospital, is of the opinion that necrosis always begins during the acute stage of the illness. In five thousand patients treated at the Western Fever Hospital, all of whom were under observation for at least eight weeks, the cases of necrosis that occurred could all be referred to the acute stage of the illness, not one having arisen during convalescence.

[1] *Dental Record*, June, 1896.

Necrosis is more common in connection with scarlet fever than with measles and is rarely met with in small-pox. In scarlet fever, necrosis is mainly met with in cases in which severe throat symptoms are present, and is usually first clinically recognized in the second and third week of illness. Children between the ages of 4 and 6 are the most frequent sufferers, but it may occur in younger and older patients.

Austen states that—

"Scarlatina necrosis of the jaw is most frequent in the lower incisor region on the labial side. It is, however, often seen in the premolar and molar regions on the buccal aspects. In the former situation it is usually symmetrical, less frequently so in the latter. In one case, under the care of a colleague, necrosis occurred on the inside of the ramus, well behind the last molar tooth, and not involving the alveolus in any way. The necrosis may involve the bone forming the sockets of the deciduous teeth only, or more rarely, and especially in the lower incisor region, cause destruction of the bone enclosing the sacs of the permanent teeth.[1] The sequestrum usually takes two or three weeks to separate. The mortality of the cases in which necrosis of the jaw takes place is high, partly from the usually intrinsically severe nature of these cases, partly from aggravation of the symptoms caused by the necrosis. In the worst cases, the mouth becomes horribly foul, and the patient soon dies of pyæmia or septic broncho-pneumonia. Two causes may be clinically recognized for this necrosis of the jaw in scarlet fever. Firstly, exposure of the bone by ulceration of the gum, seen in severe stomatitis, already alluded to. Secondly, and more frequently, injury. The latter cause may appear a somewhat remarkable one to anyone not acquainted clinically with this disease."

"For the efficient treatment of the very severe throat conditions present in so many cases of scarlet fever, constant applications to the fauces (of antiseptics, &c.) becomes necessary, with removal of any secretions likely to decompose or lead to injury. This is done by syringing, spraying, or swabbing, the latter procedure being most effective. These methods, however,

[1] It is possible that some cases where destruction of the permanent tooth sacs occurs may be overlooked, owing to the fact that the condition so often proves fatal.

necessitate the introduction into the mouth of bone or vulcanite syringe nozzles, spatulas to depress the tongue, occasionally a cork wrapped with lint to gag the mouth open temporarily. However great be the care employed, it is almost impossible in some children to avoid injury to the deciduous teeth. The child will bite the spatula or the nozzle of the feeding vessel, &c., until the teeth become quite loose and fall out, the septic state of the mouth then causing ulceration, and ultimately necrosis of some part of the socket. I have been many times surprised at the very slight pressure with a spatula, or other implement used in examining the throat, that will loosen or extract the teeth in these cases, even when employed with the greatest care and gentleness. Even short of extraction of these teeth I am convinced from clinical observation that necrosis of the alveolus often arises merely from pressure on the crowns, and that not undue in amount. In severe cases in which extensive necrosis appears, I am convinced that it is best to leave the fauces entirely alone, and to feed the child solely with the nasal tube, as if the treatment be persevered in the case will only go from bad to worse."

Dr. Austen's remarks have been quoted fully because they seem to throw much light upon this hitherto obscure condition. During the acute stage a piece of bone may die from either ulceration or injury, and may remain hidden beneath the gum for some time, the true condition only becoming manifest when the bone has separated from the living bone and is being exfoliated. Exanthematous necrosis so called would therefore seem to be not a secondary specific sequel, but rather a condition which arises during the acute stage.

(*b*) **Chemical Poisons.**—*Arsenious Acid.*—The commonest example of necrosis traceable to chemical poisoning is that which is caused by the escape of arsenious acid used for devitalizing the pulp. The poison may act directly on the gum, or may escape through the apical foramen. Usually, the necrosis is not extensive, but, with superimposed bacterial infection, a considerable portion of the bone may become involved. In a case under the care of Mr. Schelling a maxillary molar was affected, the exfoliation from the socket fitting like three little caps over the surfaces of the roots.

Mercury.—A long course of mercury or the constant inhala-

tion of mercurial fumes may cause necrosis. This form of necrosis is uncommon at the present day, as mercury is not now given in quantities sufficient to produce salivation, and operators employed in the manufacture of looking-glasses are not now subjected to the same risks as formerly. Mercury causes necrosis by setting up an acute suppurative periostitis (see p. 576).

Phosphorus.—This form of necrosis was first described by Lorinser, of Vienna, while Dr. Wilks was the first in this country to draw attention to the subject. It is a severe form of disease and may affect both jaws, though usually only one at a time[1] is

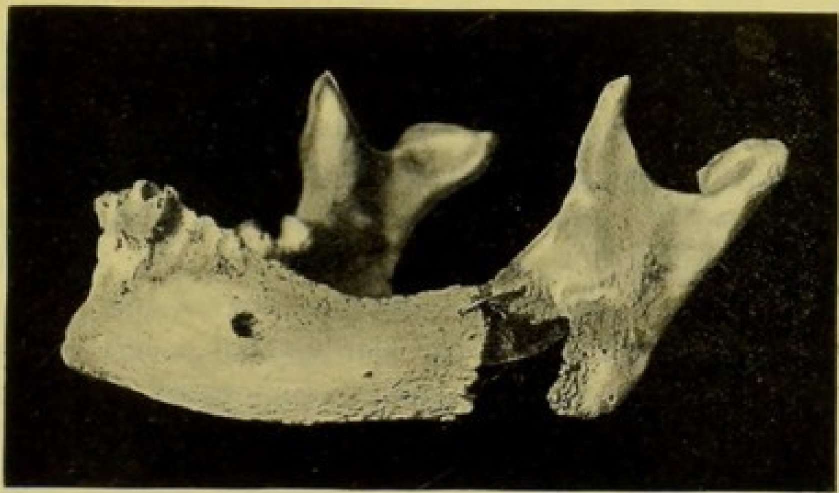

FIG. 846.—Extensive necrosis of the mandible occurring in a lucifer match maker. In this specimen the "pumice-stone" deposit is not present in the sequestrum.

affected. In the early stages it is slow in its progress. The condition is one of cario-necrosis and differs in no respect from the same lesion seen in other bones and arising from various causes.

This form of necrosis is nearly always seen in those subjected to the fumes of phosphorus. The following figures, by Professor Oliver, will give some idea of its frequency. It is computed that about 4,500 people are engaged in the United Kingdom in lucifer match making. In six years (1893 to 1898) thirty-seven cases of necrosis are known to have occurred. It is to be noted that

[1] In 51 cases collected by von Bibra, 21 occurred in the maxilla, 25 in the mandible, and in 5 cases both jaws were involved.

the disease is mainly met with in those engaged in the dangerous parts of the manufacture, namely, "mixing," "dipping," "drying," and "boxing."

A case has been recorded in a child aged 7 who was in the habit of playing with matches, while a very curious case is given in *L'Odontologie*: "The patient was a man of good health, but addicted to the habit of excessive cigar-smoking, consuming about twenty cigars a day and using many matches to each one, as he frequently interrupted the smoking during his work. It was computed that for the last twenty years he had daily inhaled the vapour of phosphorus given off by over 100 matches. The early symptoms were pain in the right eye, with swelling involving the whole side of the face. Suppuration supervened and the pus obtained a free flow into the oral cavity. The patient's condition grew worse and the maxilla was eventually removed. A few months later a fresh operation was necessary; but the patient collapsed, dying from meningitis. The patient's teeth were in a deplorable condition."

The late Dr. Magitot, who carefully studied the question of phosphorus poisoning, was of the opinion that operatives exposed for a prolonged period to phosphorus fumes develop a peculiar constitutional condition which he termed **phosphorisme.** There is a general lowering of the system, inducing dyspepsia, bronchitis and allied affections. Dr. Arnaud, the medical officer in charge of the French Government Works at Marseilles, states "that about one-half of the operatives are anæmic, especially young females from 18 years upwards; also 28 per cent. of the hands suffer from bronchitis." He, however, does not consider that work in a match factory necessarily predisposes to tubercular diseases of the lungs.

In Grammont, one of the principal seats of the industry in Belgium, the medical officer treated in twenty-five years thirty cases of spontaneous fracture of long bones caused by muscular effort. This liability to fracture of long bones is confirmed in a measure by Dr. Garman, the medical officer to Messrs. Bryant and May.

The fumes emanating from phosphorus consist principally of phosphorus anhydride (P_2O_3) and phosphoric anhydride (P_2O_5). These fumes are probably dissolved in the saliva. (1) The action

may be purely local, in which case the irritant finds its way through a septic pulp or wound of the bone and sets up an inflammation of the periosteum, followed by suppuration and necrosis; or (2) the phosphorus fumes produce a general lowering of the resistance of the individual, and also locally, by their irritant action, weaken the nutrition of the bone and render it more liable to attack by micro-organisms.

There is some uncertainty as to whether the phosphorus fumes act directly upon the oral tissues. In experiments conducted by von Bibra, suppuration and cario-necrosis were produced in rabbits which had been exposed to the fumes of phosphorus after teeth had been extracted and the bone fractured.

In an excellent article on the causation of phosphorus necrosis, Mr. F. Dearden[1] refers to experiments undertaken by von Stubenrauch which go to prove that the local action of phosphorus is insufficient to produce necrosis. Von Stubenrauch drilled holes into the jaw-bones of dogs and filled them with phosphorus and then plugged with cement, but no necrotic changes followed. In dogs, rabbits, and guinea-pigs, wounds were exposed to phosphorus fumes for three to four months without effect, unless the wounds were kept open artificially, and then the the resulting necrosis was quite superficial. As a result of his long series of experiments, his opinion is that phosphorus fumes exert no specific action on exposed bone or periosteum. It is to be noted that necrosis does not occur until the worker has been exposed to phosphorus fumes for some years, and that cases have occurred which have commenced several years after the sufferers have discontinued match-making. Dearden considers that the constant inhalation of the fumes brings about a saturation of the tissues which influences bone tissue generally and is chemical in its nature.

The necrosis of the jaw would seem to be due to local injury by bacterial poisons acting upon tissues already damaged by the action of the phosphorus poison circulating in the blood. If other bones in the body were as liable to local injury from bacterial poisons as the bones of the jaws, necrosis in those bones would be as frequent as in the jaw.

[1] *Brit. Med. Journ.*, August 17, 1901, p. 408.

Stockman[1] considers that necrosis is tuberculous in character. He exposed four rabbits in hutches to phosphorus fumes after the periosteum and gum in each had been removed over a considerable portion of the maxilla and mandible, a tooth in one of the rabbits also being loosened. The operations were all performed under chloroform. The animals seemed to suffer no inconvenience either from the operation or from living in the phosphorus-fume atmosphere. It was very difficult to prevent the gum growing over the exposed bone, and after many weeks there was not the slightest trace of any jaw affection. The exposed surface of bone became slightly eroded and rough, but whether from the action of the acid fumes or from that of the bacilli of the mouth it was impossible to decide.

Six specimens of pus from cases of phosphorus necrosis were examined by Stockman. He found *Staphylococcus albus*, streptococci and numerous other organisms. In every case he was able by the Ziehl-Neelsen method to demonstrate the presence of the *Bacillus tuberculosis*. Stockman considers that the condition is of a tubercular nature, the phosphorus fumes simply rendering the tissues more liable to attack by lowering their vitality.

The sequestrum from cases of this form of necrosis is often peculiar, owing to a deposit known as the "pumice-stone" deposit. This is found in sequestra from the mandible, but not in those from the maxilla. It is formed from the periosteum, but is so closely adherent to the sequestrum as to be generally brought away with it. A point of interest in regard to the structure of the deposit is that the Haversian canals are larger than in normal bone: they run at right angles to the general direction of the bone, and not parallel to it; they interlace with one another, and in some places form sac-like expansions. Although this peculiar deposit is generally to be found in cases of phosphorus, it may occur in other forms of necrosis.

The *symptoms* of this disease generally commence with toothache, which is at first local and constant, and later becomes more severe and erratic, the pain shooting to the side of the head and towards the shoulder. The disease is at first subacute. The gums become swollen and livid, the swelling and tenderness in-

[1] *Brit. Med. Journ.*, January 7, 1899, p. 9.

crease, and suppuration eventually takes place. The skin over the part becomes red, tense, and distended. Bronchial and pulmonary symptoms from irritation may develop, while later, during the advent of suppuration, there is often well-marked pyrexia, accompanied by rigors. The sufferings of the patient are much relieved by the discharge of the pus.

Prognosis.—If the disease is not too far advanced and the treatment is prompt, the prognosis is favourable. In about 83 per cent. of the patients attacked with this disease recovery takes place.

The prophylactic treatment is the most important. The yellow phosphorus is the dangerous allotropic form, and its use is now abandoned in this country in match-making. Since the enforcement in lucifer match factories of special rules relating to general hygiene, regular medical and dental inspection, &c., the number of operators attacked by phosphorus necrosis has considerably decreased. In the years 1893 to 1899, previous to the institution of the special rules, thirty-seven cases of phosphorus poisoning occurred among 1,908 persons employed in the dangerous processes, while since the institution of the rules, namely 1900 to 1907, the incidence has been thirteen in 1,378.

(*c*) **Trauma.**—Necrosis from traumatic causes is only liable to occur when the injury leads to a comminution of the bone in such a way that the fragment is cut off from its blood supply. Necrosis of small portions of the alveolar process following extraction often occurs in this way. In the majority of cases of necrosis following trauma, however, the death of the tissue is due to septic infection.

(*d*) **Tubercle.**—Tuberculosis of the jaws is a rare and intractable disease. It is usually met with in patients affected with tuberculosis of the lungs. The disease usually starts in other parts of the mouth and spreads to the gum and teeth, more rarely the primary lesion is in the alveolar process. In a case under my care, the seat of trouble was a left mandibular second premolar, and the disease, in spite of treatment, involved the whole of the horizontal ramus on that side. An interesting case is recorded by Partsch[1] in which the primary lesion was a tuberculous

[1] *Deutsche Med. Woch.*, September 22, 1904 (translated in *Brit. Dent. Journ.*, vol. xxvi, p. 657).

periodontitis, the bacilli having gained access through a carious first mandibular molar.

Injury of the bone from tooth extraction in patients with active phthisis is liable to be followed by necrosis; the death of the bone may be due to the inability of the tissues to react to the injury, or to infection of the bone by sputum.

According to Carl Zandy,[1] tuberculosis of the alveolar process usually develops between the ages of 15 and 20, and affects males more frequently than females.

(*e*) **Syphilis.**—Necrosis from syphilis occurs in the tertiary stage, a common seat being the hard palate, but any part of the jaws may be affected. The primary cause is invariably injury to the bone from trauma, or sepsis; the part thus injured becomes the seat of a gummatous infiltration or a proliferative osteitis. The mandible is said to be less liable to syphilitic disease than the maxilla.

(B) SIGNS AND SYMPTOMS

Necrosis in the early stages simulates periostitis. The gums become much swollen and tender, and suppuration occurs, the pus discharging and leaving sinuses; the teeth become very loose and pus oozes up the sides. The skin may be shiny, red, œdematous, and the breath fœtid. In severe cases, gangrene may ensue, with fatal results.

(C) DIAGNOSIS

Necrosis is apt to be confounded with epithelioma of the gums, which has spread to the antrum (creeping epithelioma), or it may be mistaken for sarcoma. Actinomycosis also simulates necrosis (see p. 871). Dead bone can be recognized by the grating sensation produced when a probe, on being passed down a sinus, impinges upon the bone. In children, the sequestrum frequently involves the permanent teeth, while in cases of phosphorus necrosis it presents a peculiar appearance known as the pumice-stone deposit, which has already been referred to. This peculiar appearance may occur in other forms of necrosis, though probably not so frequently as in that caused by phosphorus. After removal of the sequestrum in the maxilla, the tissue of repair is usually

[1] *Arch. f. klin. Chir.*, iii, p. 178.

fibrous in character, no new bone being formed; whereas, in the mandible, a considerable amount of new osseous tissue is formed from the periosteum, and in a notable case recorded by Mr. Savory (*Roy. Med. Chir. Soc. Trans.*, vol. lvii, pp. 187-191) the whole jaw was removed from a lad aged 18, and six months afterwards, when death occurred, almost a new mandible had formed.

(D) TREATMENT

In the early inflammatory stages, any cause, local or general, should be removed, local depletion carried out either by scarification or leeches, and hot poppy fomentations applied. A good purge must be given, and in addition, large doses of iodide of potassium, are recommended, opium being added when there is much pain. Should destruction of the bone seem probable, free incisions must be made to relieve tension, while loose teeth should be removed. The health must be supported, and, if solid food cannot be taken, fluids must be given. If the bone is necrosed, but immovable, the case should be left alone for Nature to throw off the sequestrum. If more than one sinus exists, they should be connected and the parts constantly irrigated. Mr. Fairbank considers that drainage plays an important part in the extent of the necrosis and the rapidity of healing. In the maxilla where there is natural drainage extensive necrosis is rare, and when necrosis does occur healing speedily follows. He therefore advises that an external incision should be made to obtain free drainage. By this means, the necrosis is prevented from spreading, healing is expedited, and the patient is, to a great extent, prevented from swallowing the discharges from the wound. As soon as the bone is loose it must be removed with suitable instruments. When the necrosis involves large portions of the jaw, surgical measures may be called for, but should not be adopted until the new bone developed from the periosteum is sufficiently complete to maintain the form of the jaw. For the method of procedure the reader is referred to one of the manuals of surgery.

Actinomycosis

This rare condition, when it affects the jaw, may easily be mistaken for necrosis, and it may with advantage be referred to here.

An excellent *résumé* of this disease was given by Mr. Eve at a

meeting of the Odontological Society in 1888. He describes the disease when attacking the maxillary region as follows: "It often begins with severe pain, localized in one or more teeth, which are frequently carious. A swelling appears about the lower, or less commonly the upper jaw, in the cheek or near the angle of the jaw. This usually softens and suppurates, the abscesses opening at many points, and giving rise to numerous intercommunicating fistulæ." The disease rapidly spreads and involves contiguous parts. Microscopic examination of the discharge will show the characteristic ray fungus, and should the disease be recognized operative measures must be adopted. See also p. 72.

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CHAPTER XXXI

Suppuration of the Antrum.—Empyema Antri.

The Anatomy of the Antrum—The Causes of Antral Suppuration — Bacteriology — Signs and Symptoms — Complications — Diagnosis—Treatment—Emphysema of the Antrum

THE chief antral disease which comes under the notice of the dental surgeon is suppuration of the antrum.

(A) ANATOMY OF THE ANTRUM.

The human antrum varies considerably both in size and shape, but these variations can be roughly grouped into three classes, namely, the normal, the small or contracted, and the large or expanded, the size being governed by the amount of tissue between the teeth and the antral floor. The dimensions may be considered as **normal** when the floor of the sinus is approximately level with the floor of the nose; the **contracted** when the antral floor is above, and the **expanded** when the antral floor is below that of the nasal fossa.

In the normal, the antrum extends from the first premolar to the tuberosity of the maxilla. The deepest portion lies opposite the roots of the second premolar and first molar, and from this point forwards and backwards the amount of bone between the teeth and the antral floor increases in thickness. In the expanded antrum the amount of bone covering the roots of the teeth is decreased, and the roots form projections on the antral floor; the molar roots mostly forming these projections, the premolars less frequently. The fact that the third molar is closely related to the antrum is often overlooked, but the knowledge of this fact is of the greatest importance in cases where suppuration of the antrum is suspected of being of dental origin. In the contracted antrum, the amount of tissue between the teeth and the antral floor is considerably increased.

The capacity of the antrum varies greatly. Those of small size may be capable of containing little more than 1 drachm of fluid; while those of large size may hold as much as 8 drachms. The antra in the same individual may vary considerably in size. The cavity in many cases is crossed by septa, which are, as a rule, placed along the floor, the most common situation being between the second and third molars. The septa along the floor may be continued up the outer wall, practically dividing the cavity into two parts.

The antrum may extend into the body of the malar bone. "Deep pockets or fossæ are met with in various parts of the cavity, particularly at the anterior and posterior corners and along the anterior wall immediately beneath the orbital plate. Sometimes a bony canal terminates in a *cul-de-sac* beneath the orbital plate in the nasal corner of the anterior wall." The average dimensions are: Vertical height $1\frac{1}{2}$ in., transverse breadth 1 in., antero-posterior depth $1\frac{1}{4}$ in.

The normal opening of the antrum is into the middle meatus towards the anterior part of the cavity. In about 10 per cent. of specimens one or even two accessory openings are present. These accessory openings are usually situated further back and on a lower level, and are usually larger and more circular than the normal ostium. Clinically they may cause antral suppuration to be masked by pharyngeal or laryngeal symptoms.

A. S. Underwood,[1] who has examined about 150 skulls of all ages and both sexes by transillumination, states that the size and position of the antrum vary considerably, and perhaps are altogether governed by the eruption, growth and subsequent loss of teeth. He finds that the molars and second premolars are almost always in relation to the cavity, the first premolar often and the canine rarely.

The relation of the teeth to the antrum depends on the size of the cavity. When the antrum is of exceptional size the canine may project in the floor of the sinus, while, in unusually small cavities, only the second and third molars are in relation with the floor.

Clinically, the size of the antrum may be gauged by the fulness

[1] *Brit. Med. Journ.*, August 22, 1908, p. 463.

of the facial and nasal walls. As a rule, the more these walls are depressed the smaller is the antral cavity.

(B) CAUSES OF ANTRAL SUPPURATION

(a) **Trauma.**—Injury to the antrum from direct violence, such as a blow on the cheek, or from fracture of the bone involving the antrum, is seldom followed by suppuration unless a bacterial infection is superimposed. Cases of empyema antri in infants, reported to be the result of injury at birth,[1] are probably cases of acute osteo-myelitis.

(b) **Bacterial Toxins.**—Injury to the antral mucous membrane by septic infection, either from the teeth or the nasal fossa, is by far the commonest cause.

The Teeth.—The roots of the canine, premolars, and molars may project into the antrum, and when this is the case direct extension of a dento-alveolar abscess from any of these teeth may infect the antrum, but more commonly the second premolar and first molar are the offending teeth. Direct infection may be due to the penetration of a septic tooth or any other foreign body into the antrum. The infection may arise from a dental cyst suppurating and opening into the antral cavity, but such cases are rare (see p. 890). One frequent source of infection, but one that is constantly overlooked, is from chronic periodontal disease (pyorrhœa alveolaris). In this condition the septic infection spreads from the periodontal membrane into the bone and thence to the antral cavity. In one case recorded by Mr. Kekwick[2] the tubercle bacillus was present in the pus, the local tuberculosis being started by a periodontitis in connection with a second premolar.

A diversity of opinion exists as to the relation which the amount of tissue between the roots of the teeth and the antrum bears to the liability to infection. Some authors consider that the thinner the bone the greater the liability to infection; others hold that the infection is due more to the infection of the bone generally than to direct extension from the teeth into the cavity.

The Nasal Fossa.—Extension of infection from the nasal fossa

[1] See case recorded by D'Arcy Power, *Brit. Med. Journ.*, September 25, 1897.
[2] *Brit. Journ. Dent. Sci.*, May 15, 1895.

is a frequent cause of antral suppuration. The acute conditions which occur in the course of influenza and some of the exanthemata are probably due to direct extension of the infection from the nose.

(C) BACTERIOLOGY

The pus in antral disease often contains a large number of the organisms which are found in the mouth, and a certain amount of diagnostic value attaches to even a microscopic examination of antral pus, in that where the infection of the antrum has taken place by penetrating periodontal disease certain well-known mouth organisms are invariably present, amongst them particularly the *Spirochæta dentium*, the *Spirillum sputigenum*, and the *Bacillus fusiformis*. Where these organisms occur in antral pus, strong presumption exists that infection has taken place from the gum margins through the bone rather than through an infected tooth pulp. On the other hand, where the infection has taken place through the nose organisms of nasal origin are found. In a number of instances of acute antral inflammation of known nasal origin, the *Bacillus influenza* is to be found, but it rapidly dies out, and a secondary infection of streptococcus, staphylococcus, or *Bacillus friedlander* may take place. In addition to these organisms, the *Micrococcus catarrhalis* and the *Bacillus septus* are to be found.

The pus from cases of antral disease usually contains a variety of organisms, the infection in most instances being of a mixed character. Mr. K. Goadby[1], in fourteen cases he records, found various forms of staphylococci in twelve of the cases.

The *Staphylococcus aureus* was met with in seven cases.

The *S. albus* was met with in eight cases.

The *S. citreus* was met with in one case.

The *S. viscosus* was met with in two cases.

The *Streptococcus brevis* occurred in eight cases.

The *S. longus* occurred in one case.

Of the other organisms met with, the *Bacillus fusiformis aerobius* (possibly an aerobic variety of Vincent's bacillus) was isolated twice (see figs. 423 and 424, p. 329), Friedlander's bacillus twice, and the *Saccharomyces neoformans* (see fig. 412, p. 307) three times.

[1] *Brit. Med. Journ.*, August 22, 1908, p. 465.

Stanuleami and Baup[1] assert that the antral pus from cases of dental origin is fœtid, the organisms found being chiefly anaerobic, *e.g.*, *Bacillus ramosus*, *B. perfringens*, *B. serperis*, while in suppuration of nasal origin the pus is more fœtid, and the organisms principally aerobic, *e.g.*, pneumococci, staphylococci, and streptococci.

Mr. Goadby's experience is that the pus in antral diseases of dental origin is generally the most fœtid, and where exceedingly fœtid pus is present in the antrum it is usually due to the extension of inflammation from the gums and alveolar margin, and not from the rare occurrence of a dental abscess pointing into the antral cavity.

(D) SIGNS AND SYMPTOMS

(a) **Acute.**—The most typical symptoms are seen after influenza. There is a feeling of intolerable distension of the zygomatic region, with pain of a throbbing character. The skin covering the bone becomes swollen, red, and very sensitive. Coughing and blowing the nose accentuate the feeling of distension by increasing the tension in the antral cavity. If the ostium maxillare is patent, there may be a discharge from the nose. The pain is most severe in cases where the opening is blocked, but it is at all times acute, as the inflammatory infiltration of the parts themselves produces pressure on the nerves. When the ostium is blocked an increased tension from pent-up discharge naturally increases the pain. General febrile symptoms are present.

(b) **Chronic.**—The symptoms are often deceptive, and a case may escape recognition for a long time. The most prominent symptom is discharge from the nostril on the affected side. A bad odour is at times noticeable by the patient himself, unless his olfactory powers have been blunted by nasal disease. Pain is not often severe and is not necessarily local. The pain may be referred to the frontal region or to the teeth, or may be felt over the affected antrum. The part may be tender and the patient unable in consequence to sleep on the affected side. There is generally some thickening and capillary injection of the soft parts over the affected antrum. In chronic cases, should the ostium maxillare become blocked when the pus has filled the antrum and

[1] Quoted by Logan Turner, "The Accessory Sinuses of the Nose," 1901.

is exerting pressure, the symptoms become acute. It must be remembered that pus under pressure in the antrum behaves precisely in the same manner as pus under pressure elsewhere, *i.e.*, it finds an exit by the path of least resistance. There is no bulging of the antral walls or displacement of eyeball or alveolar process. Many cases presenting symptoms which have hitherto been regarded as suppurating antra are really cases of suppurating cyst, most often dental cysts.

(E) COMPLICATIONS

Suppuration in an antrum may lead to **necrosis** of its walls, to **infection of the sphenoidal sinuses**, or to **septic meningitis** through venous channels (deep facial and pterygoid plexus).

(F) DIAGNOSIS

In all cases of chronic suppuration there is some thickening of soft parts over the affected antrum ; slight in many cases, but always noticeable. ' A purulent discharge from the nose, accompanied by a dull, deep-seated pain, is strongly suggestive of antral suppuration. Empyema antri must always be diagnosed from ozœna ; in the latter, the breath is offensive to bystanders, but not to the patient, while the contrary is the case in suppuration of the antrum. The presence of septic teeth in the molar or premolar region would assist in the diagnosis. Pain in the frontal region of one side (supra-orbital nerve) should always arouse suspicion of antral disease of that side ; this pain is in some cases severe, even in chronic antral disease.

The **presence of pus may be positively determined** by several methods :—

(*a*) Cleanse the nasal cavity, **make the patient assume a position so as to bring the ostium lowest.** If the ostium is patent pus will trickle from the nostril. With a nasal speculum pus may be seen in the middle meatus.

(*b*) The **antrum may be punctured** by a trocar and cannula through the canine fossa or nose, and washed out through the canula so inserted.

(*c*) **Transillumination.** — For this purpose the patient is placed in a totally dark room and an electric lamp placed in the mouth. The two sides are then compared.

Note :—

(i.) Whether the pupils are equally illuminated from within.

(ii.) Whether the patient appreciates light equally on both sides (patients can usually answer the question intelligently).

(iii.) The amount of light visible around the lower edges of the orbits.

(iv.) The amount of light passing through the cheeks.

Conditions influencing Transillumination.

Anatomical.—Transillumination is best seen in patients of thin, spare build, with normal palates and nasal fossæ. A high palate with narrow nasal passage transillumines badly, and the same occurs when the antrum is small or bony partitions are present.

Pathological.—The general transillumination is increased in cysts with clear contents, causing thinning and expansion of the bone. Transillumination is interfered with through the pupil in certain morbid conditions of the eyes, while general transillumination is diminished when (1) the antrum contains pus, mucus, &c., (2) the lining membrane is thickened as the result of a chronic inflammatory process, (3) solid growths are present either within the cavity or invading it from without.

Transillumination is not an infallible method of diagnosis, but in combination with other methods it is one of great value. Errors are likely to arise through the varying thickness of the antral walls in the same individual and the presence of double antral suppuration.[1]

Occasionally the signs of antral suppuration are obscure, as the following case illustrates[2] :—

"A female, aged about 55, very neurotic, complained of severe neuralgic pains of the left side of her face and head, of many years' standing—probably twenty at least. Her peculiar mental condition made it impossible to get a history or to trace any coherence in the distribution or occurrence of her pain. One point only stood out—that she always began her tale of woe by reference to the left maxilla. The mouth was edentulous and all that called for note was a slight fulness of the left maxillary tuberosity, as compared with the right. There was no tenderness observable. Examination of the nose and

[1] See useful paper on "Transillumination of the Antrum of Highmore," by A. Brown Kelly, *Brit. Med. Journ.*, March 25, 1905, p. 650.

[2] Recorded by Mr. J. G. Turner, *Gazette of the Royal Dental Hospital of London*, vol. i, p. 49.

antral transillumination were negative; a radiograph showed no sign of teeth. No treatment improved her, and eventually it was decided to explore the left tuberosity influenced by the slight fulness and persistent reference of pain to that part. On opening up, the crown of a molar tooth was met with and its extraction was followed by a gush of muco-pus from the antrum. The roots of the tooth were almost absorbed and the remains of the periodontal membrane engorged, showing that the surrounding bone was inflamed."

In this case tangible signs were practically absent, the only indications of trouble being the persistent neuralgia and the tenderness and fulness of the left maxillary tuberosity.

(G) TREATMENT

(**a**) **Acute.**—The treatment of suppuration in the antrum consists in giving free vent to the pus, and thoroughly draining the cavity as in the case of suppuration in other parts. For giving vent to the pus it will be needful to "tap" the antrum at some point. If carious teeth are present they should be removed and the antrum perforated through the socket of the extracted tooth; when possible, the anterior buccal root of the first molar should be chosen, because this root opens into the antrum more frequently than any other. When the teeth are sound and living the canine fossa is the best situation for opening into the antrum. To perform the operation a cone-shaped burr fitted in a socket handle should be used, a small burr being used first, followed by a larger one. It is important to have a good-sized opening. The burr should be held somewhat like an elevator, the first finger acting as a stop. By adopting a steady rotary motion the danger of penetrating through the floor of the orbit will be avoided. An opening having been obtained, the cavity must be well syringed with some antiseptic, and provision made to keep the opening patent. The antrum should be syringed twice a day at first, and subsequently once a day. **Acute cases usually get well.**

(**b**) **Chronic.**—These cases are often extremely difficult to treat, more especially when they arise from a nasal cause. The main difficulties in treatment are :—

(1) The cavities into which the antrum must be made to drain, namely, the nose and mouth, are not usually aseptic.

(2) The mucous membrane is considerably thickened, and at times polypoid.

(3) The nature of the antrum itself.

(*a*) The cellular character of the upper part around the ostium.

(*b*) The ease of communication with the frontal sinus by which an antrum may be infected from that cavity.

(*c*) The possibility of infection from the ethmoidal sinuses.

In cases obviously of dental origin the mouth should be rendered as aseptic as possible by the removal or treatment of all sources of sepsis, and an attempt made to treat the antrum by lavage through an opening *via* the alveolar process (see above). The opening should be kept free by means of a "plug," preferably of vulcanite. The antral cavity should be syringed regularly twice a day, first with warm saline solution followed by a mild antiseptic solution. The alkaline solution assists the removal of the mucus, and allows the antiseptic used to act more efficaciously, the irrigation being continued until the discharge from the antrum completely ceases. Cases even of comparatively long standing (four or five years) will often clear up under this simple treatment, but there is a greater likelihood of success when the treatment is commenced early, and when the cause is dental and not nasal. In the irrigation of the cavity, force must not be used, as undue pressure of fluid in the cavity may push the septic matter into the frontal sinus and so affect that cavity.

In cases which do not react to alveolar drainage, and in those due to infection from the nasal fossa, intra-nasal drainage should be tried. Simple intra-nasal drainage consists in the removal of the anterior half of the inferior turbinate bone, and the removal of the whole or part of the inner antral wall so as to admit the tip of the small finger. The after-treatment consists of intranasal irrigation.

In very intractable cases, especially when associated with polypi in the middle meatus, a more extensive operation is called for, and that known as the Caldwell-Luc is generally adopted. A large opening is made through the canine fossa, and the greater part of the naso-antral wall is removed, including the anterior half of the inferior turbinate. The diseased portions of the mucous membranes are scraped away, and the bucco-antral wound sutured. In exploring the cavity care must be taken to gain access to the recesses of the upper and inner part in the region of the ostium for cellular recesses. The cavity is not

packed, and the after-treatment consists in intra-nasal irrigation. Obstinate cases of antral suppuration treated in this way often improve rapidly and a permanent cure follows. Compared with simple intra-nasal drainage, it possesses the disadvantage of being a much more extensive operation, but it has the advantage of affording direct inspection of the antral cavity.

The adoption of vaccine treatment may be tried in cases which do not respond readily to drainage and lavage. With our present knowledge of this method of treatment it is difficult to say how much value can be placed upon it. Mr. Tilley[1] states that in a small experience of it the results have not been satisfactory. Mr. K. Goadby,[2] however, states that the results of this treatment in his hands have been most encouraging. He gives records of fourteen patients, in all of whom a great improvement occurred in the general health. In six cases there was a diminution of the discharge, and in one it had become intermittent. In eleven out of the fourteen cases the method of infection was definitely traceable to the mouth; these cases, it must, however, be remembered, are more likely to yield to treatment than those of nasal origin.

To sum up, in cases of dental origin, treatment by lavage *via* the alveolar route should first be tried, and in the event of a continuation of the disease, the intra-nasal method adopted, combined, if considered advisable, with vaccine treatment.

Emphysema of the Antrum.—Under this title D. B. Kyle describes a condition in which there is an accumulation of gas in the antral cavity. The gas originates from carious teeth which communicate with the antrum, and if the ostium maxillare is closed, the accumulation of the gas causes pressure, the symptoms being similar to those seen in antral suppuration with blocked ostium maxillare. With the opening into the nose patent, the symptoms are slight; the patient complains of a sense of intra-nasal pressure, there is often a heavy, sick headache, and disturbances of the eye, nose and buccal cavities. The escape of the gas into the nose is liable to be mistaken for an ozæna of nasal origin.

[1] *Brit. Med. Journ.*, August 22, 1908, p. 463.
[2] *Ibid.*, p. 464.
[3] *Intern. Med. Mag.*, December, 1898.

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CHAPTER XXXII

Cysts and Tumours of the Jaw

It is proposed in this chapter to give a brief description of the more salient features of the cysts and tumours of the jaw, with a view to assisting students to diagnose the swellings of the jaw that may come under their notice.

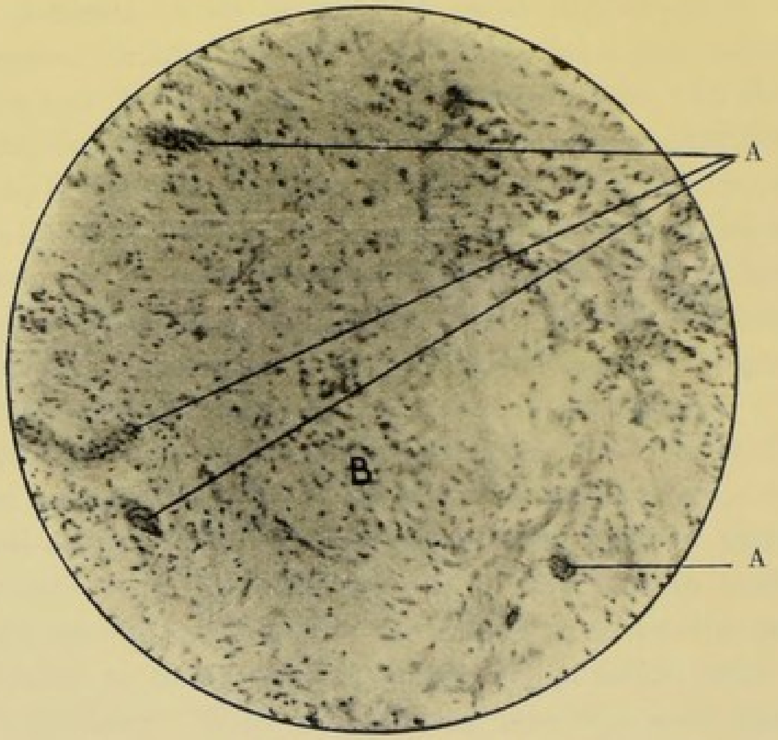

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FIG. 847.[1]—Section of thickened alveolar dental ligament from near the apex of a tooth. A, masses of cylinders of epithelium; B, inflammatory tissue.

(A) CYSTS OF THE JAW

The cysts met with in connection with the jaws are :—

(1) Dental cyst.

(2) Cystic disease of the antrum.

[1] Figs. 847 to 849, and 856 to 858 are from photo-micrographs by Mr. J. G. Turner. The blocks are from the *Journ. Brit. Dent. Assoc.*

(3) Epithelial odontome.

(4) Follicular odontome.

(5) Compound follicular odontome.

(1) **Dental Cysts.**—Cysts connected with the roots of fully developed and erupted teeth are called "dental cysts." The nature of these tumours has been carefully investigated by Mr. J. G. Turner.[1] The development of a dental cyst can always

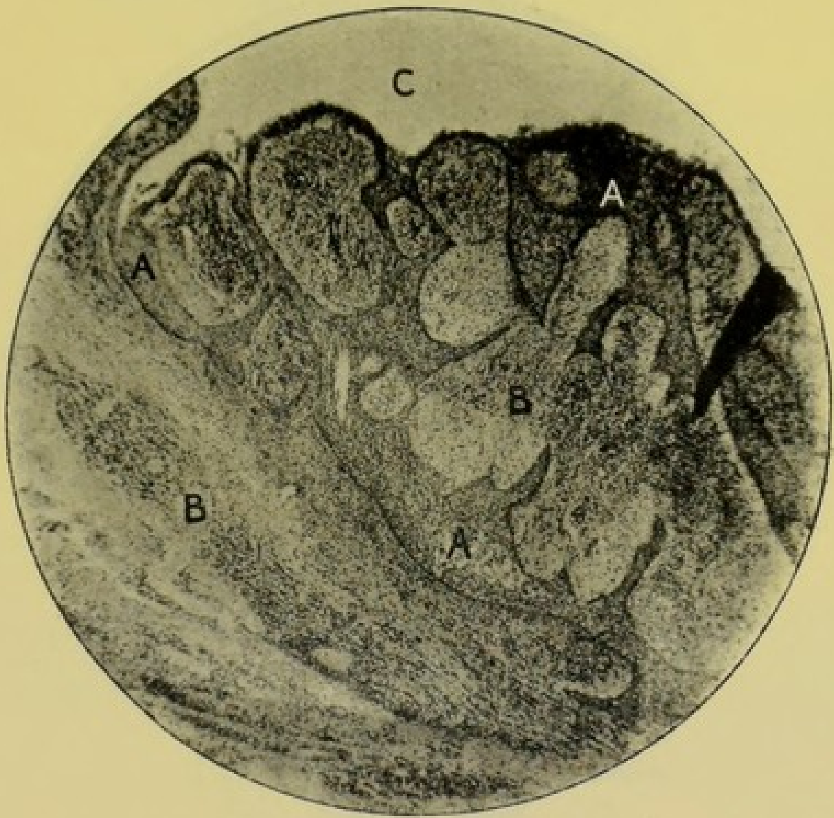

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FIG. 848.—Section of part of an epithelial granulome; C is placed in central cleft. A, trabeculæ of epithelial reticulum, central cells degenerating; B, mesoblastic tissue.

be traced to the irritation of toxins from a septic tooth, even though the tooth may have been lost. Dental cysts occur most frequently in connection with the molar teeth, and are more commonly met with in the maxilla than in the mandible.

Morbid Anatomy and Pathology.—The formation of a dental cyst probably takes place as follows: The epithelium composing one or more of the aberrant masses (fig. 847) proliferates and this

[1] *Journ. Brit. Dent. Assoc.*, October, 1898.

eventually leads to the formation of a solid tumour, "epithelial granulome," the epithelial portion of which is sometimes in the form of a solid mass, but usually is found as a reticulum or spongework (fig. 848). The cells on the periphery of the mass are in a state of active growth, while those towards the centre are in a process of degeneration. Around this epithelial mass

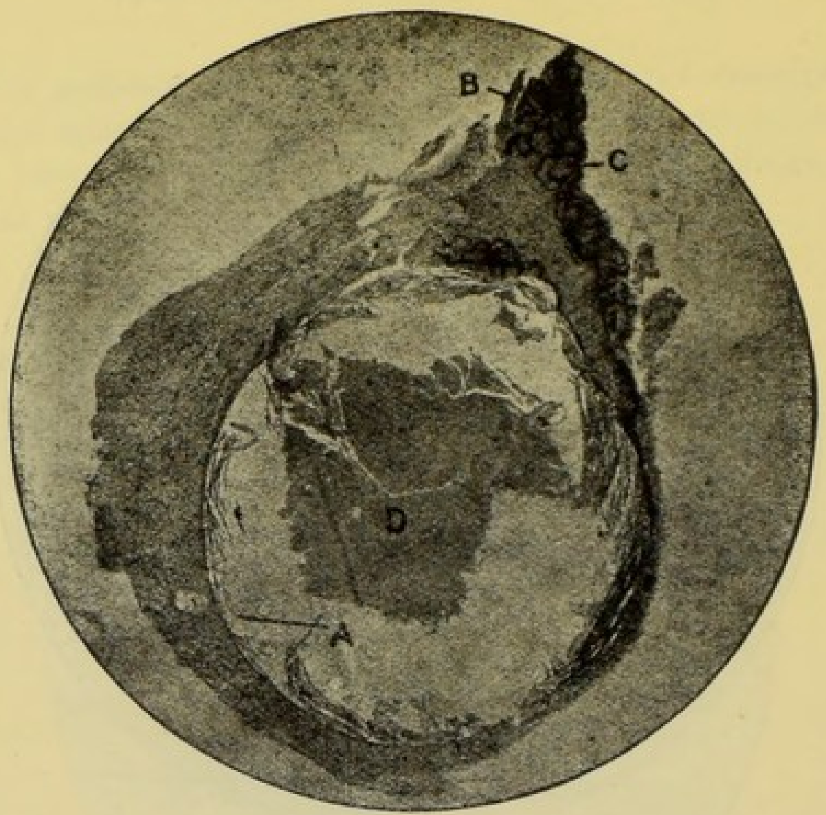

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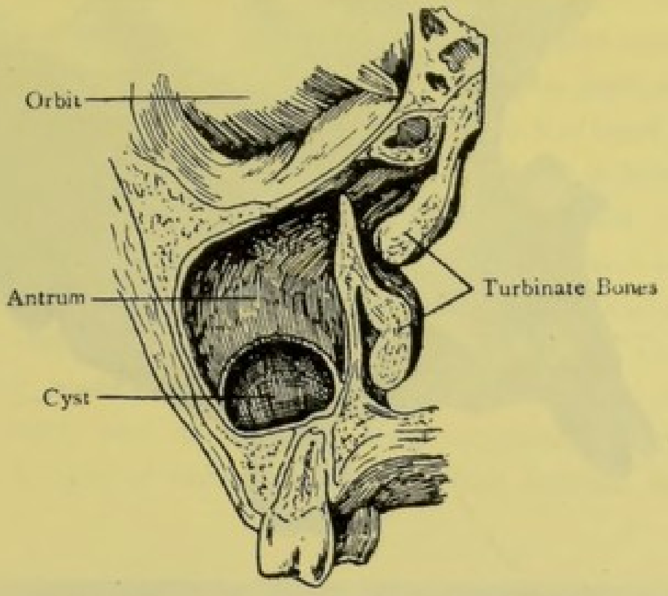
FIG. 849.—Section of a small cyst attached to the apex of a root. A, epithelial lining; B, mass of epithelium; C, remains of epithelial reticulum; D, semi-solid contents.

a capsule is developed from the surrounding mesoblastic cells. The cells towards the centre of the mass in time degenerate and liquefy, forming a distinct cyst (see fig. 849). The cells at the periphery continue to multiply and increase in size, shedding themselves towards the centre and at the same time undergoing a liquefying degeneration. In this way the fluid contents of the cyst are formed, and by growth at the periphery and degeneration at the centre the enlargement of the cyst is explained.

Being a fluid growth, the cyst will displace the tissues and



(*From a specimen in the Royal College of Surgeons' Museum.*)

FIG. 850.[1]—Cyst connected with a molar root presenting in the antrum, the floor of which is pushed in, thinned, and the bone perforated in places.

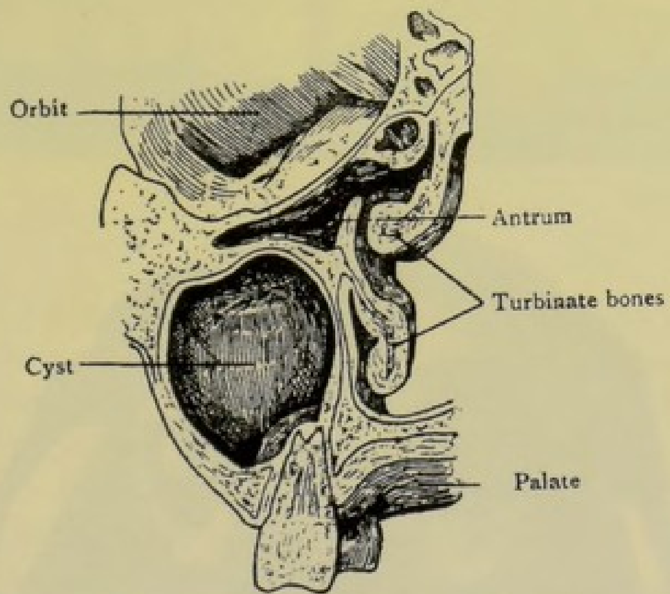


FIG. 851.[1]—Dental cyst pushing up the antrum until it is a mere slit beneath orbit. Modified from Zuckerkandl.

[1] From *Journ. Brit. Dent. Assoc.*

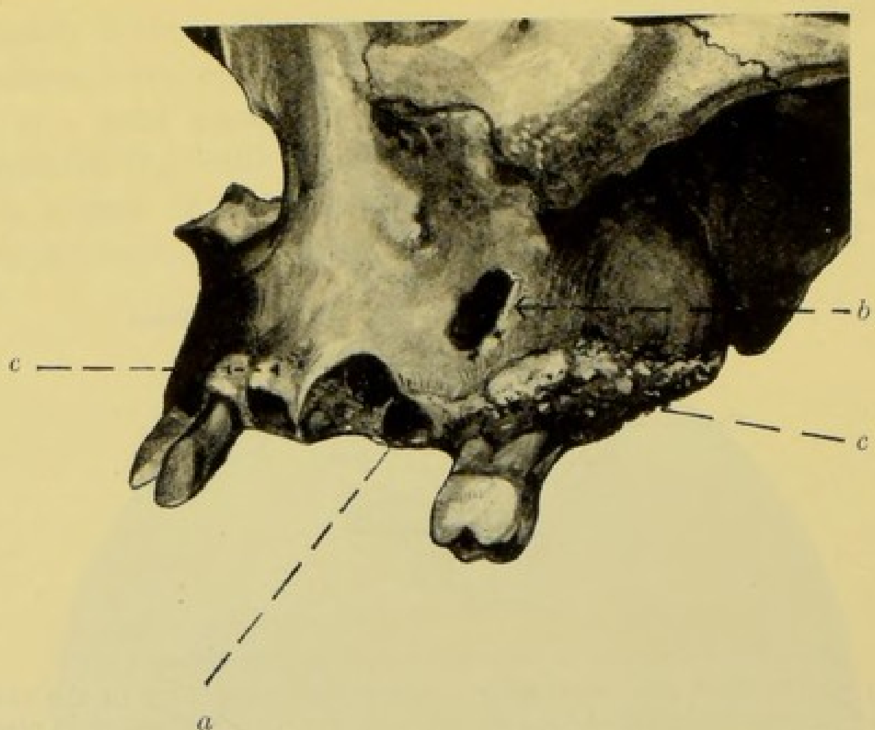


FIG. 852.—*a*, socket of the first molar; *b*, sinus opening on the external alveolar process; *c*, thickened margin of the alveolar process the result of productive periostitis.

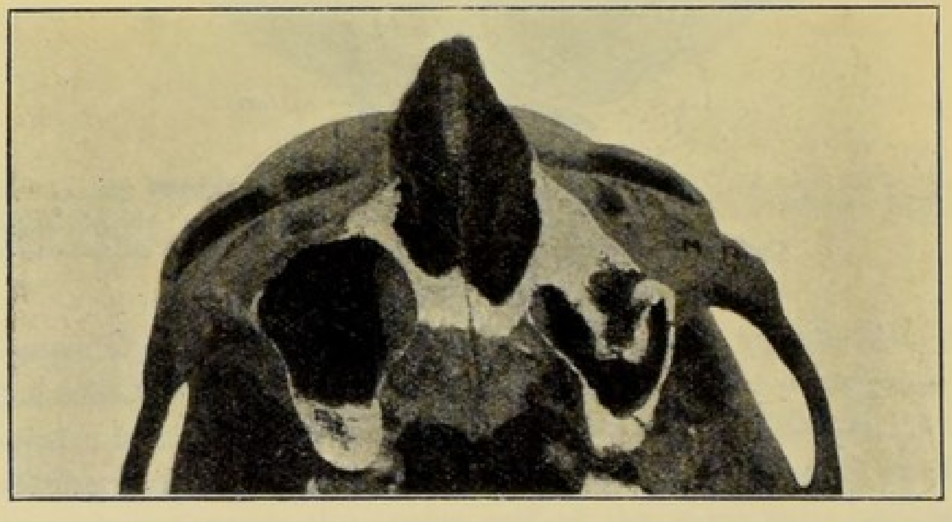


FIG. 853.—Transverse section through the antra of the specimen shown in fig. 852.

enlarge in the direction of least resistance. In the maxilla a cyst usually pushes out, thins and expands the outer plate and eventually perforates it at the most prominent part, and the same process occurs, though far less frequently, in the hard palate. The cyst frequently encroaches on the cavity of the antrum in exactly the same manner, the bony floor being pushed in, expanded, thinned, and perforated (see fig. 850), but in some instances the whole floor is pushed up until the antral cavity is almost entirely obliterated (fig. 851). A cyst may form without any distension of the outer alveolar wall. The specimen shown in fig. 852 is a case in point, and also shows that suppuration may occur in the cyst. A cyst of considerable size had formed in connection

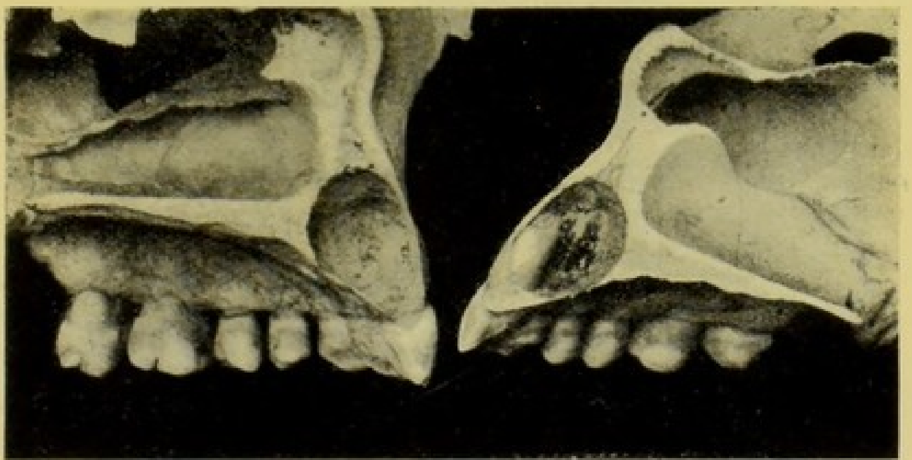


FIG. 854.

with the first molar tooth, the cause of the cyst being sepsis from periodontal disease. (Note the condition of the second molar, and the thickening of the outer alveolar border.) The cyst had caused no bulging of the outer alveolar plate, but it had encroached to a considerable extent into the antral cavity. Suppuration had followed, a sinus had formed in the alveolar process and the bony cyst wall had been perforated and suppuration had occurred in the antral cavity (see fig. 853).

In fig. 854 is shown a cyst in connection with a lateral incisor. The lateral incisor was free from caries, but the pulp had died. The cyst had excavated the bone, but had caused little bulging of the anterior alveolar plate.

In the incisor region, a cyst may present in the incisive fossa and encroach on the floor of the nose.

In the mandible, as in the maxilla, the outer plate rather than the inner plate is expanded and perforated by a cyst, but, where the cyst is of large size, both plates will suffer, and cysts have been seen presenting on the inner side only.

If the cyst in its growth comes across the root or roots of teeth, it does not bare them of their living surroundings. Further, the root from which the growth arises never projects bare into the cavity of the cyst.

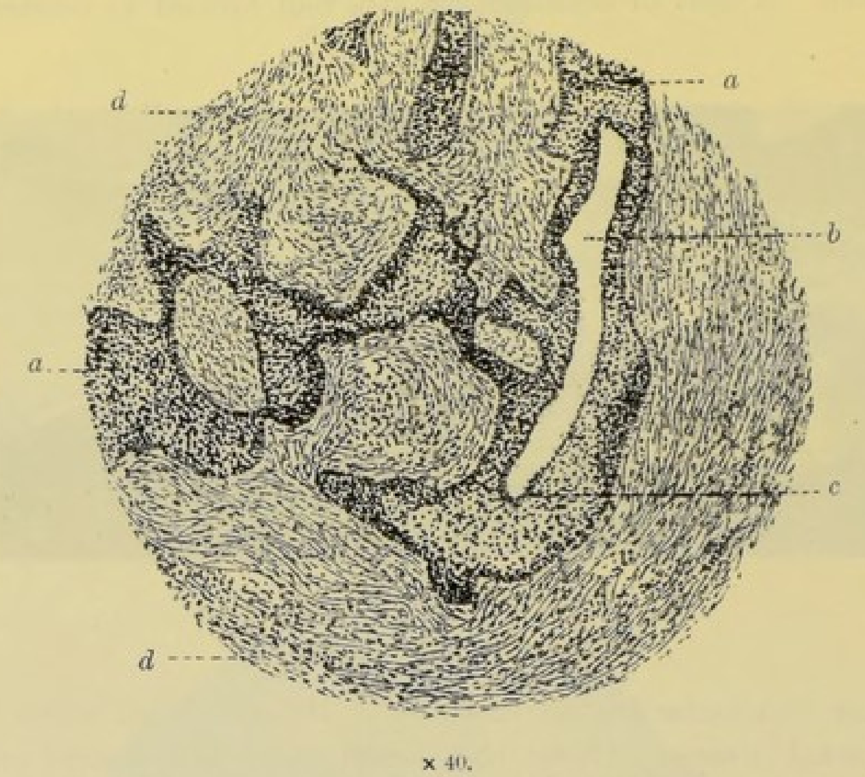


FIG. 855.—Dental cyst—early stage of formation (from a drawing by Mr. A. Hopewell-Smith). *a*, epithelial cells ; *b*, cyst cavity ; *c*, a few ciliated columnar epithelial cells ; *d*, connective tissue.

Contents. — A dental cyst contains a viscid, translucent, mucus-like fluid, with also crystals of cholesterin in suspension. *Chemical examination* shows the presence of proteids in the form of serum albumin and serum globulin, the latter being more abundant. There is an abundance of cholesterin, but no fats or fatty acids. A small quantity of nucleo-albumin is also present.

Structure of the Cyst Wall.—A section through the wall of a dental cyst shows an outer layer of connective tissue which forms the capsule. This is lined with epithelium, which is, in some cases, of the stratified variety, while in other examples the cells tend to assume a stellate form and are similar in appearance to those of the body of the enamel organ. The cells immediately bordering the cavity are in a state of degeneration (not colloid). Occasionally, columnar ciliated epithelium is met with (see figs. 855 to 858).

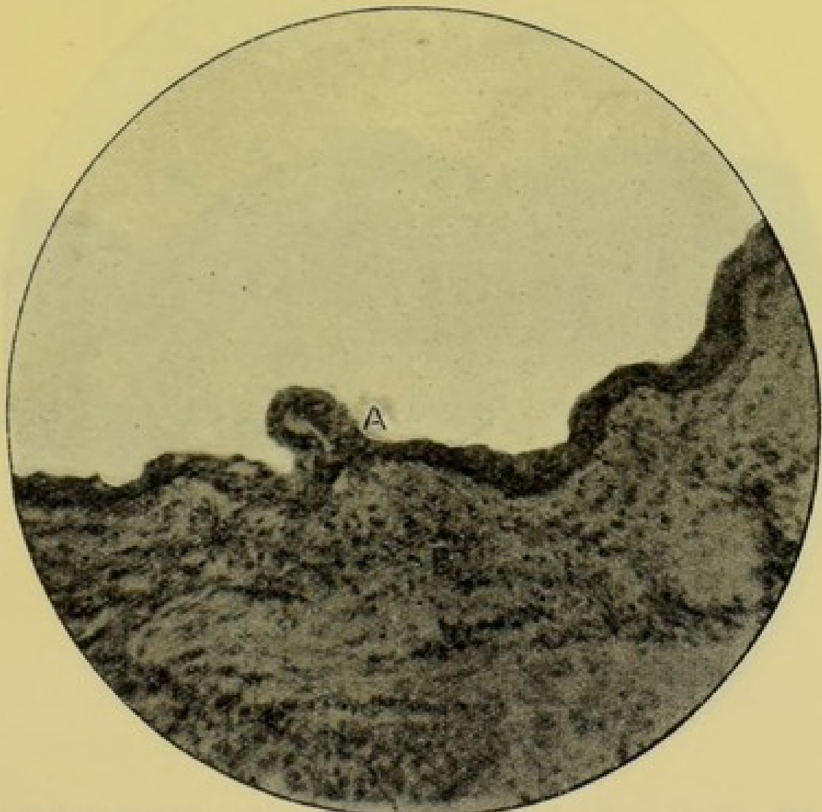


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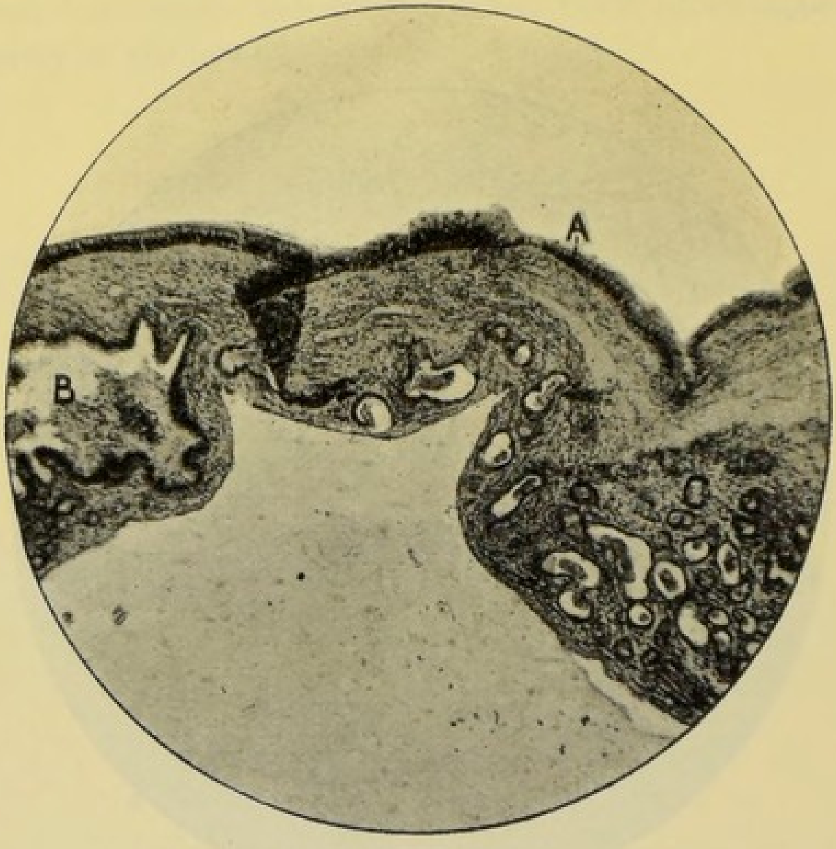
FIG. 856.—Section of wall of large dental cyst. A, thin regular lining of epithelium; B, connective tissue capsule.

In some cysts, the epithelial cell growth may be very active, and the connective tissue wall may be very thick and approach in structure a multilocular cystic tumour, in which one loculus has far exceeded the others in growth (see fig. 857). In some cases, micro-organisms can be demonstrated in the contents of the cyst and also in the inner periphery of the wall.

Signs and Symptoms.—Dental cysts give rise to smooth, globular swellings. The growth is slow but progressive. Inflammatory symptoms are usually absent, the mucous membrane being freely movable over the surface of the tumour. Occasionally, dental cysts suppurate, and the symptoms of pus formation will then be added to the physical signs of tumour growth. Pressure on the surface of the swelling will frequently produce a peculiar sensation of crackling, demonstrating the presence of a thin layer



× 43, $1\frac{1}{2}$ in. obj., N.A. ·15.

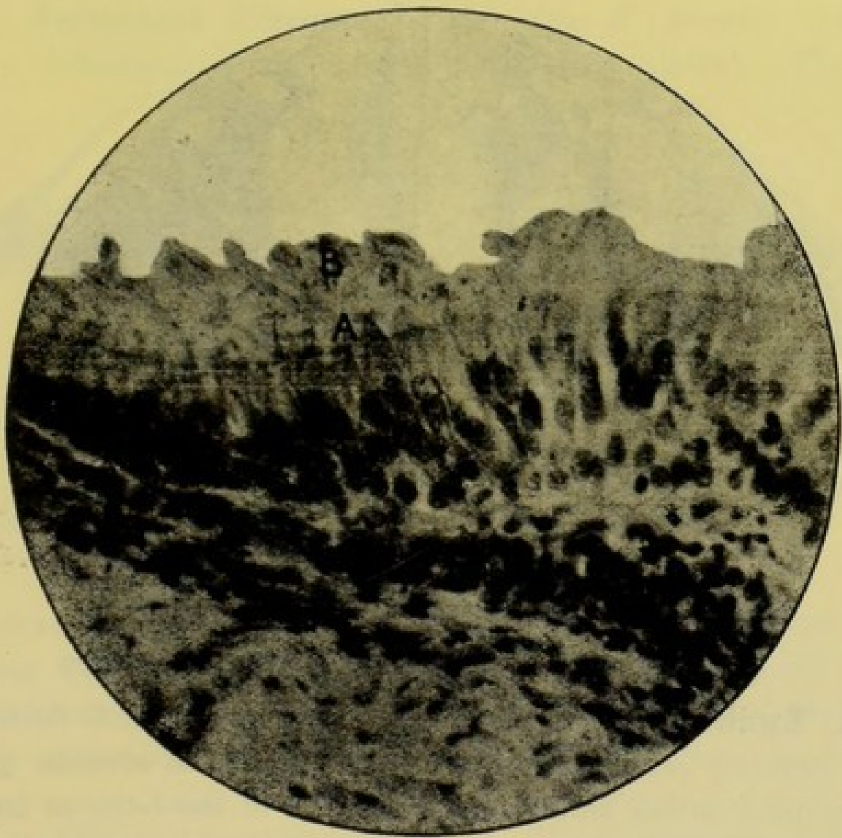
FIG. 857.—Section of wall of dental cyst, showing columnar ciliated epithelium and loculi. A, columnar ciliated epithelium; B, large irregular acinus; C, smaller acini and tubules.

of bone. Often the cyst makes its way through the bone, and then distinct fluctuation can be obtained; the fluctuating area being frequently bounded by a bony edge. *The differential diagnosis* from other swellings in the jaw is dealt with in chapter xxxiii.

Treatment.—The septic roots must be removed. The cyst should then be thoroughly opened by removing a considerable portion of the outer wall. The contents of the cyst must then

be removed, and the walls dissected out or scraped away. This must be done thoroughly, for if any portion of the wall be allowed to remain recurrence may take place. The cavity of the cyst should be packed lightly with iodoform gauze for the first twenty-four hours and the surface allowed to granulate over.

(2) **Cystic disease of the antrum** is an extremely rare disease. The mucous membrane of the antrum becomes the seat of cystic growths and, to the naked eye, presents the appearance shown in fig. 859.



× 350, ¼ in. obj., N.A. ·6.

FIG. 858.—Section of dental cyst showing at A, ciliated epithelium; B, products of degeneration or secretion.

According to Heath,[1] "the history of the cases is one of gradual, painless dilatation of the upper jaw, until its outer wall becomes so thin as to crackle like parchment upon pressure being made, or at certain points being so absorbed that fluctuation is readily perceptible."

[1] "Injuries and Diseases of the Jaw," by Christopher Heath. Fourth Edition.

Cystic disease of the antrum must be clearly differentiated from cysts which arise in connection with the teeth and encroach upon the antral cavity. There is little doubt that many of the cases recorded as cystic disease of the antrum are examples of dental cysts. These cysts may obliterate the antral cavity and cause expansion of the facial wall of the maxilla (see Dental Cysts).

For the description of Epithelial Odontomes, Follicular Odontomes, and Compound Follicular Odontomes, see chapter xxii.

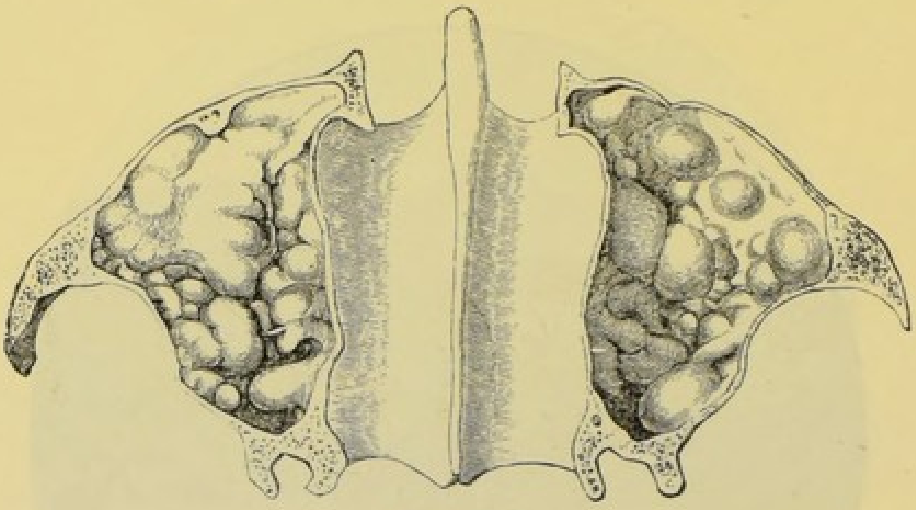


FIG. 859.[1]

(B) TUMOURS OF THE JAWS

(1) Innocent Connective Tissue Tumours

(a) **Epulis.**—This clinical term is broadly used to denote any solid swelling originating at the margin of the alveolar process. The growth arises from the periosteum of the bone or from the periodontal membrane and may be found in any part of the alveolar process, but more especially in the maxillary incisor region (figs. 860 to 862). These growths may be purely inflammatory in origin and then consist solely of granulation tissue, more rarely the epulis is of the nature of a true tumour and is sarcomatous in character, the structure in some cases being that of a fibro-sarcomata and in others a mixed and fibro-sarcomata containing myeloid cells. The myeloid variety *is not similar in character to the ordinary sarcomata of bone or the*

[1] From "Injuries and Diseases of the Jaw," by Christopher Heath.

central myelomata of the mandible. "The giant cells lie in tissue composed of oval and round nuclei embedded in a distinctly fibrillar matrix, and there is a distinct tendency to fibrillation of the stroma, and in this fibrillation the giant cells take a distinct part."[1] The malignancy is slight and recurrence, if it takes place, is local.

In a few specimens of epulis a development of myxomatous cells is seen (see fig. 863).

(**b**) **Fibroma.**—Tumours composed of fibrous tissue in connection with the jaws may be either (*a*) periosteal or (*b*) endosteal.

(**i.**) **Periosteal Fibroma.**—This type of growth must be clearly differentiated from the epulis (see above). The true

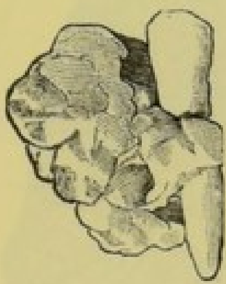


FIG. 860.—Mandibular canine, with a growth adherent to the periodontal membrane.

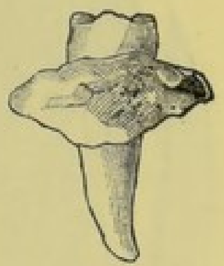


FIG. 861.—Mandibular premolar, with growth adherent to the periodontal membrane.

periosteal fibroma is composed of bundles of white fibrous tissue crossing one another in various directions and assuming a concentric arrangement in the periphery. The periosteal fibroma is usually pedunculated and of slow growth, and may occur from infancy up to adult life. The usual sites are in the mid-line of the mandible and in the premaxilla. These facts are suggestive of the origin of the growth. In the mid-line of the mandible they may arise from some embryonic tissue or "rests" left at the time of fusion of Meckel's cartilage, and in the premaxillary region they may be due to overgrowth along the sutures between the premaxilla and maxilla. A case in support of this latter view is contained in the museum of St. Bartholomew's Hospital. A fibroma grew from the maxilla at the site of the right incisor

[1] See "The Pathology and Treatment of Tumours of the Jaw," by F. Eve. *Brit. Med. Journ.*, June 29, 1907, p. 1525.

tooth of an infant one month old; it extended a short distance backwards over the hard palate and caused some projection of the upper lip.

(ii.) **Endosteal Fibroma.**—In the maxilla this growth is said to spring from the periosteum of the antrum. It is usually slow in its growth and causes a gradual enlargement of the antrum by

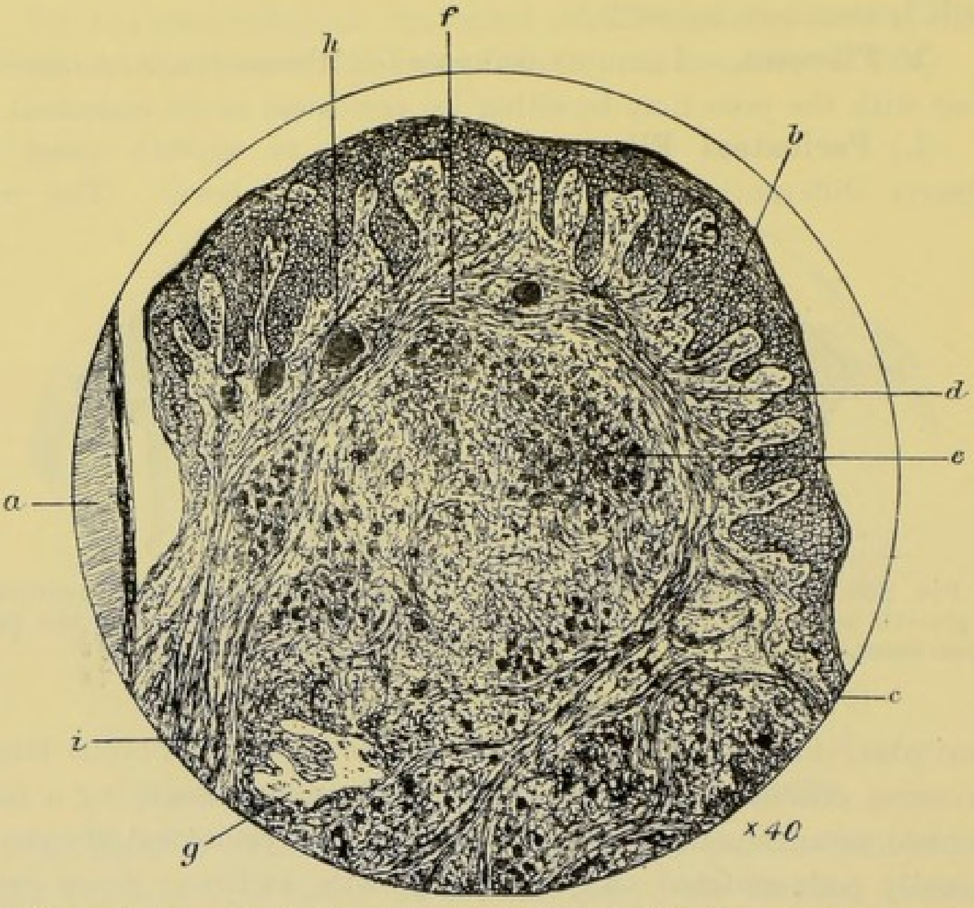


FIG. 862.—Longitudinal section of a growth similar in external appearance to figs. 860 and 861. *a*, dentine and cementum; *b*, stratified epithelium; *c*, basement membrane; *d*, submucous tissue; *e*, masses of giant cells; *f*, fibrous septa; *g*, nodule of bone; *h*, spaces filled with colloid material; *i*, attachment of tumour to cementum. (From a drawing by Mr. A. Hopewell-Smith.)

pressure upon its thinner and more readily deformed boundaries —viz., the facial, orbital and nasal walls (fig. 864). In the mandible the endosteal fibroma causes a gradual expansion of the body of the jaw, the external and internal plate walls both giving way, but this is not an invariable rule. The outline of the swelling is fairly regular.

Considerable interest attaches to the origin of the endosteal fibroma of the mandible. J. H. Targett[1] gives an account of a small fibrous growth which was removed from the mandible of a boy aged 9. At the age of 7 this patient had received a blow on the chin, and six months afterwards a small swelling which steadily increased was noticed in the jaw. On removal, the mandibular nerve was found to pass through the middle of the tumour, the fibrous growth completely surrounding it, and Mr. Targett is inclined to think that this and other cases of

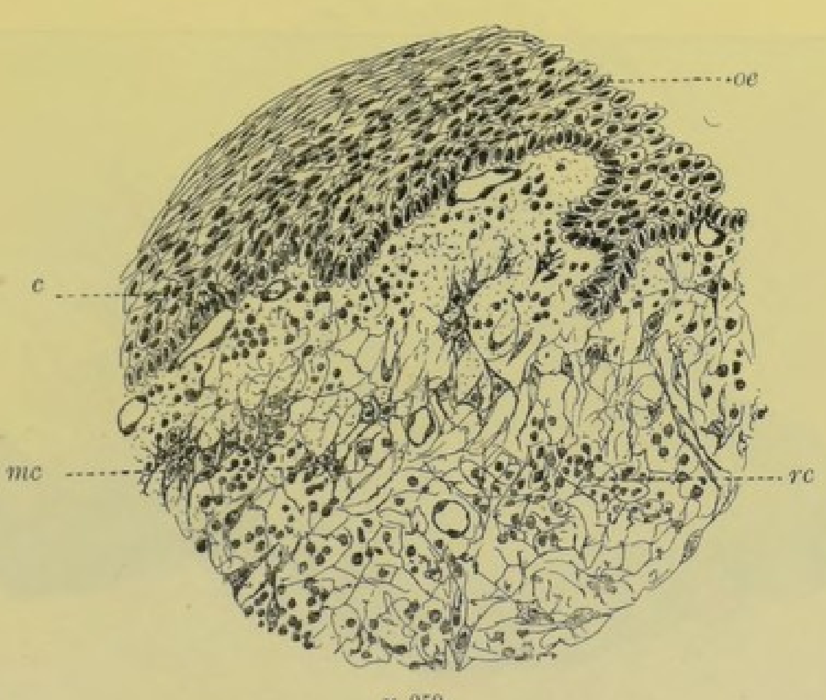


FIG. 863.—"Epulis" containing myxomatous cells. *oe*, oral epithelium; *mc*, myxomatous cells; *rc*, round cells; *c*, capillary. (From a drawing by Mr. A. Hopewell-Smith.)

central fibromata of the jaw may originate in the sheath of the mandibular nerve.

It is, however, quite possible that many of the cases recorded as endosteal fibromata belong to the category of fibrous odontomes. As an example we may quote the following case[2]: A female child, aged 8, presented an ovoid, elongated, smooth, hard

[1] "The Pathology of Certain Growths about the Lower Jaw," *Trans. Odonto. Soc.*, vol. xxxiv, p. 215.

[2] Recorded by Jordan Lloyd, *Journ. Brit. Dent. Assoc.*, August, 1898, p. 563.

and painless swelling of the right side of the mandible. The swelling extended forwards to within 1 in. of the symphysis and backwards beyond the angle of the jaw. The outer plate of the bone was principally bulged, the inner surface being but little altered. The soft parts over the tumour were quite normal, and the teeth behind the canine were missing. On removing the outer plate of bone, the tumour was found to be lying loosely between the plates of the jaw, and was shelled out with little difficulty, being held only at the lower and hinder part where it lay over a

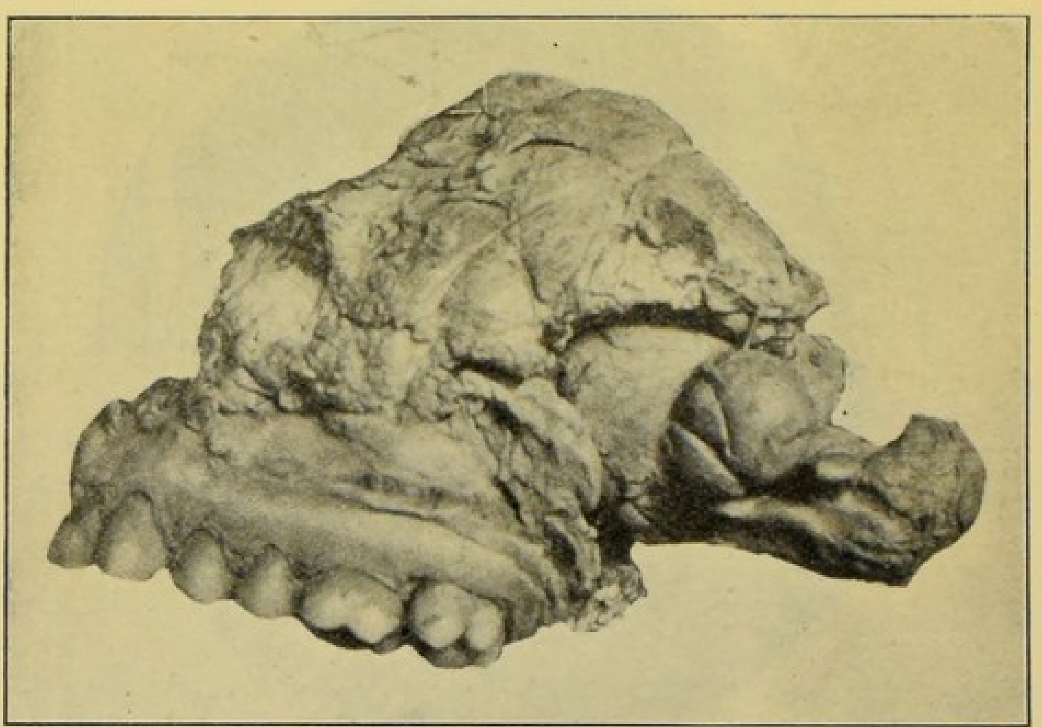


FIG. 864.—Fibroma of the maxilla arising in the antrum. (Museum of Charing Cross Hospital.)

permanent molar tooth. This tooth was removed along with the tumour, and was found to be attached to the tumour by a thin membrane. A careful examination showed that this delicate fibrous membrane passed from the outer surface of the tooth root to the delicate connective tissue capsule of the tumour.

(c) **Chondroma.**—Tumours composed of cartilage but rarely occur in the jaw. In the maxilla, according to Heath, "The disease appears as a rule early in life, springing from the surface of the bone or from the antrum, and then making steady

progress either externally or internally. The tumour produces absorption of the bone of the maxilla in its progress, and protrudes beneath the skin, which, however, it rarely involves."

In the mandible a chondroma may be endosteal or periosteal. The former type causes a gradual distension of the body of the bone somewhat similar to an endosteal fibroma; the latter type may grow to an enormous size, a specimen recorded by Heath

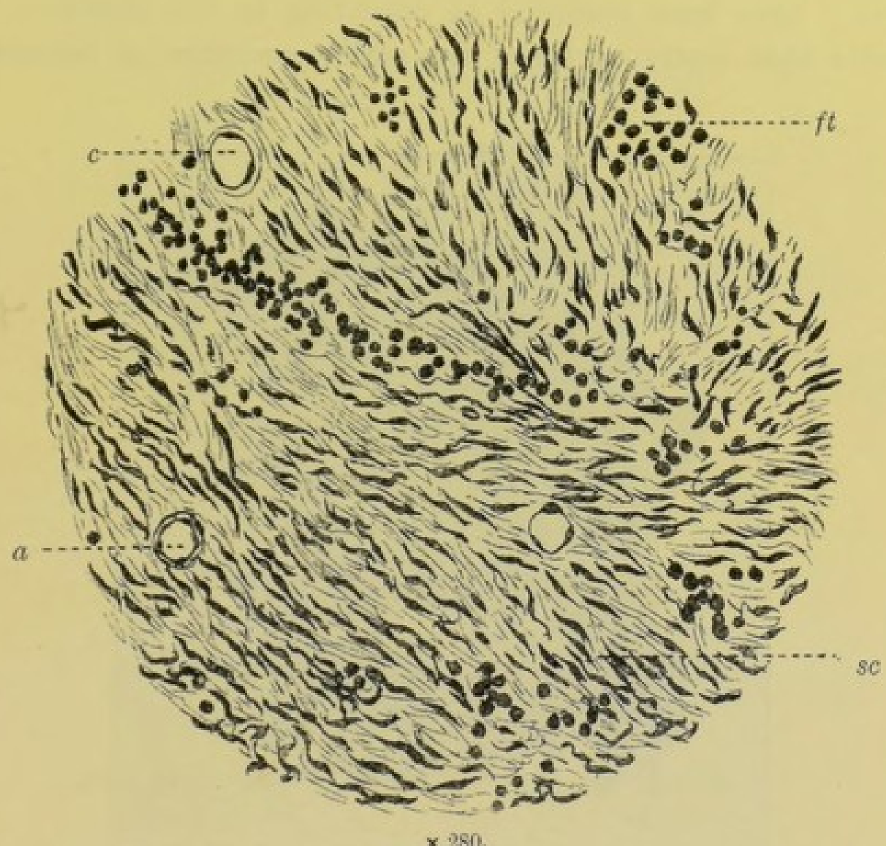


Fig. 865.—True fibroma of the gum. *sc*, spindle cells embedded in fine stroma of connective tissue fibres; *ft*, formative tissue composed of round cells; *c*, capillary; *a*, arteriole. (From a drawing by Mr. A. Hopewell-Smith.)

weighing $3\frac{1}{2}$ lb. There is reason to believe that some of the cases recorded as chondromata are of a sarcomatous nature.

(d) **Osteoma.**—Tumours composed of bone form a most interesting group of jaw tumours. They may be circumscribed or diffuse. They may be composed of cancellous or compact bone.

In the maxilla the whole bone may be affected. An excellent example of this is shown in figs. 866 and 867.[1] The jaw is expanded generally, but more especially the facial surface. The outer compact plate is smooth except near the infra-orbital foramen, where the cancellous structure forming the tumour appears. Mr. Hancock, who removed this growth, refers to the fact that the bone "yielded to pressure to such an extent as to lead to some doubt as to its osseous nature."

Tumours composed of compact bone and of an ivory consistency have been recorded as occurring in the antrum. It is possible that many of these are really examples of odontomes.

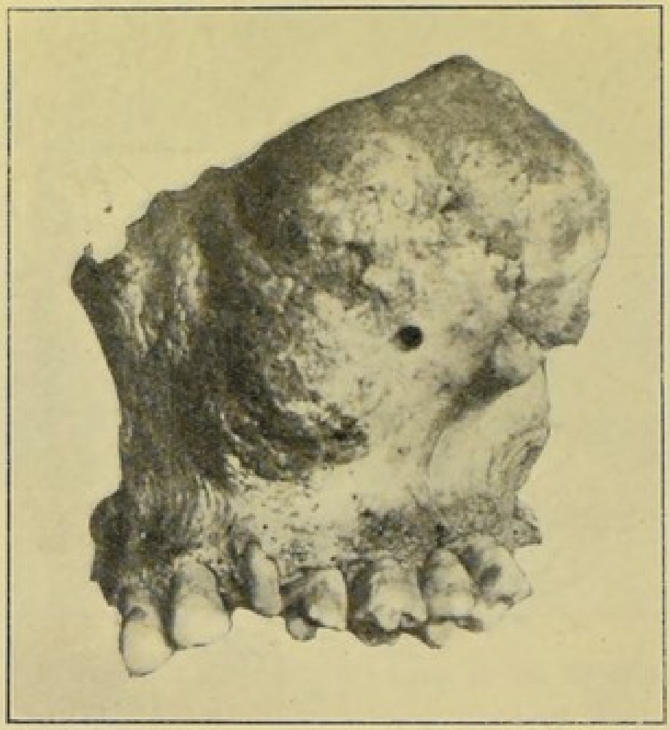


FIG. 866.—Osteoma of the maxilla. (Museum of Charing Cross Hospital.)

For example, the odontome described on p. 714 was originally described as an exostosis, but there is little doubt, from the clinical history of the case and the structure of the tumour, that it was in reality an example of a composite odontome.

Circumscribed osteomata growing from the facial aspect of the maxillæ are often symmetrical (fig. 869).

[1] From the Museum of Charing Cross Hospital.

In the mandible the tumour formed of compact bone is the most common, but, occasionally, the cancellous variety occurs. Osseous growths of the mandible are sessile in the majority of cases, and grow from one or other aspect of the jaw. The commonest situation is the inner aspect of the alveolar process covering the premolar teeth. Other favourite situations are the angle of the jaw (fig. 868) and the region of the mental foramen. The whole thickness of the bone may be affected, but such conditions are extremely rare.

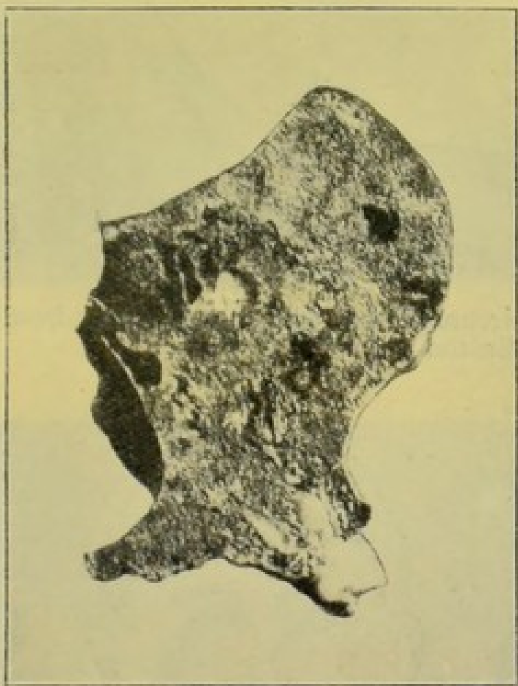


FIG. 867.—Section through tumour shown in fig. 866.

Torus Palatinus.—This name is given to a thickening of the bone in the mid-line of the palate, which from its clinical appearance simulates an osseous growth. The condition varies; in some cases the thickening extends almost the entire length of the palate and is symmetrical, as shown in fig. 869; at other times, it is asymmetrical, while other examples may present the appearance shown in fig. 871. Sections of bones showing the torus palatinus are given in figs. 872 and 873.

Näcke[1] states that he examined 1,449 individuals, of whom

[1] *Neurol. Centralbl.*, June 15, 1893.

22 per cent. showed the deformity and he states that it is more commonly met with amongst the insane and criminals.

(*e*) **Adenoma.**—This form of tumour may arise in the soft palate or the mucous membrane of the hard palate. Adenomata

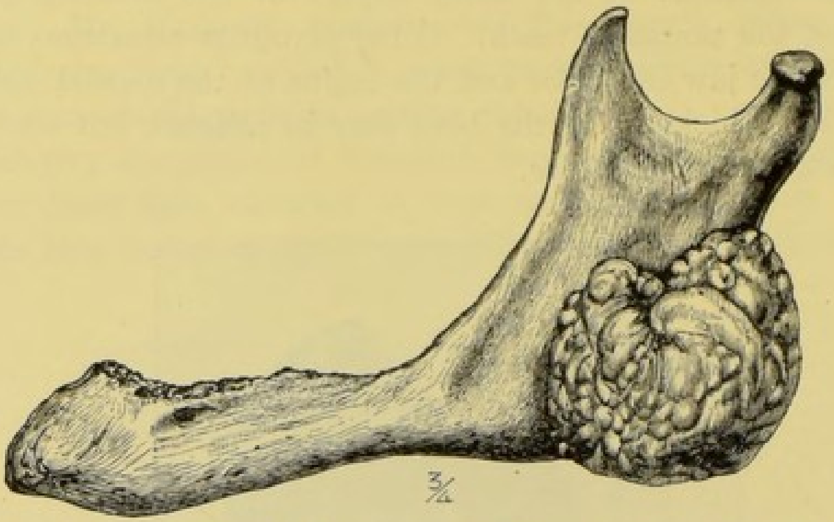


FIG. 868.[1]—A circumscribed osteoma growing from the angle of the mandible. (Bland-Sutton.)

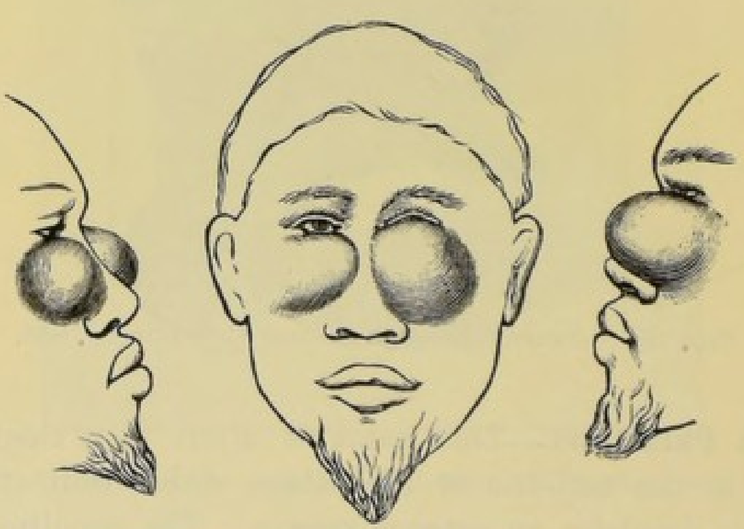


FIG. 869.[2]—Symmetrical osteomata of the maxillæ. (Bland-Sutton.)

give rise to firm, slow-growing tumours, which on removal shell out easily. A typical adenoma should exactly resemble the tissue of the gland from which it springs ; but the departures from the

[1] From "Tumours, Innocent and Malignant," by J. Bland-Sutton.

[2] Figs. 870 to 873 are from a paper on the Torus palatinus by Mr. Rickman Godlee, *Proc. Roy. Soc. Med.*

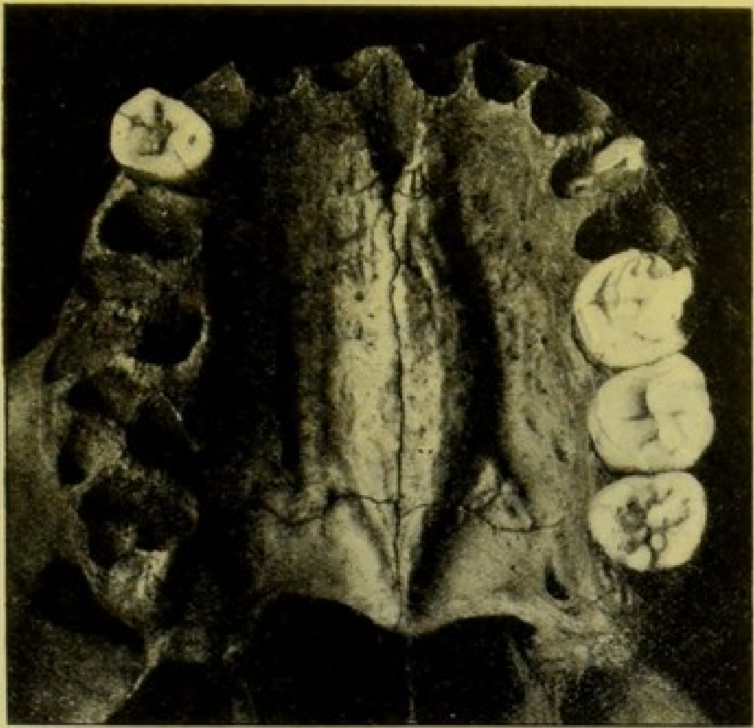


Fig. 870.[1]

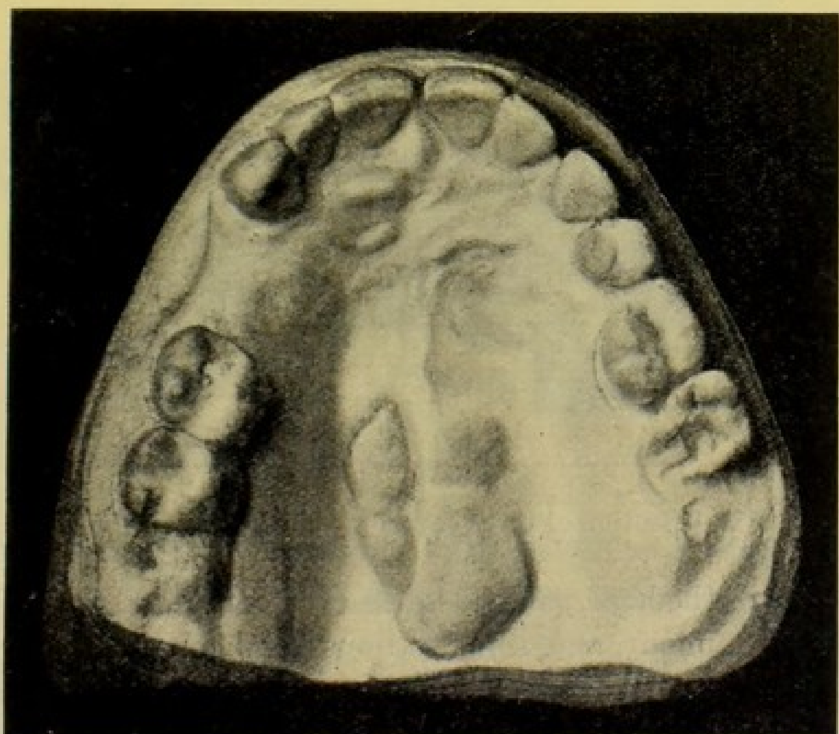


Fig. 871.

[1] For the use of figs. 870 to 873 I am indebted to Mr. Rickman Godlee.

typical type vary, and it is at times almost impossible to differentiate between the adenomata and the carcinomata.

There would seem to be a tendency for adenomata occasionally to become malignant. The following case[1] is instructive from the clinical aspect. "A female, aged 37, noticed a growth about the size of an almond freely movable under the mucous

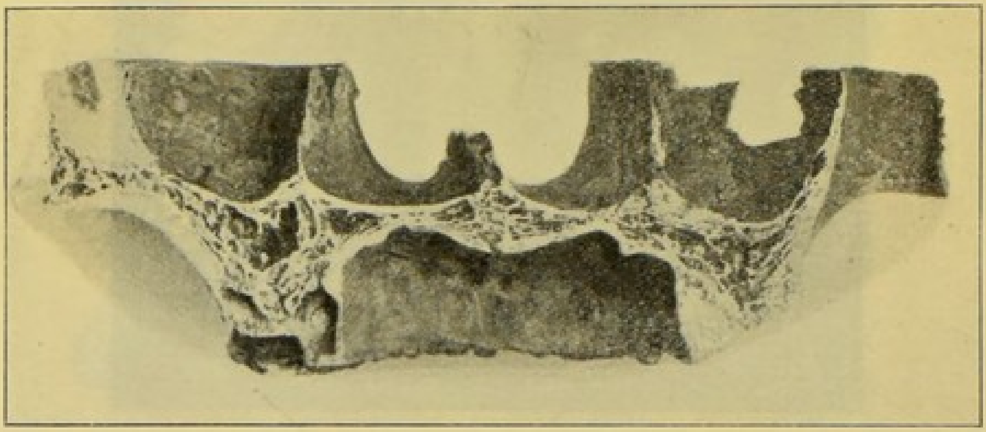


FIG. 872.—Section of fig. 870; the lower table as well as the diploe is thickened.

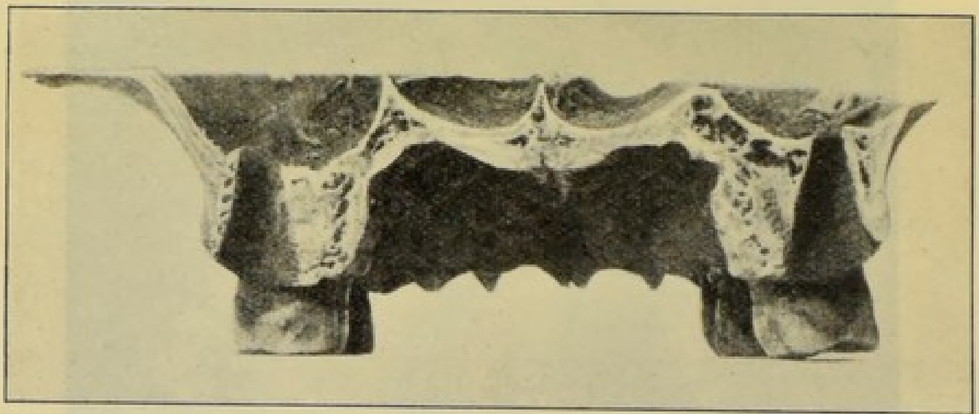


FIG. 873.—Section of torus caused by thickening of the diploe.

membrane of the hard palate. There was considerable lancinating pain in the tumour, and some carious teeth on that side of the mouth were removed, as they were considered to be the cause of the swelling. There was a discharge of pus from the socket, and the swelling in the palate diminished in size but did not disappear.

[1] See *Brit. Dent. Journ.*, vol. xvii, p. 181.

Three years subsequently the growth was incised, the dimension of the swelling then being an inch by half an inch. Ulceration followed, and the growth was then freely removed. Microscopic examination showed that it was an adenoma of the palate which had become malignant and infiltrating."

(*f*) **Angioma.**—These tumours, which occasionally occur upon the gums, may simulate a capillary nævus, in which case they are composed of dilated capillaries; a venous nævus, where

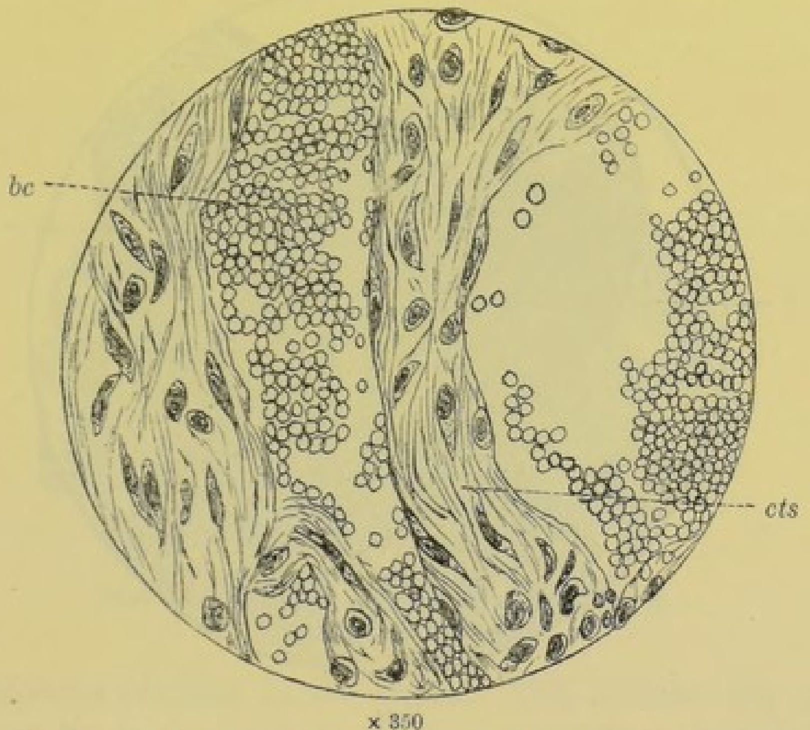


FIG. 874.—Angioma. *bc*, blood corpuscles; *cts*, connective tissue stroma.

they are composed of irregular spaces containing venous blood; or an arterial nævus, when the irregular spaces are filled with arterial blood.

These growths usually present a smooth surface. They vary in colour, being bright red in arterial and purple in venous nævi; on pressure being applied they become pale, rapidly returning to their original condition after removal of the pressure. They are more common in the incisor region, though they may occur in

that of the molars. Starting as a little red spot, they gradually spread between the teeth and extend principally along the margin of the gum, both in front and behind the teeth. These growths bleed readily when touched with the tooth-brush, and in one patient under notice the hæmorrhage was severe. In the case of distinct venous nævi, the tumour may attain to a large size, and involve the mucous membrane of the gum, cheek and lip.

Arterial angiomata are rare on the palate. A case is reported by Treves[1] of a small angioma about the size of a cherry situated

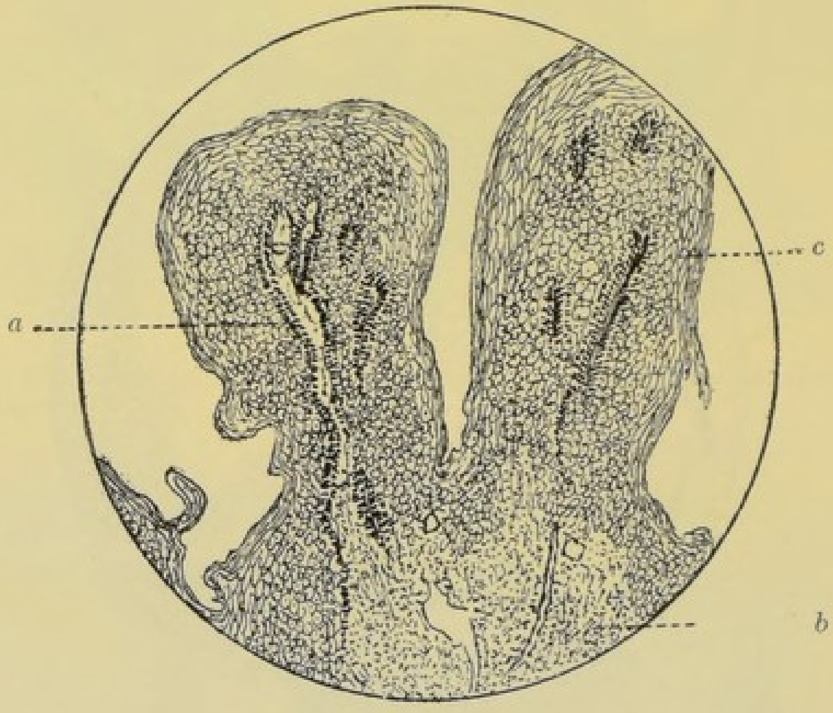


FIG. 875.—Papilloma of gum (from a drawing by Mr. A. Hopewell-Smith). *a*, oral epithelium (stratified); *b*, sub-mucous tissue; *c*, *Rete malpighii.*

between the two right upper incisor teeth. The angioma grew from the periodontal membrane and came away with the lateral incisor.

The *treatment* of these cases belongs to the domain of surgery, and the patient should be at once referred to a surgeon. In a case under the care of Mr. Shield of an aneurysm by anastomosis occurring in the palate, resection of a portion of the jaw was carried out on account of the repeated and serious hæmorrhages.

[1] *Journ. Brit. Dent. Assoc.*, vol. ix, p. 252.

(*g*) **Papillomata.**[1]—Two varieties are met with, the pedunculated and the sessile. The pedunculated are delicate polypoid growths and are always attached to the soft palate.

The sessile or warty papillomata may be found in the mucoperiosteum of the alveolar process or hard palate (see fig. 876).

(*h*) **Myxoma.**—Pure myxomata are rare. A case of this type was reported by Dr. W. Daniels.[2] The patient, a woman, aged 27, noticed a hard lump on the side of the mandible near the premolars nine months before coming under observation. The tumour was firm and hard uniformly; there was no fluctuation

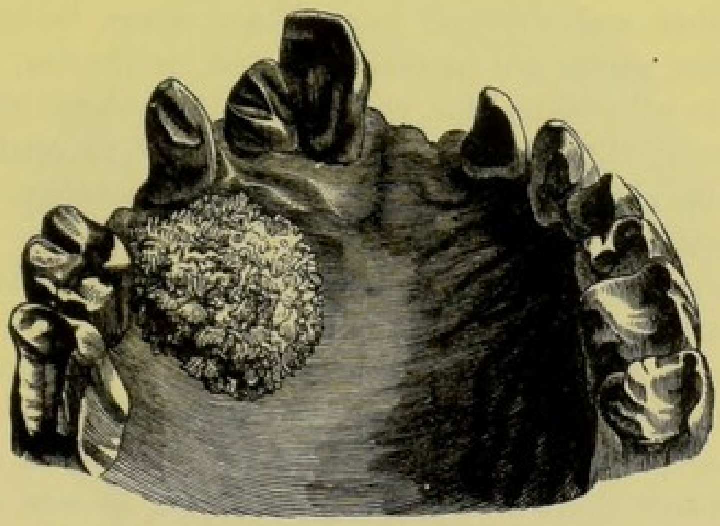


FIG. 876.[3]—Papilloma of the gum. (Heath.)

and no obvious swelling in the cheek. The tumour was readily shelled out, leaving a cavity in the bone extending through to the inner plate. The tumour was a pure myoma, unmixed with any other tissues.

(2) Malignant Epithelial Tumours

Carcinoma.—"The essential character of a cancerous growth consists in an unlimited multiplication of the epithelial elements of the organ attacked. In some cases this may result in the formation of a superficial outgrowth of a papillomatous type,

[1] See "Papilloma of the Oral Cavity," by J. Arkovy, *Trans. Odonto. Soc.*, vol. xiii, p. 16.

[2] *Lancet*, December 12, 1908, p. 1747.

[3] From "Injuries and Diseases of the Jaw," by Christopher Heath.

while deep processes or columns of cells advance into the tissues along the lymphatic channels, and even burst through the basement membrane of glandular alveoli. The irritation of this development leads to an infiltration of the surrounding structures with round cells, which are presumably inflammatory in origin, by the agency of which the normal tissues are disintegrated and removed, and a stroma of variable density develops around the epithelial outgrowths. Hence all cancerous tumours may be said to consist of a fibro-cellular or fibro-cicatricial stroma within the alveoli of which are collections of epithelial cells, sometimes arranged in a methodical manner, but more often packed irregularly together and with no intracellular tissue between them. The alveolar spaces are in reality dilated lymphatics, and hence it is easy to understand that carcinomata are disseminated along these vessels; the cancer cells are epithelial in origin, and of very variable size and shape; but they always retain more or less the character of the epithelium from which they are originally developed, so that, *e.g.*, a squamous epithelioma is never derived from a part covered with columnar epithelium, or *vice versa*. Blood-vessels ramify through the stroma, and are more or less abundant according to its density" (Rose and Carless).

Histologically, cancer consists of connective tissue containing alveolar spaces filled with epithelium varying in size, shape and arrangement. The alveolar spaces communicate with one another so that the growth of the epithelium is continuous. No connective tissue structure exists between the individual cells as seen in sarcomata.

Maxilla

(*a*) **Squamous-celled Carcinoma.**—This always arises from the epithelium adjacent to the maxilla and secondarily invades the bone. A common starting point is the margin of the gum, generally the outer aspect, adjacent to a tooth which has been the seat of long-continued sepsis. In such a case the chronic irritation from the tooth seems to have determined the growth of the epithelioma. This tumour may originate in the hard palate, where, in some cases, it may be traced to the chronic irritation of a badly fitting denture. The disease may also commence in the soft palate, the pillars of the fauces, the tonsil, and the buccal mucous

membrane, and thence spread to the jaw-bone. Rarely it may happen that the irritation of the discharge from a chronic ulcer, primarily syphilitic in character, may cause a malignant growth of the adjacent epithelium. This, a comparatively common sequence in the tongue, is rarely seen in the maxilla, since chronic syphilitic lesions are uncommon in the mucosa covering it.

The squamous-celled carcinoma clinically may be first evident as an ulcer. There is little doubt that in many of these

FIG. 877.—Squamous-celled carcinoma of the palate. *ec*, epithelial cells; *mc*, mesoblastic cells of submucous tissue; *eg*, epidermic globule of concentrically stratified epithelial cells; *ccc*, cylindrical cancer cells; *sc*, four "spiny" cells. (From a drawing by Mr. A. Hopewell-Smith.)

cases a simple ulcer is present for some time associated with sepsis before malignant change occurs. If, after the removal of all source of irritation, the ulcer does not rapidly heal, it should be viewed with grave suspicion, and immediately submitted to microscopy (fig. 877). At other times the earliest sign of the disease may be a nodule in the mucous membrane or a papillary excrescence. In whatever way it starts, an ulcer with more or less characteristic qualities soon appears. Its edge is hard, raised and

tends to grow luxuriantly over the surrounding tissue, or, as is commonly said, is "everted." The surrounding tissues of the base are infiltrated; the floor is irregular, and may show irregular warty prominences and deep excavations, at the bottom of which the bone may be exposed. The discharge from the ulcer abounds in cancer-cells. A characteristic feature is the extremely fœtid odour emitted from the growth. The ulcer spreads rapidly until a large tract of the jaw may be involved. Cervical glands are

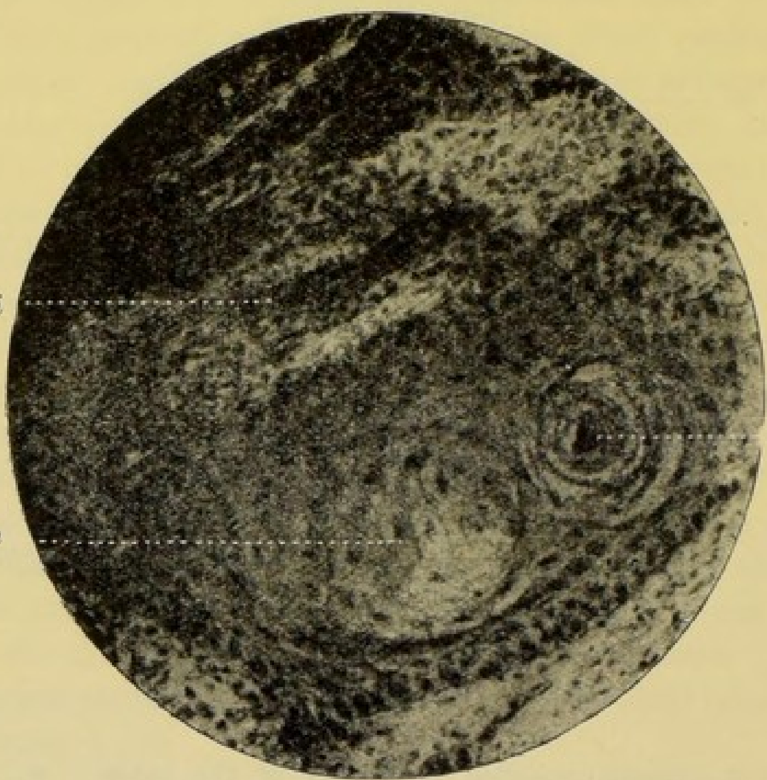


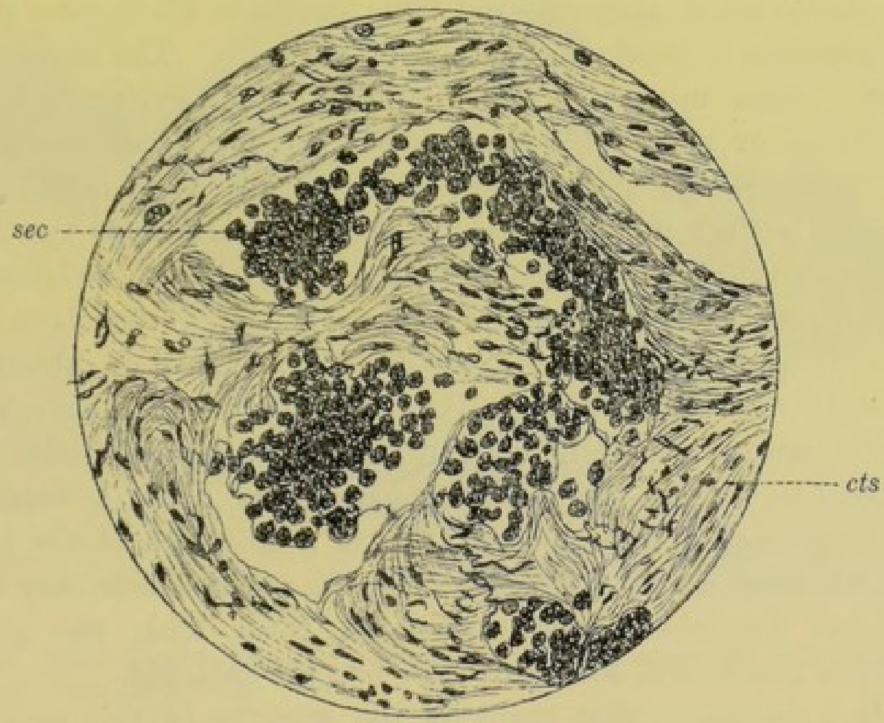
FIG. 878.[1]—*cn*, cell-nest; *ci*, small-celled infiltration of the tissues; *e*, islands of epithelial cells.

early enlarged, mainly by malignant deposits and to a lesser degree by chronic sepsis.

A curious form of squamous-celled carcinoma occurs in the upper jaw, to which the name "boring epithelioma" has been given. As the name implies, this type of cancer tends to burrow

[1] From "Histology and Patho-histology of the Teeth," by A. Hopewell-Smith.

into the substance of the jaw-bone or even into the antrum, showing from the surface very little, if any, evidence of its grave nature. The onset of this disease is insidious, and the symptoms very indefinite. It often appears to originate in chronic sepsis, as the following case shows: A patient,[1] a female aged 35, had for a period of two years had suppuration in connection with a left maxillary lateral incisor. The alveolar process had its natural contour; there was no swelling or redness, but about half to three-quarters of an inch above the neck of the tooth there was a sinus, the edge of which was not swollen, but was covered with



× 310.

FIG. 879.—Spheroidal-celled carcinoma. *sec*, spheroidal cells; *cts*, connective tissue stroma. (From a drawing by Mr. A. Hopewell-Smith.)

sodden epithelium. The tooth was loose and a little tender, and, on pressing the parts, a small quantity of thickish pus was discharged through the sinus. The tooth was removed with a little difficulty, and was found to have adherent to it ragged masses of tissue. On examination this proved to be epitheliomatous in

[1] *Trans. Odonto. Soc.*, vol. xxxiii, p. 231.

character (fig. 878.) At the operation the growth extended from the right central to the first left molar, and had only burrowed in the alveolar process, avoiding the antrum, which was free.

(*b*) **Columnar-celled Carcinoma.** —This arises from the epithelium lining the antral cavity, and the growth is primarily intra-antral. The growth tends to fill the antral cavity completely, and finally erode one or more of its walls and invade the adjacent soft tissues. When confined to the cavity, the symptoms are very indefinite and are generally those of a persistent and intractable neuralgia. At an early period, if the antrum were transilluminated from the mouth, opacity might suggest the cause of the neuralgia. Generally speaking, the symptoms are in abeyance until the cavity is filled with growth and pressure is exerted upon one of its walls. The growth may merely press upon the walls of the antral cavity and cause distension, or may erode through the boundaries of the antrum and infiltrate the soft tissues. For instance, the orbital plate may be pushed up, and perhaps some limitation of the movements of the globe of the eye may be seen; the facial surface may be encroached upon and a prominence of the cheek, with or without infiltration of the soft parts, occur; or, should the posterior wall of the antrum be affected, a swelling may appear in the temporal region of the head above the malar arch. Inspection through the anterior nares may show a bulging of the inner wall of the antrum, or even a fungation of the growth into the nasal cavity. The teeth on the affected side may loosen and fall out, the sockets becoming filled with the growth. Cervical glands will sooner or later become enlarged.

Eve maintains that many of the growths of this type have their origin "from rests" of the germinal epithelium of the teeth. (See chapter on Odontomes, p. 688.)

(*c*) **Spheroidal-celled Carcinoma.**—This may originate from the epithelium of the glands of the mucous membrane of the antrum. The growth exhibits the same clinical characters as the columnar-celled antral neoplasm (fig. 879).

Mandible

(*a*) **Squamous-celled Carcinoma.**—This is very much the more frequent type which affects the mandible. As in the

maxilla, the growth arises from the adjacent epithelium, and, secondarily, invades the bone. It may originate at the gum margin, when chronic sepsis appears to play an important part in its causation; or it may commence in the floor of the mouth, the tongue, the buccal mucous membrane, or the jaw may be secondarily invaded from the lower lip. However and wherever it commences, an ulcer speedily forms which has characters similar to those already described in the upper jaw.

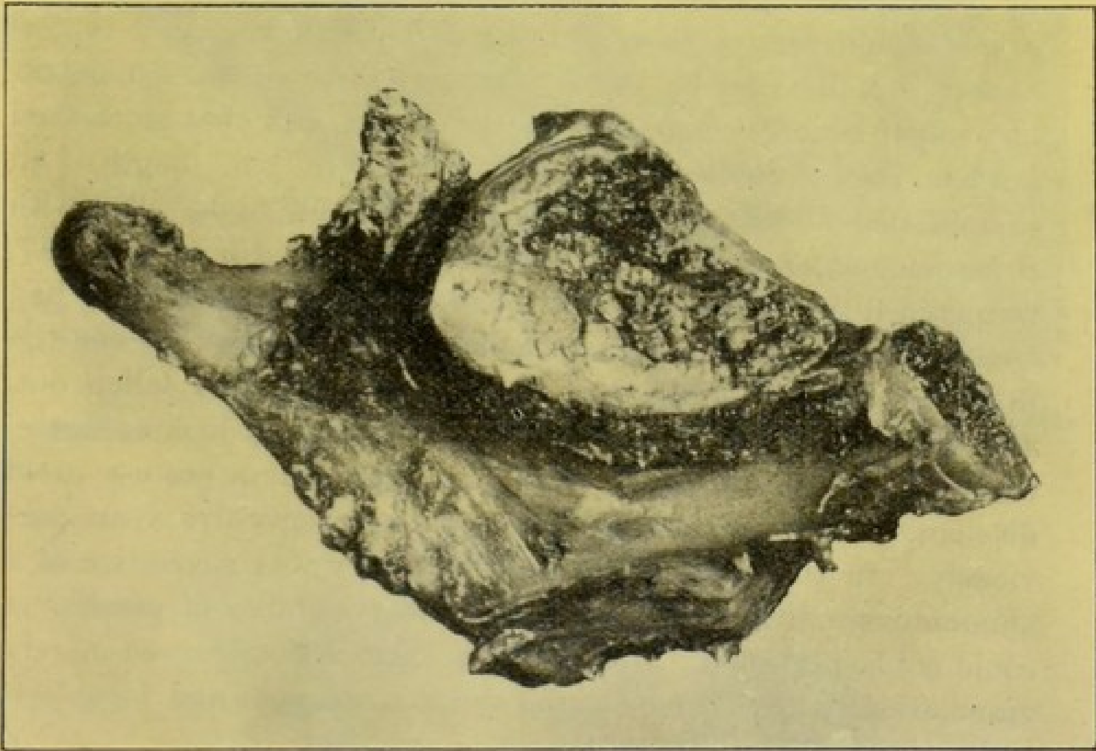


FIG. 880.—Squamous-celled carcinoma of the mandible. (Museum of Charing Cross Hospital.)

A squamous-celled carcinoma arising in the anterior extremity of the sublingual sulcus (sublingual epithelioma) is of importance to the dental surgeon, as the ulceration may be mistaken for a simple ulcer arising from the irritation of a denture. The disease starts as a small nodule, or warty ulceration, in the floor of the mouth, ulceration follows, and the disease spreads rapidly between the root of the tongue and the concave surface of the arch of the mandible. The surrounding tissues are speedily infiltrated; the tongue becomes fixed and the salivary ducts obstructed by pressure, or laid open by ulceration.

58

(*b*) **Columnar-celled carcinoma** occurs with great rarity in the lower jaw. It originates in all probability in the "enamel organ rests" of the periodontal membrane, or the body of the jaw. The growth causes an enlargement of the mandible before ulcerating into the cavity of the mouth.

The early recognition of carcinoma is most important, and, as it may come under the notice of dental practitioners in its early stages, its clinical signs should be thoroughly understood by them. All patients over 30 with ulceration of recent origin should receive close scrutiny. The following is a typical history: A. B., aged 55, states that two teeth in the left maxillary molar region became loose and fell out, and that since then he has been troubled with a nasty taste in the mouth. An examination of the tooth sockets showed them to be filled with a carcinomatous mass. On another occasion, a man, aged 47, complained of pain in the left maxillary molar region. He had received a blow in this region eighteen years previously, and the first and second molars had recently loosened and fallen out. The wound was filled with a mass of unhealthy-looking tissue, necrosed bone could be detected, and there was a profuse fœtid discharge. The patient acquired syphilis twenty-five years previously. In this case, although the history was suggestive of a gummatous infiltration of the bone, the possibility of carcinoma could not be neglected. Microscopical examination showed merely granulation tissue. Under antisyphilitic treatment and local irrigation the condition cleared up.

(3) Malignant Connective Tissue Tumours

Sarcoma.—The term **sarcoma** is used to designate a tumour composed mainly of embryonic connective tissue cells. A sarcoma usually presents a homogeneous appearance, the colour varying from a whitish hue as seen in the fibro-sarcoma to the deep maroon colour characteristic of the myeloid type. The colour depends to a certain extent upon the vascularity of the growth, Sarcomata vary considerably in their malignancy; certain types, for example the alveolar, showing a high degree of malignancy, while other types, such as the myeloid, show practically no tendency to recur if completely removed. Locally this group

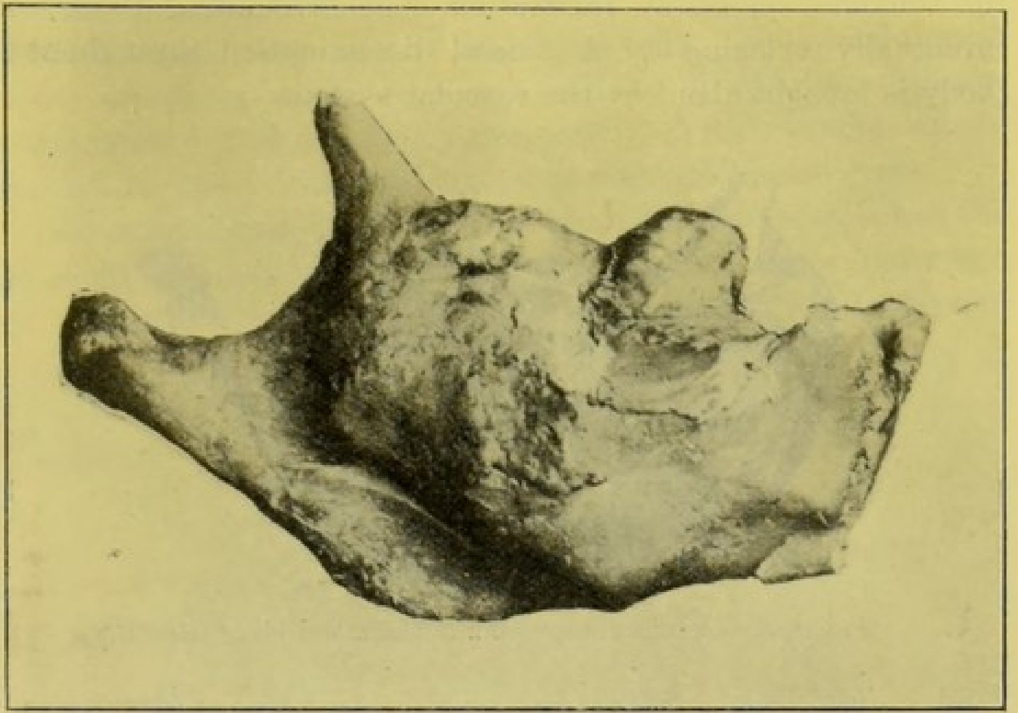


FIG. 881.—Myeloid sarcoma of the mandible. (Museum of Charing Cross Hospital.)

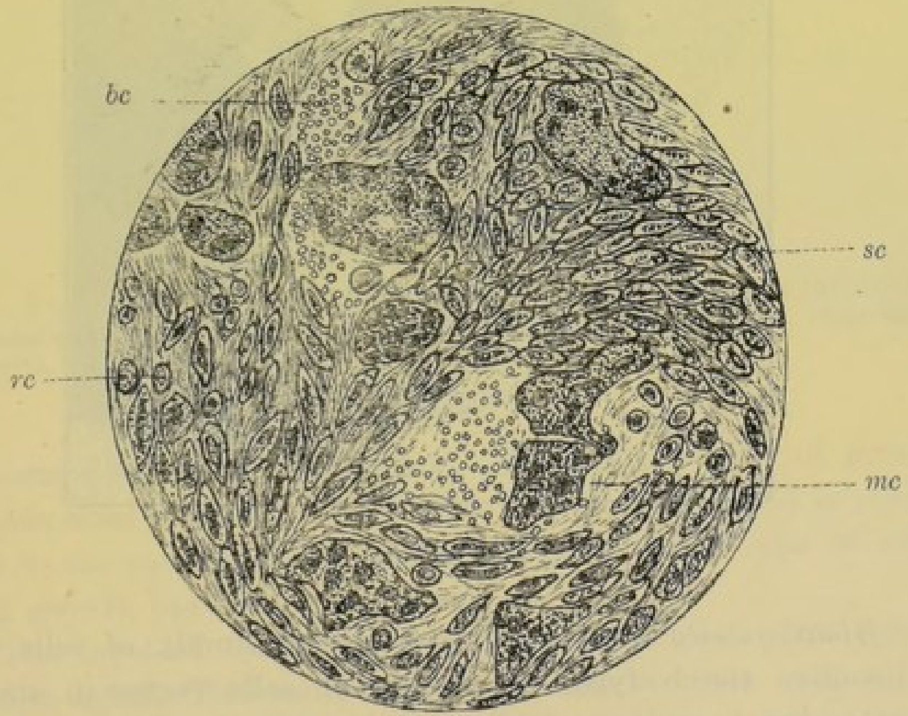


FIG. 882.—Myeloid sarcoma. *mc*, myeloid (giant) cells; *sc*, spindle cells, seen longitudinally; *bc*, blood corpuscles; *rc*, spindle cells, seen transversely. (From a drawing by Mr. A. Hopewell-Smith.)

of tumours spread by infiltrating the surrounding tissue, and eventually replacing it. A general dissemination throughout the body is brought about by the vascular system.

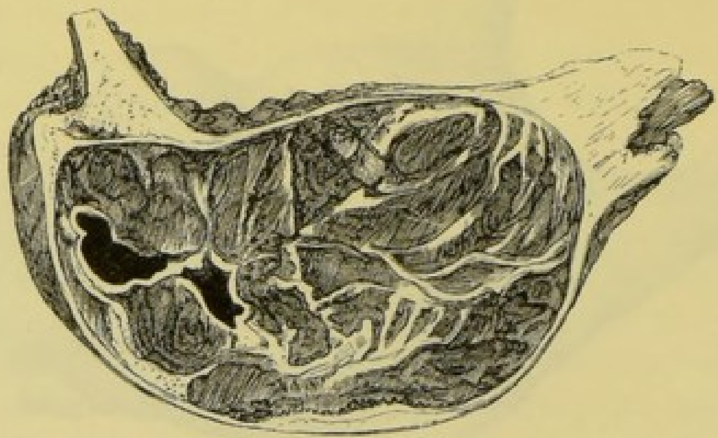


FIG. 883.[1]—A myeloid sarcoma of the mandible. (Heath.)

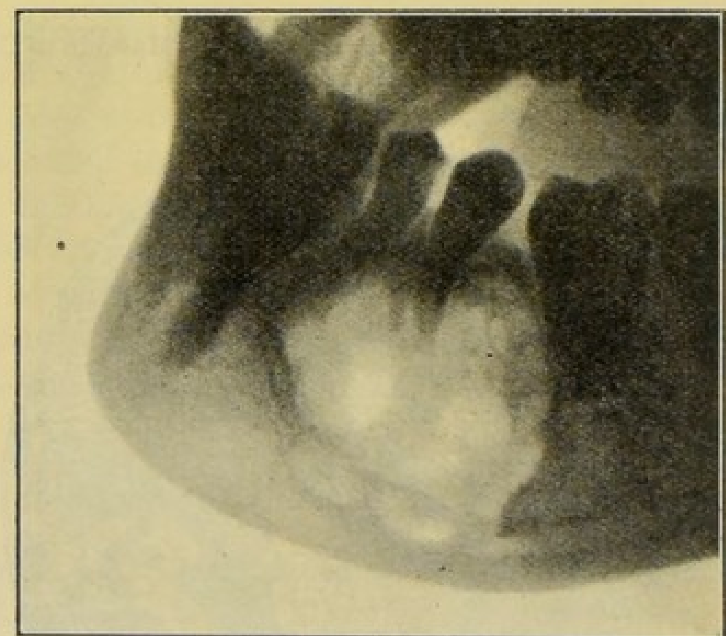


FIG. 884.

Histologically a sarcoma is composed simply of cells of the connective tissue type. The type of cells varies in size and shape; for example, the cells may be classed as large or small, round, spindle, oval, myeloid. The cells are held together by

[1] From "Injuries and Diseases of the Jaw," by Christopher Heath.

a delicate reticulum, which, with suitable preparation, can always be demonstrated between the individual cells. The blood-vessels consist of spaces between the cells and are lined with a delicate endothelium. This peculiar arrangement of the vascular supply accounts for the extreme liability of sarcoma to hæmorrhage.

Sarcomata of the jaws are most commonly met with before the age of 20; roughly speaking, about 40 per cent. occur under this age. As in cancer it is possible that chronic irritation plays an

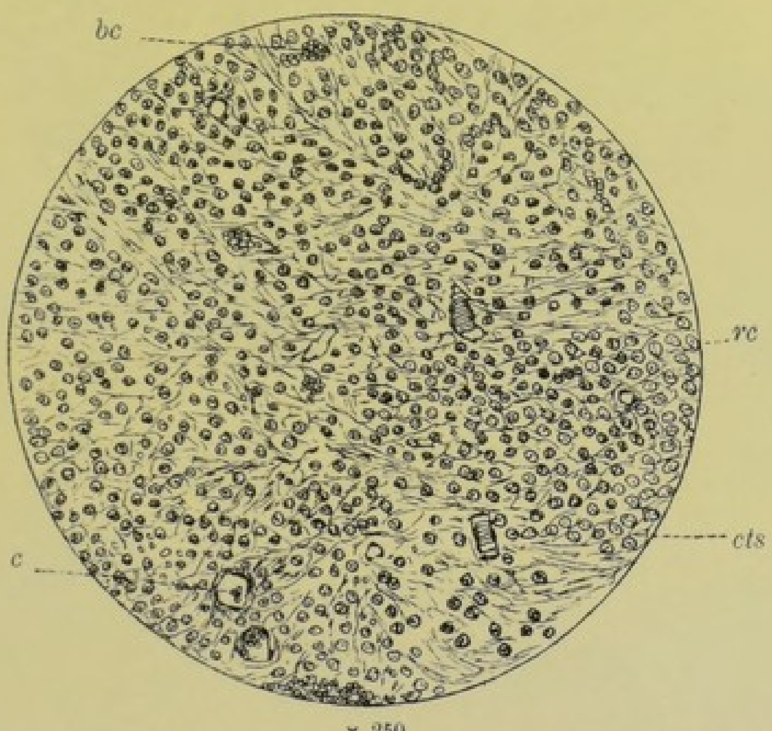
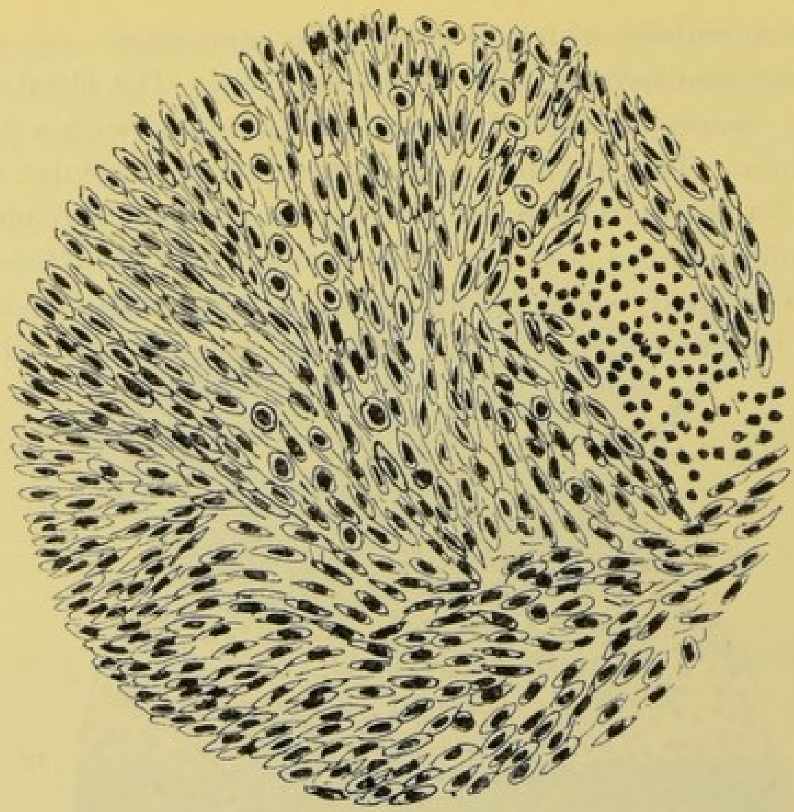


FIG. 885.—Round-celled sarcoma. *rc*, round cells; *cts*, connective tissue stroma; *bc*, blood corpuscles. (From a drawing by Mr. A. Hopewell-Smith.)

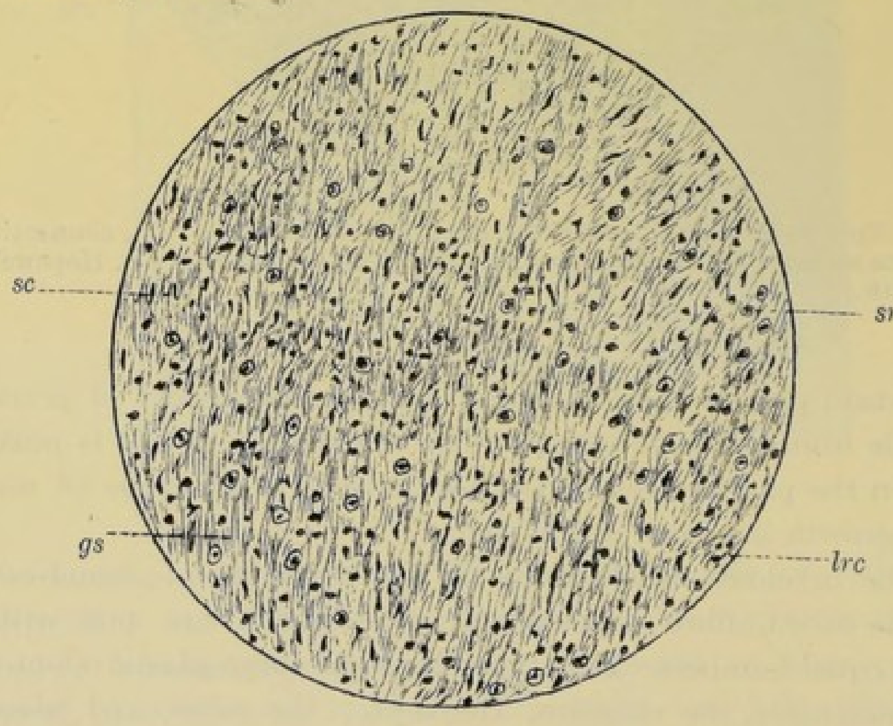
important part in their etiology. A definite history of previous trouble from the teeth can at times be obtained, and it is possible that in the past the relation of septic teeth to this type of malignant growth has been overlooked.

The myeloid variety is by far the commonest; round-celled, spindle-celled, fibro-sarcoma and mixed-celled are met with in about equal numbers. Rare types are the embryo-plastic odontome, the melanotic, the chondro, the myxo, the osteo, and alveolar varieties.



× 250.

FIG. 886.—Spindle-celled sarcoma. (From a drawing by Mr. A. Hopewell-Smith.) The cells are arranged longitudinally except in places, where they are transversely cut.



× 250.

FIG. 887.—Fibro-sarcoma. *sc*, spindle cells; *src*, small round cells; *lrc*, large round cells; *gs*, ground substance. (From a drawing by Mr. A. Hopewell-Smith.)

(*a*) **Myeloid Sarcoma.**—The naked-eye appearance of this is characteristic—it is a maroon or dark red colour (fig. 883). In structure these growths closely resemble the red marrow of young bones. Microscopical sections show them to be composed of spindle and round cells, with numerous giant cells more or less uniformly interspersed (fig. 882). They are always endosteal in origin, and show merely local malignancy, never having been

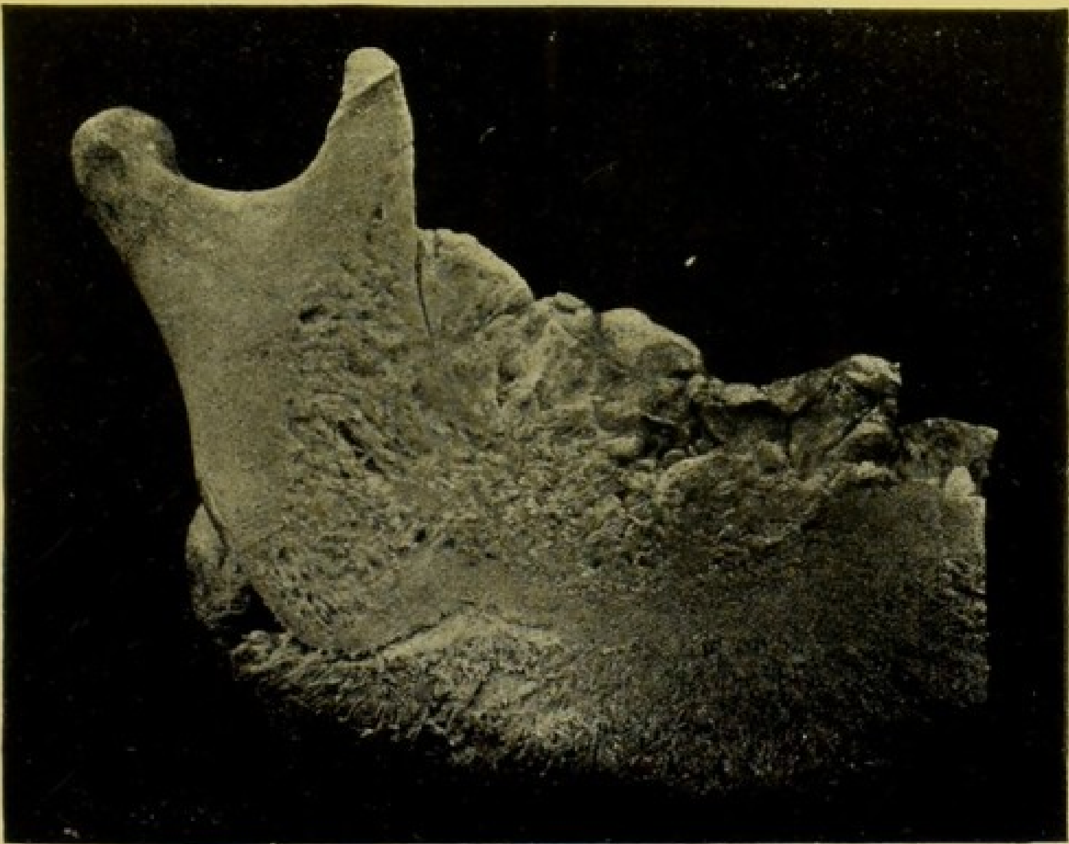


FIG. 888.[1]—A periosteal sarcoma. (Targett.)

known to invade glands, nor to disseminate by the blood-stream. Hence some writers place them in a class separate from sarcomata, under the name of myelomata.

In the maxilla they arise in the alveolar portion of the bone, or in the facial wall of the antrum, near its junction with the alveolar process. In the mandible they arise in the body of the bone below the level of the teeth in the alveolar process. In both jaws the favourite situation is the region of

[1] From *Trans. Odonto. Soc.*

the second premolar and first molar. They may arise in the premaxilla, or even in the hard palate.

Myeloid tumours grow in a way somewhat similar to cysts. They tend to keep a more or less spherical shape, and bulge the walls which present the least resistance. The growth frequently makes its way to the surface *via* a tooth socket, and may be mistaken for a simple epulis. In the maxilla the growth may bulge into the antrum without invading the walls. In the

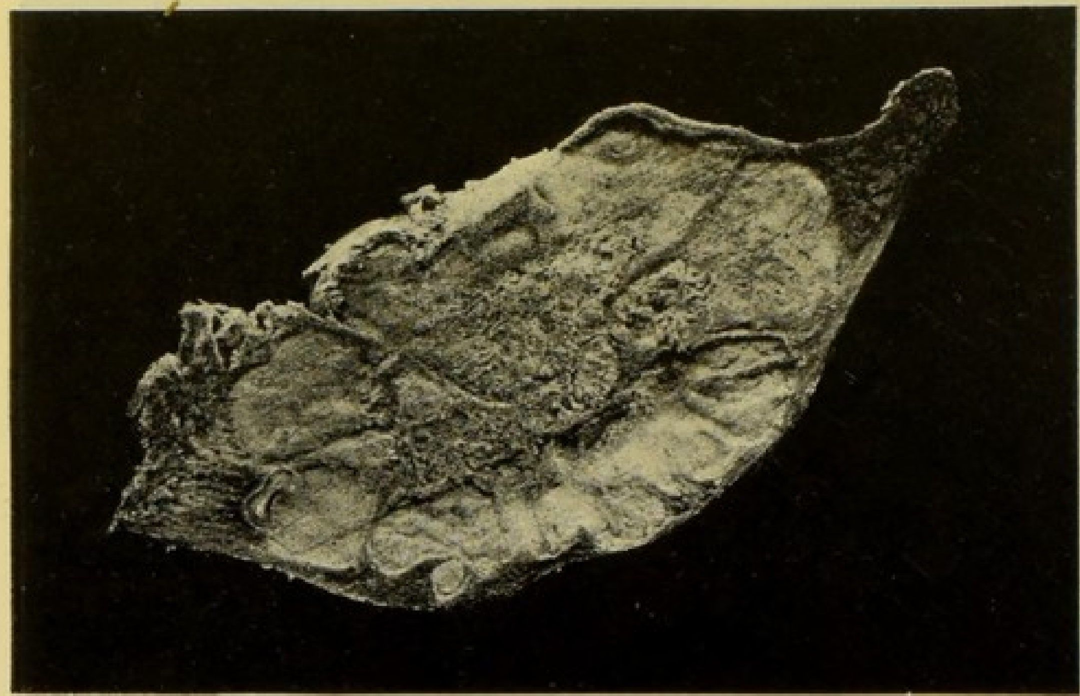


FIG. 889.[1]—An endosteal sarcoma. (Targett.)

mandible these growths give rise to painless swellings, and tend to deform, and, finally, in part destroy the outer plate long before the inner (fig. 881). When projecting into the buccal cavity the outline of the swelling is, however, not globular as with a cyst but presents slight undulations; it is solid and non-fluctuating.

In fig. 884 is shown the radiograph of a myeloid sarcoma growing in the region of the right mandibular first molar. There was a previous history, six years before, of a difficult extraction, and the patient at the time of being seen was unaware of any swelling in the jaw. This growth clinically simulated a dental cyst.

[1] From *Trans. Odonto. Soc.*

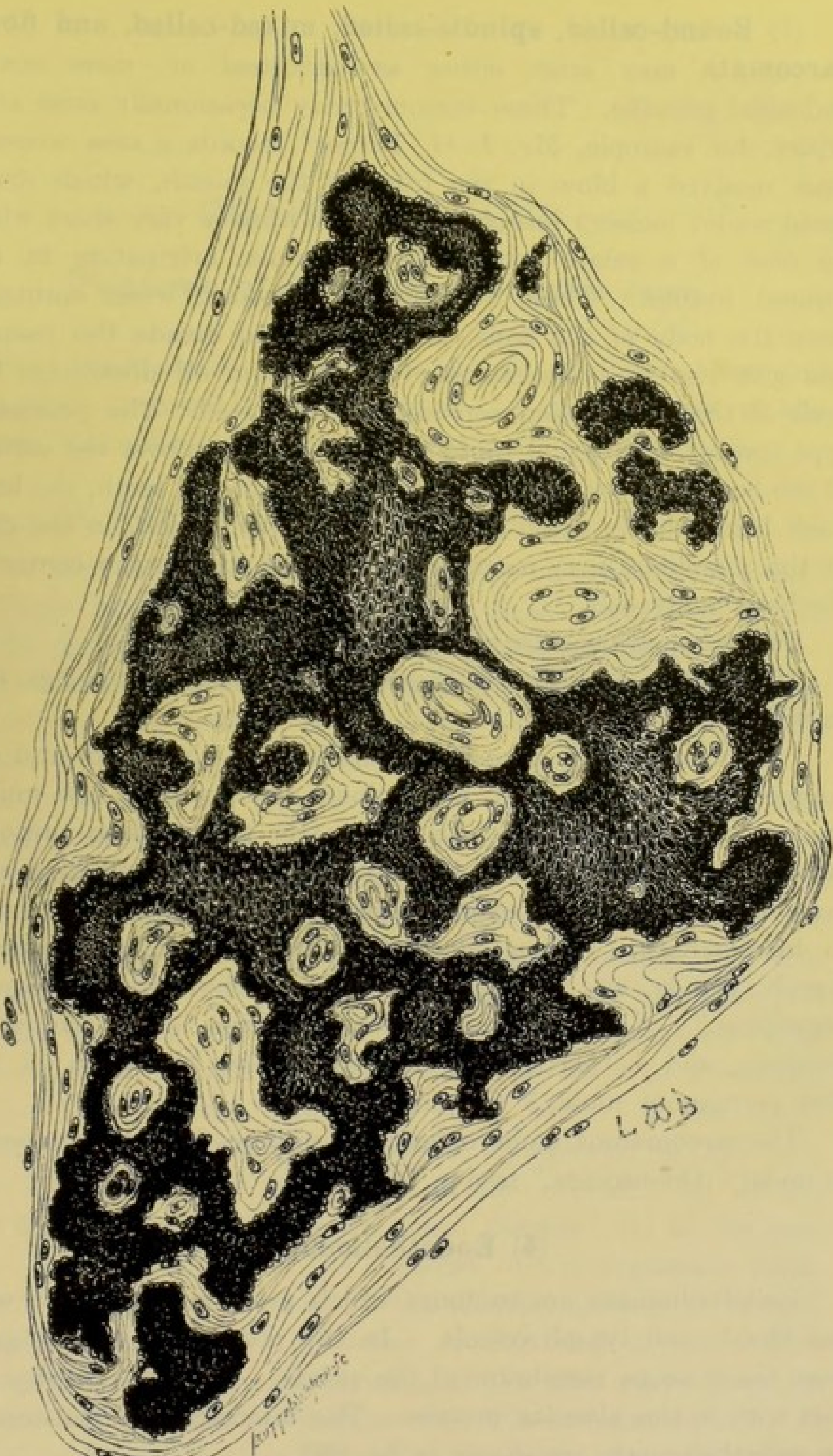


FIG. 890.—Microscopic characters of an endothelioma of the gum. (Sutton.)

(*b*) **Round-celled, spindle-celled, mixed-celled, and fibro-sarcomata** may arise, either as periosteal or, more rarely, endosteal growths. These tumours may occasionally arise after injury, for example, Mr. J. G. Turner[1] records a case where a man received a blow in the front of the mouth, which drove some septic incisors into the bone. Within a very short while he died of a small, round-celled sarcoma, originating in the injured tissues. These varieties of sarcoma, when springing from the body of the bone, tend rapidly to invade the tissues, and give rise to a distension of the bone in all directions, the arch of the teeth being considerably distorted. The periosteal type spreads with equal rapidity in all directions over the surface of the bone, and extends down the sockets of the teeth, the bone itself being slowly eaten into by the growth, which, in the case of the mandible, may entirely surround it, before the centre of the bone is invaded.

Typical specimens are shown in figs. 888 and 889.

Microscopical sections of these growths are shown in figs. 885 to 887.

"Sarcomata may arise in the follicles of the teeth, and are composed of small, round, and spindle cells, with a few multi-nuclear cells interspersed. In their early stages these tumours are distinctly encapsuled, but as they increase in size and involve the gums the exposed surfaces ulcerate and give rise to hæmorrhage. When ulceration occurs, the neighbouring lymph glands are apt to become infected with pyogenic organisms." "Sarcoma of a tooth follicle only occurs in children, and is particularly apt to involve the germ of the first permanent molar" (Bland-Sutton).

The sarcomatous embryoplastic odontomes have been referred to under "Odontomes" (see p. 710).

(4) Endotheliomata

Endotheliomata are tumours which arise in connection with the blood- and lymph-vessels. In the jaws they usually grow from the mucous membrane of the palate. More rarely they are met with in the alveolar process. The microscopical features of an endotheliomata are shown in fig. 890.

[1] *Trans. Odonto. Soc.*, vol. xxxix, p. 112.

CHAPTER XXXIII

Diagnosis of Swellings about the Jaws

SWELLINGS of the jaws are not always easy to diagnose, and it is often impossible to determine the exact nature of the growths without making a preliminary incision or puncture.

(A) SWELLINGS INVOLVING THE MAXILLA

For convenience these swellings will be considered under: (1) Those involving the antrum; (2) those originating in the alveolar process; and (3) those growing from the palate.

(1) **Swellings involving the Antrum.**—A tumour may arise primarily in the antrum, or a growth, having its origin in the alveolar process, may involve the antrum secondarily.

In order that the clinical features of antral swellings may be clearly understood a brief reference must be made to certain points in the anatomy of that sinus. The antrum may be regarded as a closed cavity, the boundaries of which, with the exception of the one formed by the alveolar process, are thin and yield readily to pressure. A distension of the cavity is therefore a sign of the presence of a growth. Expansion (1) of the facial wall, probably the least resistant, leads to a swelling on the face situated under the lower border of the orbit; (2) of the orbital wall, to pressure symptoms on the eye, often accompanied by protrusion of the eyeball; (3) of the nasal wall, to obstruction of the nasal passage; (4) of the posterior wall, to pressure on the contents of the zygomatic fossa. The floor of antrum formed by the alveolar process is of considerable thickness, and distortion of this wall seldom occurs (see fig. 864). The second division of the fifth nerve (superior maxillary) is in close connection with the antrum, entering at the spheno-maxillary fossa, traversing the infra-orbital canal, and opening on the face at the infra-orbital foramen. Implication

of this nerve in an antral growth may give rise to persistent neuralgia before symptoms of antral distension are apparent. The bony walls of the nasal duct, which are partly formed by the maxilla, may be invaded, leading to pressure on the duct, which is shown clinically by epiphora (overflow of tears).

(*a*) **Swellings arising primarily in the Antrum.**—The *only fluid swelling* primarily arising in the antrum is the condition known as "cystic disease of the antrum." This gives rise to a slow but painless distension of the walls. The thinner or facial wall gives way more readily than the more resistant, and the bulging on the face is therefore one of the most prominent symptoms. The swelling itself is smooth and globular, and, on pressure, may give rise to the sensation known as "parchment-like crackling." The alveolar border is not, as a rule, interfered with. In some cases the patient is aware of the presence of fluid in the antrum.

With **innocent solid tumours** there is a gradual distension of all the walls of the antrum, with the exception of the alveolar border. Epiphora may be present and severe neuralgia.

Malignant tumours give rise to a rapid distension of the facial, orbital, and nasal walls of the cavity, the alveolar process being involved in the later stage. Severe pain is frequently associated with malignant disease; the skin is implicated at an early stage, and œdema of the face is present. The lymphatic glands do not become enlarged until the growth is well advanced.

(*b*) **Swellings involving the Antrum Secondarily.**—The antrum is frequently involved secondarily by tumours originating in the alveolar process. These tumours will be described under the next headings. Such swellings do not usually lead to antral distension unless the growth attains a considerable size.

In **diagnosing between the swellings of the antrum** it is of primary importance to determine whether the growth is fluid or solid. This point may be determined by transillumination. The period of growth will enable innocent growths to be differentiated from malignant growths, a rapid growth suggesting malignant trouble. The rate of growth of tumours of the jaw is, however, not always easy to ascertain, the patient frequently being quite unconscious of the presence of any swelling in the mouth, and in other cases the swellings are not recognized until

long after their appearance. The history given by a patient of the rate of growth must therefore be accepted with caution.

The solid innocent tumours occurring in the antrum are : (1) Fibroma, (2) enchondroma, (3) osteoma, (4) myxoma. The differential diagnosis of these tumours is at times far from easy, more especially in the early stages, as they all give rise to distension of the walls of the antrum. Osseous growths are generally exceedingly slow in development, while fibromata and enchondromata may grow at times with great rapidity.

The malignant tumours occurring in the antrum are : (1) Carcinomata, (2) sarcomata. The differential diagnosis between carcinoma and sarcoma can sometimes be arrived at from the age of the patient; growths in the young are invariably sarcomata, while those occurring in persons over the age of 40 may be either sarcoma or carcinoma. A tendency to hæmorrhage will indicate a sarcoma; and growths springing from the region of the malar bone are nearly always sarcomatous. In the case of malignant tumours a diagnosis should always be made from necrosis, especially when there is a large amount of inflammatory material and sloughing of the soft tissues. In doubtful cases, a portion of the diseased tissue should be microscopically examined before an operation is performed.

(2) **Swellings originating in the Alveolar Process.**—These may be divided into (*a*) those growing from the surface of the bone; (*b*) those growing within the bone.

(*a*) **The usual growths springing from the surface of the bone** are the various types of epulides and the true fibroma. Their diagnosis presents but little difficulty. The epulides spring from the margin of the alveolar process, usually from the septum between two teeth. The possibility of the growth being an excrescence from a tumour involving the body of the bone must always be considered. This condition is seen more particularly in connection with myeloid growths.

The true fibroma can be recognized by its slow growth, and its frequent attachment to the bone by a pedicle (see p. 895).

(*b*) **The swellings growing within the alveolar process** are the most important from the point of view of dental practice. These may be divided into fluid and solid.

The fluid growths are :—

(1) Acute abscess.

(2) Chronic abscess.

(3) Dental cyst.

(4) Follicular odontome.

(5) Epithelial odontome.

The solid growths are :—

(1) Fibroma.

(2) Calcified odontome.

(3) Sarcoma.

(4) Carcinoma.

In diagnosing between these growths the fluid swellings must first be separated from the solid. Fluid swellings are indicated when fluctuation is present, and when the swelling is regular, smooth, and globular in character.

The **differential diagnosis of the fluid swellings** lies between chronic abscess, dental cyst, follicular odontome, and epithelial odontome. The teeth should be carefully examined, and, if septic teeth are present, the probability is that the swelling is either a dental cyst or a chronic abscess. The differentiations between these will be assisted by considering the history of the swelling. In the case of a dental cyst there is a history that the swelling has slowly but progressively increased in size; with a chronic abscess there may be a history of rapid swelling and of variation in size from time to time. The swelling from a cyst is usually more defined, and the fluctuation is more elastic in character than in the case of a chronic abscess. If, however, septic teeth are present the growth is probably either a follicular or epithelial odontome. With a follicular odontome a tooth is invariably absent from the series and the outline of the swelling is globular. With the epithelial odontome one or two teeth may be absent, but the swelling is frequently lobulated.

Fluid growths can be efficiently diagnosed from solid growths by radiography.

As regards **the solid tumours,** the rate of growth must be ascertained in order to determine whether the growth is innocent or malignant in type. The endosteal fibroma leads to distension of the outer alveolar plate; there is no fluctuation, and the

character of the swelling is not globular in outline as it is in the case of cysts. A calcified odontome tends to produce a swelling similar to a fibroma. A cancer arising in the alveolar process or starting in the gum may cause but little swelling, the growth spreading rapidly towards the antrum. A myeloid sarcoma, on the other hand, leads to a distension of both plates of the alveolar process, the outer plate giving way more readily than the inner. The swelling is generally distinctly lobulated in outline, but this is not always the case, and in the early stages a diagnosis between a fluid swelling and a myeloid sarcoma is by no means easy. A fast-growing tumour springing from the outer aspect of the bone, especially in the region of the malar bone, is invariably sarcomatous in nature.

(3) **Swellings in connection with the Palate.** — The commonest fluid swelling in the palate is a chronic abscess. It generally arises in connection with the lateral incisor, but may be connected with a premolar or molar. The association of a well-marked fluctuating swelling with a septic tooth is sufficiently diagnostic. The other fluid swellings that may occur are dermoid cysts (in the soft palate), follicular odontomes, and aneurysm of the descending palatine artery, but they are rare.

The solid tumours are : **Innocent**—(1) papillomata, (2) fibroma, (3) adenoma, (4) osteomata. **Malignant**—(1) sarcoma, (2) carcinoma. The papillomata are recognized by their characteristic appearance, but the possibility of the growth being an epithelioma in an early stage must not be forgotten. It is well to submit all papillomata after removal to microscopy. Fibromata may be recognized by their slow growth, their putty-like consistency, and in many cases their pedunculated character. Osteomata, in the form of so-called torus palatinus, are common. They are situated in the median line towards the back of the hard palate. Their extreme hardness and slow growth are sufficiently characteristic. Adenomata are rare. They give rise to solid sessile tumours and their true nature is often only apparent after operation, when they are found to shell out easily from the surrounding tissues.

Of the **malignant** tumours, sarcomata and carcinomata are both met with. A fast-growing tumour springing from the hard palate is generally a sarcoma; from the soft palate, a carcinoma.

(B) SWELLINGS INVOLVING THE MANDIBLE

With swellings in the neighbourhood of the mandible the first step is **to determine whether or not the swelling is in connection with the mandible,** and if it is, whether it involves the substance of the bone or is only connected with the bone externally.

(1) **Swellings connected with the Bone Externally.**—These include the various types of epulis. Their attachment to the margin of the alveolar process is sufficient to establish a diagnosis, but here, as in the maxilla, the possibility of the growth being simply an excrescence of a tumour involving the body of the bone must be kept in mind. The other solid growths arising from the external aspect of the bone are: **Innocent**—(1) fibroma, (2) enchondroma, (3) osteomata. **Malignant**—(1) sarcoma, (2) carcinoma.

Of the innocent growths the fibroma usually springs from the bone in the neighbourhood of the median line; the enchondroma and osteoma from the inner side of the alveolar process near the premolars or the angle of the jaw. Malignant growths springing from the external surface of the bone tend rapidly to involve the overlying tissues, as shown by the fact that the skin is adherent to the growth and not freely movable over the surface.

(2) **Tumours involving the Body of the Bone.**—The principal symptom will be gradual expansion of the two plates of the mandible, the outer generally yielding to a greater extent than the inner. Fluid swellings may be suspected when the bulging of the walls is quite smooth and globular in character; the outer plate may become so thin that, on pressure upon it, the sensation of "parchment-like crackling" may be felt. If the swelling is fluid, a diagnosis will have to be made between chronic abscess, dental cyst, follicular odontome and epithelial odontome. The mode of diagnosis between these has already been mentioned.

An epithelial odontome is likely to be mistaken for a myeloid sarcoma, and the diagnosis between the two is often very difficult, but with the former there will nearly always be an absence of a tooth or teeth from the series.

With solid growths, the character of the expansion of the bone is not so regular as in fluid collections, the inner plate being involved as well as the outer. With innocent growths the swell-

ing will be of long duration, while with malignant the swelling is generally nodulated and always of quick growth. The innocent tumours may be either fibrous, cartilaginous, or osseous; the malignant either epithelioma or sarcoma. The usual form of sarcoma is the myeloid, and its diagnosis from epithelial odontome has already been considered. Necrosis must be carefully diagnosed from malignant disease, and the likelihood of mistaking a calcified odontome for more serious mischief must not be forgotten.

CHAPTER XXXIV

Interference with the Movements of the Temporo-mandibular Articulation (Closure of the Jaws)

In practice, cases of closure of the jaws are frequently met with, and the treatment of some of them falls within the province of the dental surgeon, while others belong to the domain of general surgery. It is therefore needful that the dental practitioner should be able to diagnose such cases, and if necessary treat them.

(A) ETIOLOGY

(1) Inflammatory Infiltration of the Tissues in the Neighbourhood of the Joint.

(*a*) *Dental in origin.*—The most common cause is suppuration in connection with the mandibular third molar. Necrosis of the jaw is another frequent cause.

(*b*) *Pharyngeal in origin ;* for example, tonsillitis and quinsy.

(*c*) *Origin in parotid gland :* acute septic infections from the mouth along the duct; pyæmic abscesses; specific parotitis (mumps).

(*d*) *Cellulitis*, deep in the neck, extending along the inner aspect of the jaw; acute infection of the upper deep cervical glands.

(2) Spasm of Muscles.

(*a*) *Dental in origin.*—Spasm in connection with unerupted third mandibular molar (rare)

(*b*) *Hysteria.*

(*c*) *Tetanus.*

(*d*) *Strychnine poisoning.*

(3) Diseases of the Articulation.

(*a*) *Acute arthritis*, most commonly perhaps gonorrhœa; other rare causes are penetrating wounds, extension of infection from the middle ear through the floor of the external meatus, extension from the parotid gland and infection through the blood.

(*b*) *Chronic arthritis.*—Practically the only chronic affection

seen is osteo-arthritis, which limits movement mechanically by the osteophytes in advanced cases, or by the pain and muscular spasm in earlier cases.

(*c*) *Anchylosis*, which may be fibrous or osseous, and results from one of the diseases (*a*) and (*b*).

(*d*) *Hypertrophy of the condyle of the mandible.*

(4) **Mechanical impediment to free movement by the contraction of scar tissue**: (*a*) on the face, following burns or operative scars, and (*b*) in the mouth, following severe ulceration or operative treatment for the removal of growths, &c.

(5) **Mechanical impediment to free movement from intra-buccal growths** of the gums, buccal mucous membrane, fauces, &c., by infiltration of the tissues by the growth.

(6) **Other very rare causes** are *exostosis of zygomatic arch*, preventing free movement of the coronoid process; *ossification of pterygo-maxillary ligament, a deep-seated growth, unreduced dislocations and fracture of the neck of the condyle.*

(B) DIAGNOSIS

The larger number of cases coming under the care of the dental surgeon arise from the **first group of causes,** and it is therefore better to eliminate these first in proceeding with the diagnosis.

When the closure is *due to inflammatory effusion* into the soft tissues, the patient's face will be found swollen, hot and tender. The mouth can usually be opened to a slight extent. Upon examining the teeth it will generally be found that suppuration exists around the third molar, sometimes the second, less frequently the first. When the trouble arises from the lower teeth, the main part of the swelling is situated over the tissues about the angle of the jaw, and the submaxillary region.

In trouble arising in *connection with the pharynx*, the patient will complain of extreme discomfort in swallowing; there will be little, if any, swelling over the region of the face, but the tissues behind the angle of the jaw will be swollen and tender to touch.

In disease of the parotid gland the swelling is situated below and in front of the ear, and the socia parotidis can be felt lying over the masseter. The condition is often symmetrical.

In deep cellulitis of the neck the tissues below the jaw are swollen, the cellular tissue of the face being subsequently involved.

Closure of the jaws *due to spasm of the masseter and other muscles* is very rare, and, when it does occur, is generally due to irritation from an erupting third molar, although trismus may also be caused by irritation of the pulps in the second and third molars. The tonic spasm which causes this variety of "closure" may come on quickly or slowly. The inflammation will be slight and there will be entire loss of power to open the mouth.

Tetanus and strychnine poisoning each lead to trismus. They are less frequently met with than other causes, and are recognized by the presence of the symptoms of a general character to which they give rise.

The **diseases of the articulation** form a most important group.

Inability to open the mouth without great pain is a symptom of both *acute and chronic arthritis* of the articulation. The diagnosis of the condition will not be difficult, as the patient will not only complain of pain on attempting to move the joint, but will also complain of tenderness over the region of the joint; and, on examination, the parts will be found swollen and tender to the touch.

Osteo-arthritis only leads in its early stages to stiffness of the jaw, which is felt more in the morning, the patient complaining that there is slight difficulty and pain when eating breakfast. On opening the mouth a clicking sound is audible, not only to the patient but also to the surgeon. The stiffness of the jaw increases until, in the most advanced cases, the articulation becomes practically fixed, owing to alterations in the shapes of the articular surfaces. Osteo-arthritis may be suspected when a patient of 40 years or upwards gives a history of gradual loss of power to open the mouth.

Osseous or fibrous anchylosis may be suspected when the patient gives a history of previous injury or inflammation in the joint. On examination it will be found that the immobility is complete in the osseous anchylosis, while, in the fibrous, a slight movement can be obtained.

Hypertrophy of the Condyle.—In this condition the side of the face on which the hypertrophy exists appears swollen over the region of the articulation. The chin is pushed to the opposite

side and the face distorted on the affected side. The movements of the jaw are restricted.

Cicatricial bands stretching between the maxilla and the mandible are a common cause of closure of the jaws. The patient generally gives a history of previous ulceration, either of a syphilitic origin or arising from some form of stomatitis, the ulceration being followed by formation of cicatrical tissue. This form of closure may occur at any time of life. Examination of the mouth will show a band of fibrous tissue stretching vertically between the jaws.

Tumours pressing upon the jaw from without may occur in the parotid or sub-maxillary regions, or in the situation of the deep cervical glands along the border of the sterno-mastoid muscle. A swollen lymphatic gland over the masseter muscle, due to septic absorption from the mouth, is a frequent cause of stiff-jaw. The diagnosis from this cause will present no difficulty.

Deep-seated malignant tumours may lead to interference with the mobility of the jaw. Cases of this character are recorded by Coleman, Tomes, and others. This condition may be suspected when, after careful examination, other causes of immobility of the jaw have been eliminated.

Exostosis of the zygomatic arch and ossification of the pterygo-maxillary ligament are rare. In the former condition an examination of the zygomatic arch at once makes the condition plain; and, in the latter, a stiff band is felt in the region of the pterygo-maxillary ligament. Patients affected by these forms of trismus are, as a rule, of a gouty or rheumatic diathesis.

The diagnosis of the causes giving rise to closure of the jaws is best carried out by a process of exclusion. The more frequent cause should be considered first, aud these may be taken in the following order: Inflammatory infiltration of the tissues, the most frequent cause being dental, and then, possibly, mumps; arthritis; mechanical impediment from growths; mechanical impediment from scar tissue; hypertrophy of the condyle; and, lastly, such rare conditions as exostosis of the zygomatic arch.

(C) TREATMENT

If the trouble is of dental origin an anæsthetic should be administered, the mouth forcibly opened, and the offending tooth

or teeth removed. Some little difficulty may be experienced in opening the mouth. For most cases a Mason's mouth-gag is generally quite sufficient, but when the degree of trismus precludes the use of this instrument in the first place, the mouth can usually be forced open by a graduated wedge or spiral cone of boxwood. Instruments for forcibly opening the mouth must be employed with great care. Following the extraction of the tooth poppy-head fomentations should be advised. The time of complete recovery of the free movement of the jaw will depend very much upon the severity of the case. Where the third molar is concerned, and it is not practicable to remove it, relief may be given by extracting the second. If the trismus is due to acute arthritis, wedges should be placed between the molar teeth and a four-tailed bandage applied, as by this means the articulating surfaces will be separated and so relieved from pressure. Over the region of the condyle tincture of iodine should be applied, and purgatives administered.

In osteo-arthritis the treatment in the early stages must be constitutional rather than local. The patient should be advised to avoid exposure to the weather as far as possible. To those whose occupation causes them to be much in the open air a cap with folds to tie over the region of the joint is to be recommended. Some relief may be obtained by careful massage of the joint and by rubbing in sulphur ointment over the affected region, sulphur and guaiacum being at the same time given internally. In the more advanced stages, when the jaw has become more or less anchylosed, the operation of excision of the condyle or section through some part of the ramus may be practised.

Osseous and fibrous anchylosis require for treatment the formation of a new joint; while for hypertrophy of the condyle excision of the joint may be necessary. Cicatricial bands can be treated by division of the cicatrices or the formation of a new joint, the latter treatment now being generally adopted.

Exostosis of the zygomatic arch and ossification of the pterygo-maxillary ligament would be best treated by the formation of a new joint. If the trismus is due to external swelling, the treatment will consist in seeking for and, if possible, removing the cause of the swelling.

CHAPTER XXXV

Some Common Affections of the Tongue met with in the Course of Dental Practice

CERTAIN diseases of the tongue, more especially carcinoma, may first come under the notice of the dental surgeon, and it is most important that these diseases should be at once recognized by the practitioner.

(A) CHRONIC SUPERFICIAL GLOSSITIS: LEUKOPLAKIA

This disease is practically confined to the papillated portion of the tongue. It is an inflammatory condition of the mucous and submucous tissues, with certain changes in the surface epithelium, which not infrequently progress to the formation of carcinoma. The disease is produced by some continued irritation, such as smoking, strong spirit, the habitual use of strong condiments, and chronic dental sepsis. It is very frequently seen in persons who have had syphilis, appearing as a late manifestation and uninfluenced by antisyphilitic treatment.

The disease does not affect the tongue uniformly, but occurs in patches. The earliest evidence is shown by a portion of the tongue becoming smooth, due to the disappearance of the papillæ. The epithelium becoming thinned, the part affected presents a smooth reddened appearance, contrasting very noticeably with the adjacent papillated tongue. This is often known as the *red glazed patch*. Further changes in the epithelium cause the patch to assume a pearly bluish-white appearance. Such a patch is quite characteristic; it is perfectly smooth, and will be slightly depressed below the adjacent papillated area of the tongue. This is the typical *leukoplakia*. Both these appearances may be present on the same tongue, and the patches vary considerably in size and distribution.

At this stage there is no real pain, and hence, before advice is

sought the disease has probably been in existence for some months or years. The tongue may, however, feel uncomfortably dry and stiff. If precautions (*i.e.*, all sources of irritation removed and the tongue kept scrupulously clean) are taken, the patients suffering from the disease in this stage may never have any further trouble. But only too frequently an abrasion may occur in the thinned epithelium, bacterial infection will ensue, and a *fissure* results. This is especially likely to happen on the borders of the tongue where friction is greatest, but fissures may occur in any of the patches. These fissures are extremely painful, and it is often at this stage that the patients first seek advice. Under treatment fissures will often rapidly heal, but only too frequently recur.

In some cases the disease does not progress further, but not infrequently more serious changes develop. In a few cases the papillæ becomes much enlarged, and, proliferating, will form a veritable tumour on the surface of the tongue. The name *ichthyosis* is given to this condition, and it is said always to advance to cancer. Ichthyosis, therefore, demands immediate and radical treatment. Far more common is the development of a *carcinoma*, either at the edge of a fissure or as a diffuse growth of the epithelium of one of the leukoplakial patches. A carcinoma demands prompt recognition and immediate treatment.

(B) ULCERATIONS OF THE TONGUE

(1) **Simple**. (*a*) **Dental**.—This is the most frequent type of ulcer met with on the tongue. The predisposing cause is the sharp edge of a tooth, or the rough edge of a denture. In some cases the ulceration is quite superficial, but, nevertheless, is very painful when speaking or eating. The surface is usually surrounded by a zone of inflammation. In other cases the ulcer extends deeper, the edges being irregular and abrupt, the surrounding mucous membrane inflamed, and the floor of the ulcer bathed with pus. The lymphatic glands may become enlarged from sepsis. When dental ulcers have existed for some considerable time the edges and base may become indurated, and in appearance the condition may mimic carcinoma. Not infrequently a carcinoma may develop at the site of a simple ulcer.

If there is any doubt about the character of the ulcer its edge should be submitted to microscopy.

Treatment consists in removing the cause. Rapid improvement and healing generally follow, but if this does not occur a V-shaped portion of the tongue containing the ulcer should be excised.

(*b*) **Injuries from other Causes than the Teeth.**—Ulcers may arise from burns, bites, stings, &c. The history of the case gives the clue to diagnosis.

Treatment.—The use of an antiseptic mouth-wash is usually all that is needed.

(*c*) **Dyspeptic** ulceration is most frequently met with near the tip of the tongue on the dorsal aspect. The ulcers are generally multiple and superficial, the portion of tongue around them being nearly always slightly inflamed, while symptoms of dyspepsia are present.

Treatment consists in attending to the dyspepsia, employing chlorate of potash mouth-washes, and, if the ulceration is very severe, brushing the surface of the ulcers with nitrate of silver.

(**2**) **Infective.** (*a*) **Syphilis.** — (**i.**) A **primary** chancre is usually situated on the tip or the edge near the tip. It is characterized by the rapid formation of a hard nodule with superficial ulceration. The submaxillary glands are enlarged, and secondary symptoms of syphilis soon appear.

(**ii.**) **Secondary.**—In the second stage of syphilis mucous tubercles may appear on the tongue. These tubercles consist of patches of enlarged and infiltrated papillæ, the superficial epithelium becomes soddened and gives rise to a characteristic yellow-white appearance. The surface of the mucous tubercles is liable to be injured, and ulceration of a septic type appears. The ulcer is therefore septic in character grafted on a syphilitic lesion.

(**iii.**) **Tertiary.**—(*a*) *Deep intramuscular gumma* forming a nodule in the substance of, and presenting on the dorsum of the tongue. The swelling, which is painless, breaks down and forms a deep excavated ulcer. This form of tertiary ulcer is solitary. (i.) The edges are sharply cut; (ii.) the induration of the surrounding tissue rapidly disappears under treatment; (iii.) the floor may present a wet washleather-like appearance, in the early

stages before the slough has disappeared; (iv.) the situation of the ulceration is usually the dorsum of the tongue immediately to one side of the median line; (v.) the submaxillary lymphatic glands are not usually enlarged, in a few cases they are from septic infection; (vi.) profuse salivation is not usually present; (vii.) there may be pain, but usually not so severe as in epithelioma.

(β) *Multiple Superficial Gummata.*—These break down and form superficial ulcers.

(γ) *Fissures and ulcerations* in connection with chronic superficial glossitis.

(*b*) **Tubercle.**—Tuberculous ulceration of the tongue is generally secondary to tuberculosis of the lung or larynx, and is due to a direct infection from the sputum. The usual situation is the under-surface of the tip of the tongue. The ulcers are superficial, often multiple and very painful. A zone of inflammation is usually present around the ulcer, and, occasionally, caseation of the floor can be seen. The coincidence of the ulcers with usually well-marked symptoms of tuberculosis of the lungs or larynx is sufficient to prevent the condition being mistaken for either syphilis or carcinoma. Occasionally, the clinical symptoms of the primary disease are not very obvious.

(*c*) **Actinomycosis.**—Ulceration from this cause is rare. A hard, brawny swelling of the tongue forms and breaks down, giving vent to a gelatinous-like discharge containing the characteristic granules. Microscopy shows the nature of the disease.

(3) Malignant. (*a*) **Carcinoma.**—This most serious disease of the tongue may start:—

(i.) In chronic ulcers or fissures, dental in origin, and very commonly situated at the borders of the tongue.

(ii.) As a warty outgrowth, with infiltration of the base and surrounding tissues.

(iii.) As a nodule.

(iv.) In association with chronic glossitis originating in an ulcer, fissure, or ichthyosis, or appearing as a diffuse infiltration.

The characteristics of a carcinomatous ulcer are as follows: (i.) Raised, sinuous, hard and everted edges; (ii.) the surrounding mucous membrane is indurated; (iii.) the floor irregular, in part excavated, and in part showing warty prominences,

and covered with a foul discharge; (iv.) the base indurated, and, in the latter stage, the tongue fixed; (v.) a darting pain; (vi.) profuse salivation; (vii.) enlargement of the neighbouring lymphatic glands (not in the very early stages); (viii.) interference with speech and mastication. The disease is more prevalent in men than in women, and occurs generally in those past the age of 40.

Treatment is excision of a portion or the whole of the tongue, and the whole lympathic area in the neck.

As before stated, early recognition of the disease is of the utmost importance. The presence of a wart on the side, tip, or, indeed, any part of the tongue in a person over 35 years of age should always be regarded with suspicion, and the patient *at once* advised to seek skilled assistance. All ulcers of some standing should be submitted to a careful examination. The particular points to which attention should be directed are: (i.) The history of the ulcer; (ii.) the character of the edges; (iii.) the condition of the surrounding mucous membrane.

Ulceration in patients over 40 is always serious, and in doubtful cases it is better to have the suspicious portion excised.

(*b*) **Rodent ulceration** is extremely rare, and scarcely needs description here, and the same may be said of (*c*) **sarcoma.**

APPENDIX

Bacteria found in the Mouth

Bacillus agglomeratus.
,, aridus.
,, bronchitidis putridæ (Lumnitzer).
,, buccalis (Robin).
,, bullosus.
,, chromicolor.
,, coccineus (Pansini).
,, coccoideus.
,, coli communis.
,, digitatus (Pansini).
,, diphtheriæ.
,, epidermidis (Bizzozero).
,, foliaformus.
,, friedlander.
,, fusiformis (Vincent).
,, gangrenæ pulpæ (Arkövy).
,, gingivitidis (Babes).
,, graveolens (Bordini).
,, influenzæ.
,, kreibohni.
,, lactis aerogenes.
,, lepra.
,, luteus (Dobisyniecki).
,, maximus buccalis (Goadby).
,, necrodentalis (Goadby).
,, necrosis.
,, pestis bubonicæ.
,, plexiformis (Goadby).
,, pneumo-septicus (Babes).
,, pseudo-diphtheriæ.
,, pyocyaneus.
,, pyogenes gingivæ (Miller).
,, ramificans.
,, rhinoscleromatis.
,, rosenthalin.

Bacillus salivæ minutessimus.
,, salivarius septicus (Biondi).
,, sputicola.
,, sputigenus.
,, squamous (Pansini).
,, subaureus.
,, suratus.
,, tenuis sputigenus (Pansini).
,, tuberculosis.
,, virescens (Frick).
,, viscosus ochracens (Freund).
,, zonatus.

Leptothrix racemosa (Vicentini).

Micrococcus canis (Manfredi).
,, catarrhalis.
,, citreus granulatus (Freund).
,, commensalis (Turró).
,, diplococcus intracellularis.
,, diplococcus pneumoniæ.
,, gingivæ pyogenes.
,, hauserii.
,, lactericens (Freund).
,, ochrædus (Rosenthal).
,, reesii (Rosenthal).
,, sublitis (Kirschner).
,, subroseus (Tataroff).
,, tetragenus.
,, viscosus (Goadby).

Saccharomyces albicans.
,, neoformans (Goadby)

Sarcina alba.
,, aurantiaca.
,, aurea (Mace).
,, lutea.

Sarcina variegata (Pansini).
Spirillum sputigenum.
Spirochæta denticola (dentium).
" pallida.
" refringens.
Streptococcus angiosus (Andrews).
" brevis (von Lingelsheim).
" conglomeratus.
Streptococcus fæcalis (Andrews).
" longus (von Lingelsheim).
Streptothrix actinomyces.
" buccalis (Goadby).
" ochera (Fullerton).
Vibrio Finkler Prior.
" Milleri.
" tonsillaris (Klein).

INDEX.

63

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