DENTAL

PHYSIOLOGY AND SURGERY

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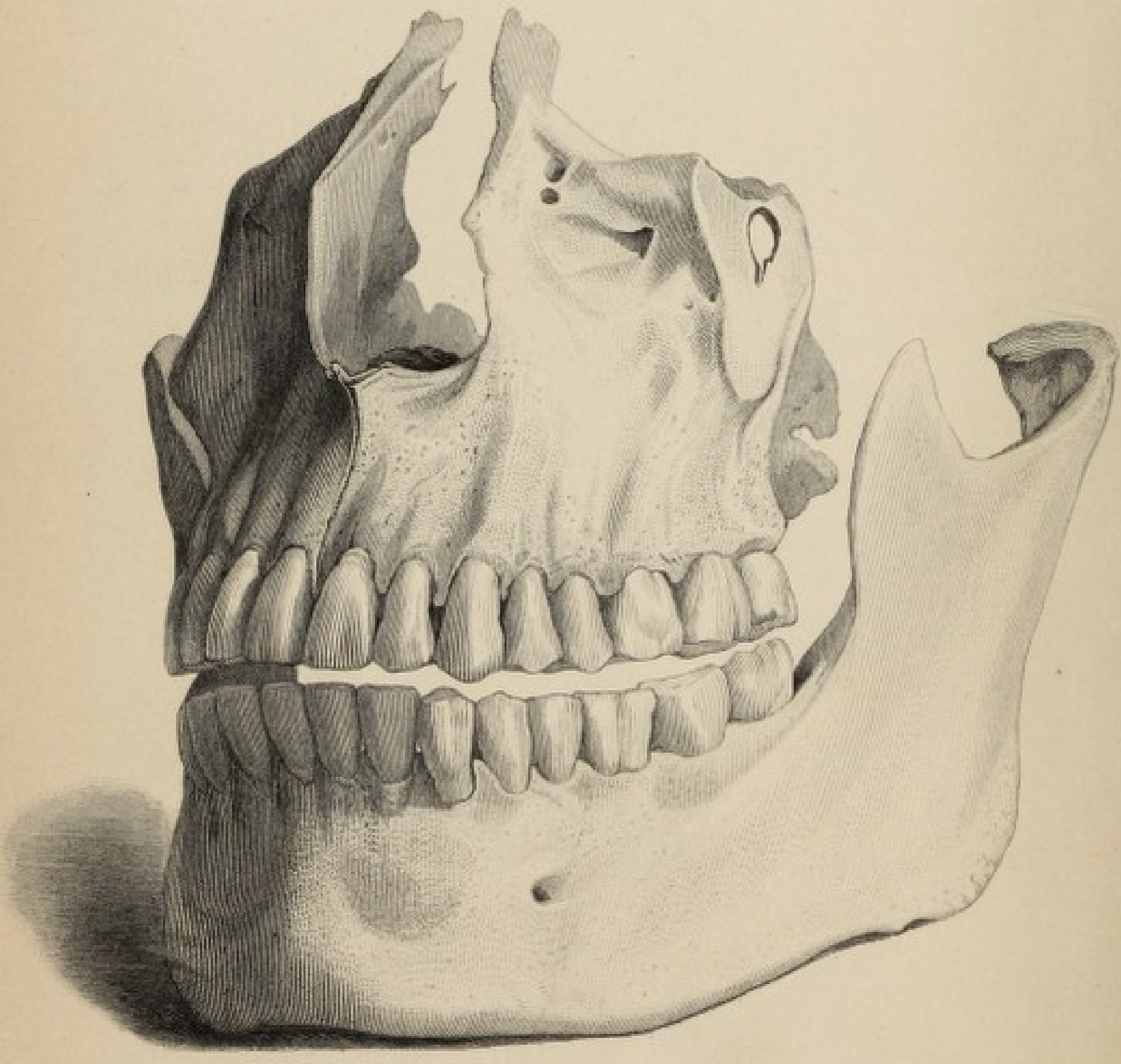

C.R. Bone. del.

J.W. Lowry fc.

THE UPPER AND LOWER JAWS

WITH THE FULL COMPLEMENT OF FINELY DEVELOPED TEETH

A

COURSE OF LECTURES

ON

DENTAL

PHYSIOLOGY AND SURGERY,

DELIVERED AT

THE MIDDLESEX HOSPITAL SCHOOL OF MEDICINE.

BY

JOHN TOMES,

SURGEON-DENTIST TO THE MIDDLESEX HOSPITAL.

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1848

PREFACE.

When I had the honour to accept the office of Dentist to the Middlesex Hospital, I promised the Medical Officers that, should it be thought desirable, I would deliver a course of Lectures on Dental Physiology and Surgery, at the Medical School attached to that institution.

In 1845, the Committee of the Medical School requested me to fulfil my promise. The Lectures were given. In the course of the same year their publication in the "Medical Gazette" was commenced, and in 1847 was completed.

It has been thought desirable that these Lectures, scattered at irregular intervals in the columns of the Gazette, should be collected; and, after undergoing such revision and amendment as my leisure and opportunities afford, be published in the present form.

The illustrations are double the number of those published in the "Medical Gazette," and are re-engraved.

I must here, as in the Gazette, express my gratitude to my friend, Mr. De Morgan, for his kindness in making the drawings from which many of the wood-cuts have been executed by Mr. Williams, the engraver on wood.

The first six Lectures are devoted to Dental Physiology, and they contain, I think, some new views on the development of the dentine and enamel; they contain also points in the structure of the teeth that have long been familiar to physiologists, but in describing which I have not acknowledged any antecedent authority. To those who are not acquainted with the matter of a controversy that existed a few years since, I may seem guilty of plagiarism. Before such an opinion is entertained, I must beg the reader to peruse the works referred to in the note at page 67.

I have intentionally avoided alluding to the circumstances that brought about the controversy, because they were wholly of a personal character, and have no bearing whatever on dental structure. My sole object in alluding to the existence of that controversy, and to the works in which it took place, is to guard myself against the charge of plagiarism.

Much statistical matter has been added in that part of the Lectures which relates to the liability of the teeth to disease. The Lecture on Caries has been considerably revised, and the results of recent examinations detailed.

The concluding Lectures have also been revised, and an account of the use of ether and chloroform, in dental operations, has been added.

These Lectures were written for, and delivered to, beginners: they were not, and they are not now, addressed to those already conversant with the subjects of dental physiology and surgery. Should these pages meet the eye of any of the latter class of readers, I must entreat them to remember, that the Lectures were not written for those who have learned, but for those who have yet to learn.

41, Mortimer Street,
July, 1848.

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[a] From TODD and BOWMAN'S *Physiology*.
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[a] From Mr. Sharp. [b] From Mr. Arnott.

LECTURES

ON

DENTAL PHYSIOLOGY AND SURGERY.

LECTURE I.

INTRODUCTION.—GENERAL CHARACTERS OF TEETH.—THEIR RELATION TO THE SKELETON.—OSSEOUS AND CUTICULAR TEETH.—CLASSIFICATION OF TEETH, IN ACCORDANCE WITH THEIR FORMS AND USE.—TYPICAL FORM OF A TOOTH.—PECULIARITIES OF THE HUMAN TEETH.—DESCRIPTION OF THE INCISORES, CUSPIDATI, BICUSPIDATI, AND THE MOLARES.

GENTLEMEN,

IN a benevolent institution like the Middlesex Hospital, made to fulfil the double purpose of providing medical aid for the indigent in their times of sickness, and of affording instruction to those engaged in the study of medicine, it becomes the duty of all who treat disease, whether grave or trivial, whether mental or bodily, to explain, to those of you who are pupils, the principles on which their treatment is based; and it is equally, too, your duty to avail yourselves of every opportunity to acquire that professional knowledge, in the practice of which your future years will be spent, honourably if you have knowledge, dishonourably if you have not. Hence it devolves on me, in virtue of my office as dentist, to describe, and on you, in your pupilage, to learn, the nature of the diseases to which the teeth are subject, and the principles on which they may be most successfully treated.

Towards the fulfilment of this purpose, it will be necessary for me, first of all, to bring to your recollection some of the more common forms of teeth, and the positions which they occupy in the alimentary tract; though on these points I shall chiefly confine my observations to the human teeth. Then, the peculiarities of dental structure, and development must for awhile engage our attention. Some points in the anatomy of the teeth will be made more intelligible, by comparing the dental with other animal tissues, or to the same tissues as they occur in animals holding a lower place than man, in the scale of organized beings. When we come to these, I shall go so far only into the subject of the comparative anatomy of teeth, as may be subservient to our explanatory purpose.

Having considered the descriptive, and structural anatomy of the dental apparatus, we shall pass to the main subject of these lectures—the diseases of the teeth, and their treatment. The diseases of the temporary teeth will form the first division of the subject, while the maladies of the permanent teeth will form the second.

In children, teething, and the diseases arising from interrupted dentition, are the most common, and at the same time the most formidable to which they are liable; indeed, on reference to the bills of mortality of this metropolis, it will be seen that, of those who die under the age of fifteen, four per cent. die from teething. This will at once show that too much attention cannot be given by those engaged in medical studies, to dentition and its coincident disorders. Many of these diseases will be treated of by your lecturer on Midwifery; but dentition itself, with some of the symptoms of interrupted dentition, will necessarily come under our consideration.

The diseases of the permanent teeth are important from their frequency, and their painful character when present; and though not in themselves often dangerous to life, yet they exercise an important influence on other diseases situated in their neighbourhood, as well as on indigestion and the various forms of nervous and spasmodic disease. During the year 1844, of the 9140 out-patients who applied for relief at this hospital, 1050 applied with diseases of the permanent teeth. Thus, while the frequency of the disease commands our attention, it at the same time renders ignorance of the treatment unpardonable.

The last subject to engage our attention will be the means we possess of supplying the loss of the permanent teeth. Under this head will be described the construction of artificial teeth, and the manner of using them, together with such information, as the general practitioner may find useful, when applied to by his patients for information upon the subject of artificial teeth.

Teeth may be defined to be hard bodies projecting from the surface of the mucous membrane, and situated in the alimentary canal, anterior to the pyloric orifice of the stomach; their use being subservient to nutrition.

The density of the teeth bears a constant relation to the density of the skeleton; and it will be shown that the structure of the teeth, with few exceptions, holds an equally exact relation to the structure of the tissue composing the skeleton.

In the class mammalia, the dental and osseous tissues reach their highest point of development and average density, while in fishes they are lower in organization and less hard; the structural relations being in this closer even than in the former class.

As regards situation, the teeth are placed in the alimentary canal, somewhere anterior to the pylorus, and are found to occupy various parts of this line, in strict conformity to the wants of the particular animal.

In animals, as low in the scale as the *monads*, elementary teeth are found disposed around the mouth in the form of stiff spines.

Among the *annelidæ*, the leech is remarkable for the sharp teeth with which it inflicts its tri-radiate wound. The individual extremely minute teeth are sharp-pointed cones fixed in single lines upon three semicircular-edged maxillæ, like the teeth of a circular saw. The maxillæ have their armed edges directed towards a common centre, and are each by suitable muscles moved upon their axes, and are, at the same time, made to approach each other; by this combination of movements, the animal saws the three-lined wound with which we are most of us familiar.

In many insects hard horny plates occupy the oral orifice, and perform the office of incisor teeth, while the œsophagus is provided with short strong teeth, which perform the function of molars, as instanced in the grasshoppers and others. The proventriculus in all mandibulated insects is armed with numerous horny teeth, which vary in form, number, and arrangement, in the different species; some being flat, others corrugated on the surface, and some conical and recurved.

In structure the teeth of insects are similar to the external skeleton [a].

In the division *mollusca*, of which the common snail is a member, we have a flat curved plate for incising, with which the creature divides the vegetable matter upon which it feeds. In the same order some of the vegetable-feeding species are furnished with dental organs in the stomach.

In *fishes* the teeth are implanted in the vomer, in the palate, and pharyngeal bones, in the branchial arches, and os hyoides, as well as in the maxillary and inter-maxillary bones.

In the *mammalians* the dental organs are alone found arranged in single lines in the maxillary and inter-maxillary bones.

Thus we find, by examining various members of the animal kingdom, teeth occupying every point of the anterior part of the alimentary canal.

Teeth are used either as organs for the mastication or prehension of food. They are also used as organs of offence and defence, and sometimes aid slightly in locomotion, and in man assist in articulation; but these latter may be considered as accessory uses only.

It admits of question whether the bills of birds should be regarded as dental organs; the evidence seems in favour that they should, since they are situated at the anterior orifice of

[a] BURMISTER'S *Entomology*.

the alimentary canal, are distinctly organs of prehension, and much used in the laceration of food, as instanced in carnivorous birds.

It may be objected that the structure is dissimilar to that of the skeleton; this objection will not, however, hold good, as we find in some animals the teeth have a structure similar to the cuticular appendages, as the nails; such are the teeth of the ornithorhyncus. It becomes obvious, therefore, that there are two classes of teeth—OSSEOUS TEETH, and CUTICULAR TEETH; the former having gelatine as their animal base, the latter albumen [a].

The structure of osseous teeth is similar to the structure composing the skeleton, whereas the cuticular teeth have a structure similar to the appendages of the epidermis.

The transition from the one class to the other is not, however, sudden; for, although we do not find a mixture of the two structures in any tooth, yet we do find that the osseous teeth of some animals have properties in common with the cuticular teeth. Thus the incisor teeth of the rodentia grow during the whole life of the animal, and the cutting edge becomes extra-vascular from the recedence of its tubuli from their connection with the pulp-cavity; a condition common to cuticular teeth, which are constantly increasing at the base and are extra-vascular. Indeed, these ever-growing teeth may in many respects, save in situation, be compared to the nails and horns. From these considerations we must admit the bills of birds and of tortoises as belonging to the dental system.

A further confirmation of this opinion will be found in the manner of development, as instanced in the mandibles of the parrot and tortoise. In the family of birds called Merganser, the mandibles are armed with sharp conical teeth.

In the jaw of the balæna mysticetus, we have the whalebone developed in the place of teeth; the structure of which is somewhat similar to that of the mandibles of birds.

[a] OWEN'S *Odontography*.

By making this distinction in the two kinds of teeth we are able to understand the conflicting opinions that existed so many years, but which recent investigations have set at rest; namely, as to whether the teeth were to be regarded as possessed of life and organization like bone, or as inorganic excretions like the hair and nails.

The durability of individual teeth varies in different classes of animals. In the crustaceans, the teeth are shed with the external skeleton, and are renewed with it. In reptiles and fish they are renewed when injured by wear or lost by violence. In the shark tribe new teeth are always forming, while the oldest and most external are being cast off by absorption of the bases, through which they are anchylosed to the jaw. In the highest class of animals—mammalia—the teeth are but once renewed; those of youth are gradually shed, and, as the animal frame approaches its full growth, are gradually replaced by a stronger and more extended set, fitted to last out the life of the animal.

Teeth admit of a general classification, based upon their various external forms and the purposes for which they are adapted. 1st. Teeth of a conical shape with sharp points: such are found in the canine teeth of the carnivorous animals, also in the more simple conical and lancet-shaped teeth of the shark tribe. Teeth of this class interlock with those of the opposing jaw, and are used either for seizing or retaining the prey. 2nd. Teeth with sharp chisel-shaped edges for cutting, as the incisor of the rodentia, illustrated in the rabbit and rat. 3rd. Teeth for tearing and lacerating, as the molars of carnivora. 4th. Teeth for crushing, as seen in the monkey tribes, where the principal food consists of fruits. 5th. Teeth for grinding: these teeth present a large flat surface, and the jaw is so articulated as to admit of great lateral motion. The grinders of the elephant afford an excellent example. This class of teeth belong mainly to animals subsisting on grain, which requires to be reduced to powder before it is received by the organs of digestion.

The conical-pointed tooth for piercing, and the broad flat tooth for grinding, offer the two extremes in form; and in passing from the one to the other, we may, by examining the teeth of various animals, observe minute gradations in the change from the vertical to the horizontal development, or *vice versâ*.

But in all instances we find the jaw beautifully adapted for the most efficient use of the peculiar teeth with which it is armed. So that, from a view of the teeth, we may with certainty predict what would be the form of articulation of the jaw to which they belong; and, on the other hand, a view of the articulation of a jaw, from which the teeth have been lost, will furnish us with means of judging what was the form of teeth with which it was furnished.

The typical form of a tooth, as developed in the mammalian class, is a modified cone or combination of cones; the apex of the cone being sometimes on the masticating surface, at other times at the end of the root. In teeth that are perfected in a short space of time (as the human teeth), the masticating surface, or the base of the crown, will present the base of the cone; while the fang presents its apex; on the other hand, in cases where the development of the tooth is progressive through the whole life of the animal, the base of the cone will be at the edge situated deep in the jaw where the dental development is going on. In man the base of the cone is in the crown of the tooth, and the apex at the extremity of the root, or on the grinding surface.

In the front teeth we have a simple cone when seen from the front, the cutting edge corresponding to the base, and the end of the root to the apex of the cone; seen from the side, they present two cones united by their bases, the point of union being the neck of the tooth. The crown, and root of the canine teeth present each a cone uniting at the neck of the tooth.

The molar teeth exhibit in their fangs modified cones, which, uniting laterally at their bases, form the neck of the tooth, while the prominences of the grinding surface are formed of lesser cones. Thus, in examining a developing or a recently developed tooth, prior to any alteration of form from use, the tendency to the conical formation is every where found.

The teeth in the human subject are arranged in the jaws in two parabolic curves, the one in the upper jaw being the larger of the two. From the greater size of the curve, the teeth of the superior maxilla close in the anterior part of the mouth external to those of the inferior maxilla, and at the sides of the mouth, the external edge of the molars of the upper close over the external edge of those of the under jaw.

The crowns of the teeth are arranged in an even line, no tooth rising higher than its fellows; a condition peculiar to man, and arising from the equal development of each tooth. A second peculiarity is found in the absence of intervals between the anterior and the grinding teeth.

The teeth are developed in pairs, one on either side of the median line, and amount in the adult, when perfect in each jaw, to thirty-two; the dental formula being, incisors, $\frac{4}{4}$; canines, $\frac{2}{2}$; bicuspides, $\frac{4}{4}$; molars, $\frac{6}{6}$. In the child, prior to shedding the temporary teeth, the number amounts to twenty only, the dental formula being, incisors, $\frac{4}{4}$; canines, $\frac{2}{2}$; molars, $\frac{4}{4}$: why the temporary and permanent set of teeth are unequal in numbers will be seen when the development of the teeth and jaws is considered.

For the convenience of description, a tooth is divided into three parts; the crown, which is the exposed portion; the neck, which is continuous with the crown, and is covered by the edge of the gums; and the root, or fang, which is a continuation of the neck, gradually diminishing in size to its extremity, and lodged deep in the jaw.

Three tissues enter into the formation of the human tooth; the enamel, which coats with variable thickness the crown of the tooth; dentine, which forms the great bulk of the tooth; and cement, or dental bone, which forms the surface of the fang.

In the centre of each tooth is a cavity partaking generally of the shape of the exterior of the tooth, being very small at its commencement in the root, and gradually increasing in size till it terminates in the crown. The vessels, nerves, and remains of the formative pulp, occupy this cavity, from which it has received the name of the pulp-cavity.

The crown of each tooth presents five surfaces. First, a masticating surface; second, an external or labial surface; third, an internal or lingual surface; fourth, an anterior or median surface, which in the front teeth is directed towards the median line, and in the molars points anteriorly; fifth, the posterior surface.

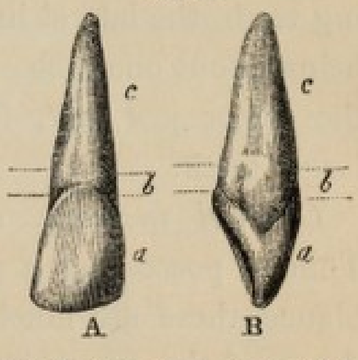
Each tooth is larger in its labial surface than in its lingual, arising from the greater size of the curve described by the outer or labial surface than that formed by the inner or lingual surface of the teeth.

We now come to the consideration of each kind of tooth, beginning with those situated at the anterior part of the mouth, and proceeding in the order of their position backwards towards the angles of the jaws. The description, however, must be general, for, as no two teeth of the same kind are *exactly* similar in size and form, a description, taken from an individual specimen, would, when applied to other individual teeth of the same kind, prove incorrect.

The *incisors* (*incido*, to cut) are four in each jaw; two central, two lateral. Of those in the upper jaw the central are the larger. The crown presents a large scarcely convex labial surface, is wedge-shaped from behind forward, and terminates in a broad cutting edge, similar in shape to a chisel. The root is conical, diminishing in size gradually to the apex; and the tooth, when seen from the front, presents in outline a tolerably perfect cone, the cutting edge forming the base.

If the tooth be examined from the

Fig. 1.



Central Incisor from the Left Side of the Upper Jaw.

A. A front view.
a. The posterior side lying against the lateral incisor, as distinguished from the anterior side, which lies against the fellow central tooth.
B. A side view.
a. The labial or front surface, as opposed to the lingual or back surface; the latter terminates in the basal ridge, which is intersected by the lower of the two dotted lines.
b. The neck.
c. The fang.

side, it will present the outline of two imperfect cones united by their bases, the apex of one cone being at the cutting edge of the tooth, and of the other at the end of the root.

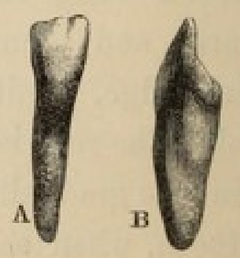
The side near the median line is longer and less curved than the opposite side of the tooth, and the angle formed by the junction of the median side and the cutting edge is less rounded and less obtuse than that formed by the opposite side and cutting edge. The anterior surface of the crown is slightly convex in each direction, and is commonly marked by one or two shallow and irregular grooves running in the length of the tooth. The lingual surface of the crown is slightly concave in each direction, but principally from above downwards; the concavity terminates in a ridge—a basal ridge, situated at the commencement of the neck, where the tooth passes into the gum.

The enamel terminates on the anterior and posterior surface of the tooth in a curved line, the convexity of the curve being directed towards the fang, while on the sides of the tooth it terminates in a curved line with the convexity directed towards the crown.

In point of size the central are larger than their neighbouring teeth, the lateral incisors, the average length of the former being about one inch. This remark applies to the incisors of the upper jaw only, for in the lower row the lateral are the larger teeth.

Central incisors, lower jaw.—Though possessing a general resemblance, these are much smaller than those of the upper jaw, being only half as wide on the cutting edge. The diameter of the antero-posterior surface is, however, almost equal. The lateral surfaces rapidly converge towards the neck, which is succeeded by a much compressed and slightly grooved root.

Fig. 2.

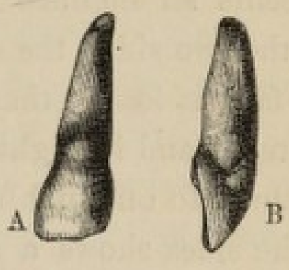


Central Incisor from the Right Side of the Lower Jaw.

A. Front view.
B. Side view.

The enamel terminates in a curved line on the labial and lingual surfaces, the convexity of the curves being directed towards the root of the tooth: on the lateral surfaces the terminal curves of the enamel are reversed. Average length, eight-tenths of an inch.

Fig. 3.



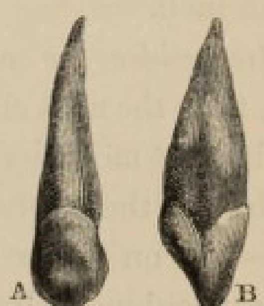
Lateral Incisor from the Left Side of the Upper Jaw.

A. Front view.
B. Side view.

Lateral incisors, upper jaw, are less in lateral diameter than the centrals, frequently to the amount of one-third, the depth of crown and of enamel being slightly less; the median surface is more or less concave, while the surface opposed to the canine is slightly convex. The anterior surface is generally convex, and broader at the cutting edge than at the neck of the tooth. The posterior surface presents an inclined plane directed from behind forwards, whereby the cutting edge is formed, while the neck of the tooth is left thick and strong. The fang is laterally compressed and somewhat shorter than that of the central; the posterior basal ridge is generally absent, though sometimes strongly marked.

Lateral incisors, lower jaw, are slightly larger both laterally and antero-posteriorly than the central incisors; the depth of the crown in the two teeth being nearly equal, while the fang of the former is slightly the longer.

Fig. 4.



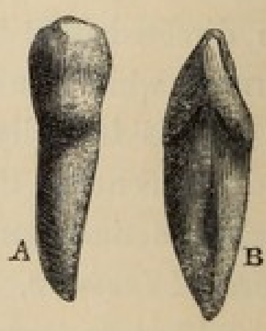
Canine from the Left Side of the Upper Jaw.

A. Front view.
B. Side view.

Canines, or *cuspidati* (from *cuspis*, the point), *upper jaw*.—These teeth are placed between the lateral incisors and the first bicuspides, are the largest of the single-fanged teeth, and have a more deeply implanted fang, and a greater antero-posterior diameter than either of the incisors. The crown terminates in an obtuse point, from whence it gradually increases in lateral dimensions, attaining its greatest diameter at a spot equi-distant from the point and neck, towards which it gradually diminishes in size. The external surface is convex, with a slight ridge, commencing insensibly at the neck, and becoming stronger as it approaches the point, bounded on either side by a depression; a similar ridge also exists upon the posterior surface of the tooth, which, like the central incisors, presents an inclined plane, terminating in a slight basal ridge. Of the two sides, the one next the bicuspid is the more convex; the fang is longer than that of any other tooth; it is compressed laterally, and is slightly grooved at its sides: the length often amounts to one inch and one-sixth. The existence of a groove in the sides shows a slight tendency to the formation of two fangs, and may be regarded as the first step towards the formation of roots. I have in my possession a canine having two fangs.

The *canines of the lower jaw* differ from those of the upper jaw principally in terminating in a broad point, and in being less convex anteriorly; in having more perpendicular coronal sides, and a fang slightly shorter and more deeply grooved on the sides: the perpendicular ridge on the external or labial surface is also very slight or altogether absent. The average length is one and one-eighth of an inch.

Fig. 5.

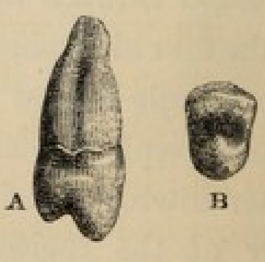


Canine from the Right Side of the Lower Jaw.

A. Front view.
B. Side view.

Bicuspides, or *premolars, upper jaw*, form the next class; and in them we find the most simple form of molar tooth. Of these there are four in each jaw—two on either side; and, from their position, called the first and second bicuspides.

Fig. 6.



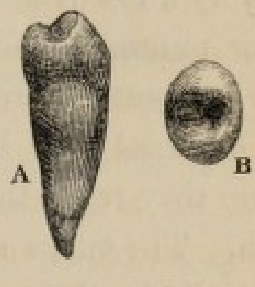
Bicuspid from the Upper Jaw.

A. Side view.
B. View of the masticating surface.

The crown is composed of two cones united laterally, from which proceeds a laterally compressed fang, common to each. The labial surface is convex, and, like that of the canine, terminates in an obtuse cone. The lingual, or internal surface, is also convex, and, unlike either of the foregoing teeth, placed vertical to its alveolus. Of the two tubercles, or cusps, of the masticating surface, the external is the larger, especially in the anterior bicuspid. The crowns of these teeth are at least one-third shorter than those of the previously described teeth. The fangs are either two in number, corresponding to the two cusps; or, if there are not two, the one is very deeply grooved and perforated by two cavities uniting to form one in the crown, or, if there be a single cavity, it resembles in section a line dilated at its extremities. In some few instances the single fang is deeply grooved externally as well as on its side, and at the apex divides into three points, thus showing a strong tendency to the formation of three fangs similar in position to those of the molar teeth of the upper jaw.

In the skull of a Chinese in my possession the anterior bicuspides have three fangs like the molars, while the posterior bicuspides have but one fang.

Fig. 7.

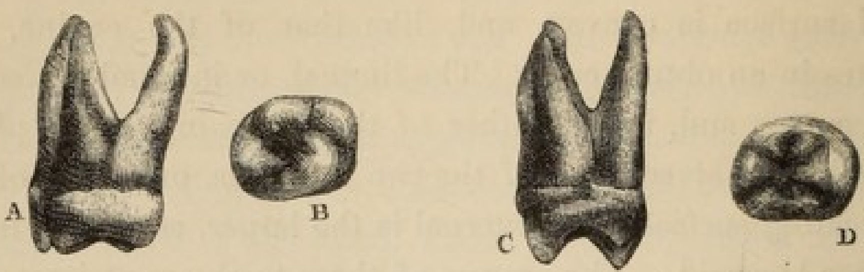


Bicuspid from the Lower Jaw.

A. Side view.
B. View of the masticating surface.

The *bicuspides, lower jaw,* have some points of dissimilarity when compared with those of the upper jaw. They are generally more rounded, and the labial surface is more convex. The two tubercles of the masticating surface are less distinct from each other, the grooves separating them being imperfect, and not carried fully across the tooth. The fang also is more rounded, and seldom, if ever, double. Indeed, these teeth may be considered as intermediate between the canines and bicuspides of the upper jaw. The first and second are much alike, the second being rather the larger, and having a more strongly developed inner cusp. In the first, the two cusps are connected by a low ridge passing from the one to the other across the centre of the crown.

Fig. 8.



First and Second Molares from the Left Side of the Upper Jaw.

A. The first molar viewed from behind, showing the three fangs.
B. View of the masticating surface of the first molar, showing the four cusps.
C. The second molar.
D. The masticating surface of the second molar.

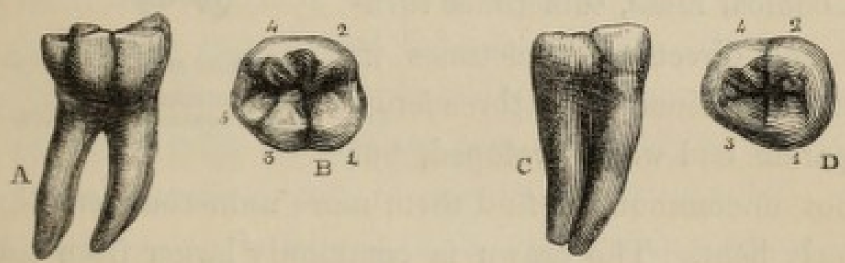
Molars (*molaris*, pertaining to a mill, a cheek tooth), *upper jaw.*—There are three pairs of molars in each jaw, upper and lower, named in the order of their respective places, as regards the anterior part of the mouth, *first*, *second*, and *third*. The first and second pair, being generally much alike, may be described together.

The masticating surface is armed with four cusps, two external or labial, anterior, and posterior, and two internal or lingual, anterior, and posterior. Of these the anterior internal is much the largest, and is connected to the posterior external cusp by a low ridge, separating, by its oblique course, the anterior external, and the posterior internal, from each other. The grooves separating the cusps at their bases extend over the external and lingual surface of the tooth, but are lost before they reach those surfaces which adjoin the neighbouring teeth. The cusps are, however, subject to variety in number, especially in the second molar; thus sometimes several lesser ones appear, while, at others, the two internal or lingual cusps are united in a large one.

The crown of the tooth, disregarding its tubercles, is a four-sided figure, with parallel sides, united with two obtuse and two acute rounded angles; two sides standing parallel with the line of the jaw, while the other two are directed inwards and backwards towards the pharynx on the opposite side.

The roots are three in number, two external and one internal. Of the two external fangs the anterior is the larger, and stands a little more outward than the posterior root; they are each compressed laterally, and have their greater diameter from without inwards. The third, or palatine fang, is much larger than either of the others; it is broad and thick at its base, and, if there be two inner coronal cusps, grooved as though formed of two conical roots; it is directed obliquely upwards and inwards towards the palate. In some few instances there are four distinct fangs[a]; on the other hand, it is by no means uncommon to find the palatine and the anterior, but more frequently the palatine and the posterior fangs, united in one, the lines of union being marked by longitudinal grooves. The enamel terminates gradually in an even line round the neck of the tooth.

Fig. 9.



The First and Second Molares from the Right Side of the Lower Jaw.

A. The first molar seen from the outer or buccal side.
B. View of the masticating surface, with the five cusps indicated by figures.
C. A similar view of the second molar, with the fangs connate.
D. The masticating surface of the second molar, with the four cusps figured.

Molars, under jaw.—Of these the first molar is the largest; the grinding surface of this tooth is divided by an irregular cross-shaped fissure into five tubercles, two anterior and two posterior; between the two latter the fifth, a wedge-shaped cusp, is situated.

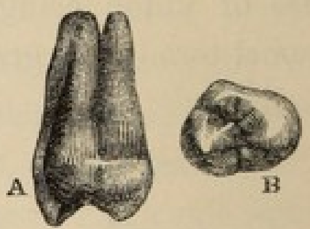
When the tubercles have been worn down by use, the grinding surface becomes flat and square, and is surrounded by a ring of enamel. The external surface of the crown is usually marked by a vertical groove, which often passes half way down the crown, and ends in a small hole, in which disease often shews itself.

[a] BELL.

The roots are two, one anterior and one posterior. They are strong, much compressed, and grooved behind and in front, generally diverged, and turned a little backwards; sometimes their backward course is very considerable. I have seen one or two instances in which, instead of two grooved fangs, four distinct fangs have been presented. In the second molar we seldom see the fifth cusp, neither is the tooth so large as the first. The roots are not unfrequently united in one conical mass; in other respects the second resembles the first molar.

Third molar, upper jaw, though generally resembling the first and second, is, in most instances, more irregular in form, and less in size. The fangs are frequently compressed into a conical mass, sometimes turning in one direction, sometimes in another. Occasionally the three fangs are separate and well developed, but it is not uncommon to find them more numerous, small, and irregularly bent. The crown is commonly larger from side to side than from the front to the back.

Fig. 10.

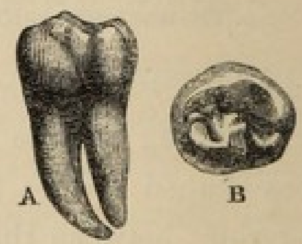


The Third Molar of the Upper Jaw.

A. Posterior view.
B. The masticating surface.

Third molar, under jaw.—This is a larger tooth than its fellow in the upper row. The crown usually bears four cusps, and resembles the adjoining molars, except that it has a more rounded appearance. The roots are two in number, generally directed backward, and very commonly connate, the lines of union being marked by longitudinal grooves; a similar groove is also seen on the other sides of the root, thus giving evidence of the tendency to the development of four fangs corresponding with the four cusps. The pulp-cavity is usually large, and if the fangs be connate does not subdivide till near the end of the fangs, and sometimes does not do so at all.

Fig. 11.



Third Molar from the Left Side of the Lower Jaw.

A. Side view.
B. The masticating surface.

LECTURE II.

RELATIONS OF THE TEETH TO EACH OTHER, AND OF THE UPPER TO THE UNDER ROW OF TEETH IN CLOSING THE MOUTH.—THE ALVEOLI.—NERVES OF THE TEETH.—BLOOD VESSELS OF THE TEETH.—THE TEMPORARY TEETH.—THE ARTICULATION OF THE JAWS.—MASTICATION.—STRUCTURE OF THE TEETH.—DENTINE.—TUBULAR TISSUE.

HAVING in the last lecture examined separately each class of tooth, it will be interesting to review their progressive increase of size, and of use, as we proceed from the anterior to the posterior part of the dental arch.

The most simple form of tooth is in shape an elongated cone, fixed at its base, and adapted for seizing only. Such a tooth is not found in the human subject, but the next form in the order of complexity of use we possess, namely, a tooth in which a broad cutting edge is substituted for a point. Such are the incisors, single-fanged teeth, with cutting edges, those of the upper jaw closing over those of the under jaw, like the blades of scissors, and in such a manner as to keep by use the edge of each tooth tolerably sharp.

From the incisors we come to the canines, which teeth, terminating in an obtuse point, and having, like the incisors, an inclined lingual surface, are adapted, from their form and the strong deeply planted root, for dividing or lacerating tough substances. In these teeth are the first indications of the development of two distinct fangs; thus exhibiting, in use and form, a third step towards the more complex teeth.

Passing from the canines, the bicuspides present themselves. In these, all the rudiments of a more complex form are observable. The crowns are tuberculated, and the root of the tooth, if not divided in two, is deeply grooved; and, in a few examples, the bicuspides of the upper jaw have three fangs, similarly arranged to those of the neighbouring molars. In use, the bicuspides are equal in the degree of their relative size to the molars which join them.

The molars are in form the most complex of the human teeth, having several divergent roots and a tuberculated masticating surface—a conformation admirably fitted for triturating the food divided by the anterior teeth.

Relations of the upper to the under row in closing the mouth.—The upper incisors and canines, when the mouth is closed, from the larger arch in which they are arranged, shut over, and in front of the lower teeth, concealing the upper third of their crowns; while the external tubercles of the bicuspides and molars of the lower jaw are received into the depressions between the external and internal tubercles of the similar teeth in the upper jaw, thus allowing the external tubercles of the upper teeth to close externally to the outer tubercles of the lower row.

From this arrangement of the tubercles, we are enabled in mastication to use the whole surface of the crowns of the opposing teeth; the act of mastication being performed by bringing the external tubercles of the under molars opposite those of the upper row, when, by the lateral motion of the under jaw inwards, the external tubercles pass down the inclinations of the external, and up the inclinations of the internal tubercles of the upper jaw teeth, reducing in the action any interposed substance.

It will also be observed that, from the difference of size laterally in the incisors of the two jaws, the central incisors of the upper extend over the centrals and half of the laterals of the under row, and that the superior laterals lie over the remaining half of the inferior laterals and the anterior half of the canines of the lower jaw. The canines close over the halves of the first bicuspides and canines, while the first bicuspides impinge on the half of the first and of the second bicuspides of the lower row. The second bicuspides close upon the anterior third of the opposing first molars, and the posterior half of the second bicuspides. The first molars oppose the posterior two-thirds of the anterior, and one-third of the second molars of the lower jaw, while the second upper molars close upon the unoccupied posterior third of the second and the anterior third of the wisdom teeth. The wisdom tooth of the upper, being smaller in size than that of the lower jaw, is perfectly opposed by that portion of the latter left unoccupied by the anterior tooth.

By this admirable arrangement, no two teeth oppose each other only, but each tooth in closing the jaws impinges upon two, so that should a tooth be lost, or even two alternate teeth, still the corresponding teeth of the opposite jaw are to some extent opposed, and thus remain useful. For, when a tooth is wholly unopposed, a process is set up in the jaw by which the useless organ is gradually ejected. The direction of the teeth in the upper is vertically downwards and slightly forwards, while those of the lower jaw are placed vertically, the molars bending slightly inwards. The relations of the teeth, when closed, are shown in the engraving at the commencement of the volume.

The alveoli.—Having become acquainted with the external forms of the various classes of teeth, we shall now consider the alveoli, or sockets, in which they are implanted. The alveolar processes bound the inferior border of the upper jaw and the superior edge of the lower jaw, and form curves more or less elliptical. They consist of an external and an internal plate, connected by transverse septa, the internal being the stronger of the two. The spaces between the septa receive the roots of the teeth, to which they are accurately moulded. The latter having been described, it is needless to repeat the description of their reverses. The septa are composed of less dense bone than that forming the external or internal alveolar plates, and are somewhat longer.

At the bottom of each alveolus is found one or more foramina, through which the vessels and nerves pass in their way to the tooth.

The external plates of the alveolar processes are in the anterior parts of the jaws, irregularly fluted, the depressions corresponding to the septa. In the upper row the external convex surfaces of the roots of the teeth are sometimes near the apex without alveolar covering, but the necks are always embraced by bone.

The free edges of both the external and internal alveolar plates have a festooned margin, the concavities being opposite to the alveoli, and directed towards the crowns of the teeth. The walls of the alveoli are perforated by innumerable small holes for the transmission of vessels to the periosteum, by which the roots of the teeth are connected to their closely fitting sockets. The surfaces of the alveoli are every where closely invested with periosteum, which on the free surface is clothed with mucous membrane continuous with that of the mouth; and thereby are formed the gums, which, having invested the outer surfaces of the alveoli, attach themselves to the necks of the teeth, and there terminate in a free edge, which lies over the neck of the tooth and the terminal line of the enamel. If a vertical section of an alveolus be made, we shall find, proceeding from without inwards, first mucous membrane, or gum, then periosteum, and next comes the osseous wall of the alveolus, and then again another layer of periosteum. If the section includes the tooth, the dental periosteum, or peridental membrane, will be then seen, and, lastly, comes the tooth itself.

The structure of periosteum and mucous membrane will be described by your lecturers on anatomy.

The kind of articulation by which the teeth are fixed is termed by anatomists *gomphosis*. The teeth are retained in their position, first by the close adaptation of the alveoli to the fang, and secondly, by the strong adhesion of the periosteum to the walls of the alveolar cavity and to the surface of the root. Where the fangs diverge, or are crooked, the teeth are held firmly by the corresponding shape of the alveoli, and offer strong resistance to the force employed for their removal. We shall, however, recur to this part of the subject when treating of the extraction of teeth.

But it must not be supposed that the teeth in their healthy state admit of positively no motion. By taking a tooth between the thumb and finger it may be made to move, though slightly, yet perceptibly, from side to side, arising from the compressibility and elasticity of the alveolar periosteum. This elastic tissue no doubt performs a threefold function; first, in contributing to retain the teeth in their place, then in maintaining their vitality, and thirdly, in diminishing the shock communicated to the jaws by the forceable closure of the teeth.

Nerves of the teeth.—The teeth of each jaw receive their nerves from sensitive branches of the fifth pair. The molars of the upper jaw are supplied by the posterior dental, a branch from the superior maxillary nerve before its entrance into the orbit, which branch, dividing into twigs, passes into the substance of the bone by small foramina at the posterior part of the tubercle.

The superior bicuspides and canines, and incisors, are supplied by two branches, the middle and anterior dental, given off during the passage of the nerves through the infra-orbital canal.

The third division of the fifth nerve furnishes the inferior maxillary by which the teeth of the lower jaw are supplied. The inferior dental nerve enters the jaw by the posterior dental foramen, and lies in its course immediately under the roots of the teeth, to each of which it sends off a small branch, which, entering the root through a small foramen, is distributed to the pulp.

The three superior dental, from the infra-orbital nerve anastomose by their primary branches, from which, and from a plexus formed by the secondary branches in the lining membrane of the antrum, two sets of nerves are directed, one set (rami dentales) to the teeth, the other (rami gingivales) to the osseous tissue and gums [a].

The infra-orbital and the inferior maxillary nerves, both before and after the origin of the dental branches, give off nerves to be distributed to the parts about the face; with these the

[a] Swan *on the Nerves.*

dental branches anastomose; thus establishing links of connection by which sensation may be transmitted from one part to another, throughout the whole course of the nerve.

By tracing these intercommunications of the nerves, we are able to understand the various sympathetic pains, so frequently manifested in odontalgia, and in neuralgia and rheumatic pains, between the teeth and the neighbouring parts.

You are aware, I presume, that sensation is manifested in the terminal filaments only of a nerve;—that in whatever part of its course a nervous filament be irritated, sensation or pain will alone be felt in the parts to which the filament is finally distributed. In accordance with this law of nervous action, we frequently have pain in sound teeth, whose nerves have passed in company with, and received irritation from, filaments distributed to a diseased and aching tooth. The irritation is, no doubt, communicated at the point where the disordered filaments join the nervous trunk, common to the filaments primarily and secondarily affected; though at that point no pain is felt, and for the reason I have told you. This circumstance often renders it difficult to ascertain the cause of pain in teeth to all appearance sound and healthy.

Then, again, pain in a tooth, even of the lower jaw, is sometimes rapidly succeeded by violent pain in the temple. In this case, some of the filaments distributed to that part must have been irritated in their circuitous rout when alongside with those primarily affected. It is intelligible only on this ground. You are aware that there is no true anastomosis between the filaments of nerves, such as exists between blood-vessels, where the tubes are continuous. A bundle of filaments from one nerve are received into the neurilema of another nerve, and passed on with it undistinguished; but this amounts to juxtaposition of filaments only. Actual anastomosis between nerves has, I believe, never been seen [a]. The accompanying figure and table are given to show the connections of the dental with the other branches of the fifth nerve.

[a] TODD *and* BOWMAN'S *Physiology*.

Fig. 12.

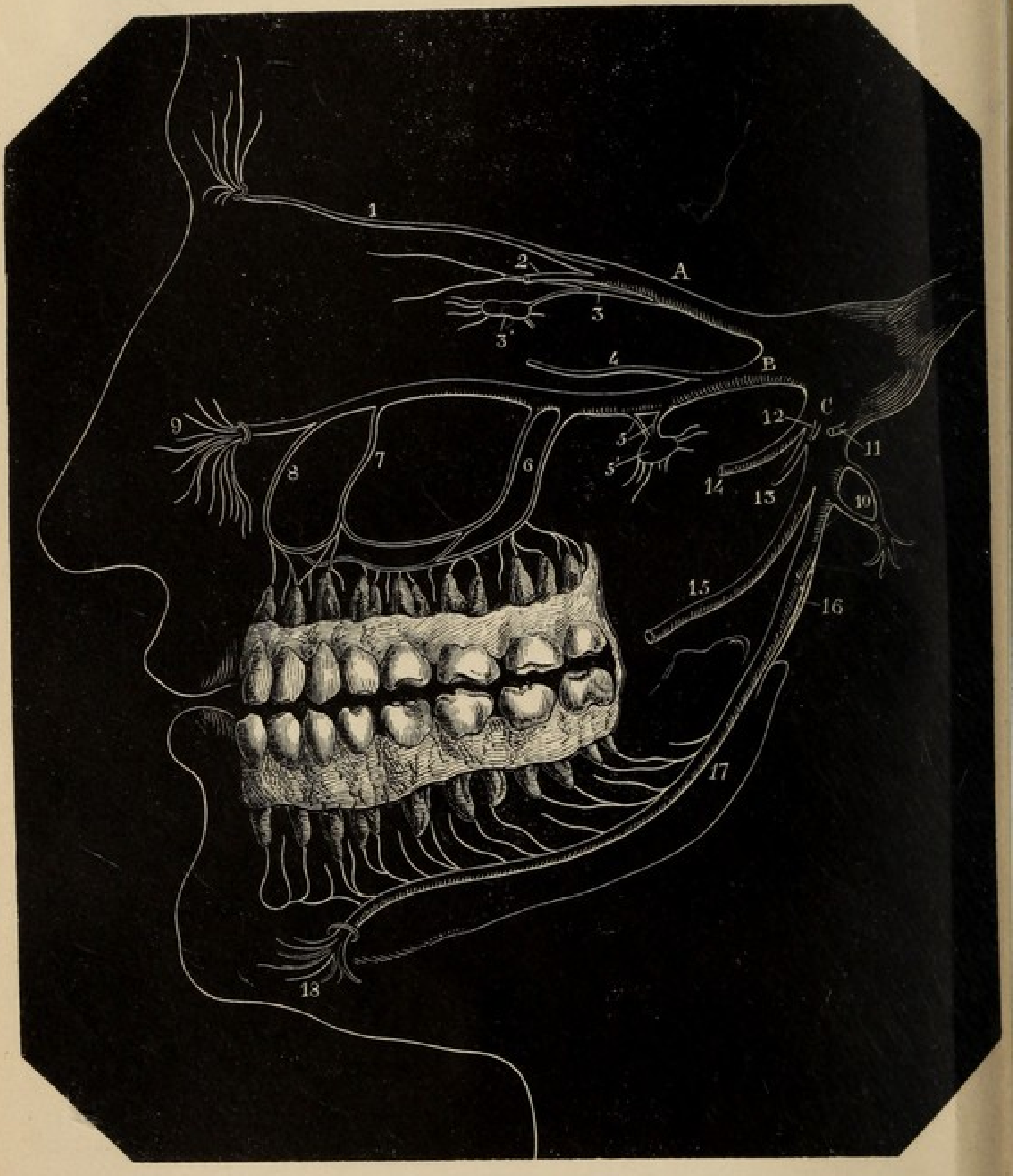


Diagram of the Fifth Nerve, with reference principally to the distribution of the Dental Nerves and their connections.

A. Ophthalmic division.
1. Frontal. 2. Lachrymal. 3. Nasociliary branches. 3'. Lenticular ganglion.
B. Superior maxillary division.
4. Malar. 5. Pterygo palatine. 5'. Meckel's ganglion. 6. Posterior dental. 7. Lesser anterior dental. 8. Greater anterior dental. 9. Infra orbitary branches.
C. Inferior maxillary division.
10. Anterior auricular. 11. Masseteric. 12. Deep posterior temporal. 13. Anterior deep temporal. 14. Buccinator. 15. Lingual. 16. Mylohyoid. 17. Inferior alveolar. 18. Inferior labial branches.

TABULAR VIEW OF THE DISTRIBUTION OF THE FIFTH NERVE.

(From Todd and Bowman's *Physiological Anatomy.*)

I. Ophthalmic—(anastomoses with sympathetic).

- *a.* Lachrymal
  - 1. *b.* To lachrymal gland.
  - 2. *b.* To unite with temporo-malar branch of supra-maxillary nerve.
  - 3. *b.* To external canthus, eyelids, &c.
- *b.* Frontal .
  - 1. Supra-trochleator *b,* to integuments of internal canthus, conjunctiva, lids, &c.
  - 2. Continued frontal nerve, or supra-orbital.
- *c.* Nasal .
  - 1. Lenticular *b,* to the ophthalmic ganglion.
  - 2. Ciliary nerves,—two in number.
  - 3. Nasal *b,* to the mucous membrane and skin of the anterior part of the nostril.
  - 4. Infra-trochleator, to the inner canthus and side of the nose.

II. Superior Maxillary—(three stages, cranial, spheno-maxillary, orbital).

- *a.* Temporo-malar *b.*—Anastomoses with the lachrymal, and is distributed to the integument of the temporal and malar region.
- *b.* Spheno-palatine *b.*—Two or three in number, which pass to the spheno-palatine ganglion.
- *c.* Post. superior dental *b.*—Two or three in number, going to the posterior teeth of the upper jaw; one branch passing along the anterior of the antrum, and anastomosing with the anterior superior dental.
- *d.* Ant. superior dental *b.*—Supplies the anterior teeth of the upper jaw.
- *e.* Facial . . .
  - 1. Palpebral.
  - 2. Labial.
  - 3. Nasal.

  Supplying the integuments of those regions.

III. Inferior Maxillary.

- *a.* Masseteric *b.*—To the masseter muscle.
- *b.* Deep temporal *b.*—Two in number, to the temporal muscle.
- *c.* Buccal *b.*—Anastomoses with branches of the facial, and goes to the external pterygoid and buccinator muscles, and to the mucous membrane of the mouth.
- *d.* Pterygoid *b.*—To the circumflexus palati and internal pterygoid muscle.
- *e.* Superficial temporal *b.*—Anastomoses with the facial, and is distributed to the skin of the temporal region and external ear.
- *f.* Inferior dental *b.*
  - By its mylohyoid branch to the mylohyoid and digastric muscles.
  - To the teeth, alveoli and gums of the lower jaw;
  - and by the mental branch to the integuments and mucous membrane of the lower lip.
- *g.* Lingual *b.* .
  - Is joined by the chorda tympani.
  - Connecting filaments to the sub-maxillary ganglion or plexus.
  - Anastomotic branches to the ninth nerve.
  - Branches to mucous membrane of the tongue.

Blood-vessels of the teeth.—The teeth are dependent upon the *internal maxillary* branch of the external carotid for their connection with the arterial system.

The molars of the upper jaw receive their vessels from the superior maxillary, which sends in small branches at the posterior part of the maxilla. The anterior teeth of the upper row receive vessels given off from the infra-orbital artery.

The inferior maxillary artery, passing downwards between the pterygoid muscles, enters the posterior maxillary foramen, and, accompanying the dental nerve, gives branches to the roots of the teeth which enter the dental foramina with the nerves, and are distributed to the pulps. The artery ultimately emerges with the nerve at the median foramen, and is distributed to the chin and lips, where it anastomoses with branches of the facial.

The dental arteries, in addition to the branches given to the teeth, contribute to supply the alveoli and neighbouring tissues.

The milk teeth are altogether smaller than their successors, not only in size, but also in number; the dental formula being, incisors, $\frac{4}{4}$; canines, $\frac{2}{2}$; molars, $\frac{4}{4}$.

In the child there are no bicuspides, the space destined for them being, at this period, occupied by the temporary molars. The incisors and canines, in form, much resemble the similar teeth of the adult.

One point of difference has, however, been described by Mr. Saunders, in his lectures[a]—namely, that the enamel terminates on the neck of the tooth by a thick edge, as compared with the terminal line of the enamel of the permanent teeth. This observation applies equally to all the temporary teeth.

The milk canines in the upper jaw, except in size, are like their successors; but those of the under jaw are more curved than the permanent teeth, and have their lateral surfaces curved, as in the canines of the upper jaw.

The deciduous molars are altogether dissimilar to their successors, the premolars; but in the number of their roots, and to

[a] *Lectures on Diseases and Operations of the Teeth,* by EDWIN SAUNDERS, Esq.—*The Forceps,* 1844.

some extent in the form of their crown, resemble the permanent molars.

The anterior molars have crowns flattened laterally, both in the lower and in the upper row. In the upper they are furnished with three cusps, two external and one internal; the latter being the larger. In the under teeth, the crown is indented by a crucial fissure, situated at the base of four cusps, the two anterior being the larger. These, the first temporary molars, resemble, therefore, the second, rather than the first permanent teeth of the same name.

The second milk molar resembles, in the shape of its crown and in the number and disposition of its tubercles, the first permanent molar.

Thus, in the upper jaw, the anterior internal and posterior external are united by an oblique ridge; while, in the lower teeth, we have a crucial fissure at the base of four cusps, with a fifth cusp wedged in between the two posterior cusps.

In addition to the peculiarities already enumerated, we find that the roots diverge from the necks of the molars at a greater angle than do the fangs of the adult teeth.

Although the temporary are less in size in each direction than the permanent molars, yet they are greater in their antero-posterior diameter than their successors, the bicuspids; so that the milk teeth, as they disappear, leave room anteriorly for the permanent incisors and canines, which, being larger, occupy more space than that vacated by their predecessors.

The portion of the jaw occupied by the milk teeth, corresponds, in size and shape, to the anterior parts of the adult maxilla occupied by the incisors, canines, and bicuspids; and the line described by the outside or labial surface of the teeth is in each (if the development be perfect) a semicircle.

The permanent molars are developed posterior to the milk molars, and are not, like the anterior teeth, preceded by temporary teeth. This, however, will be explained when speaking of the development of the teeth.

Before leaving the descriptive anatomy of the teeth and alveoli, it will be well to consider the form of articulation of the jaw, by which the organs of mastication are made to operate upon the substances submitted to their action.

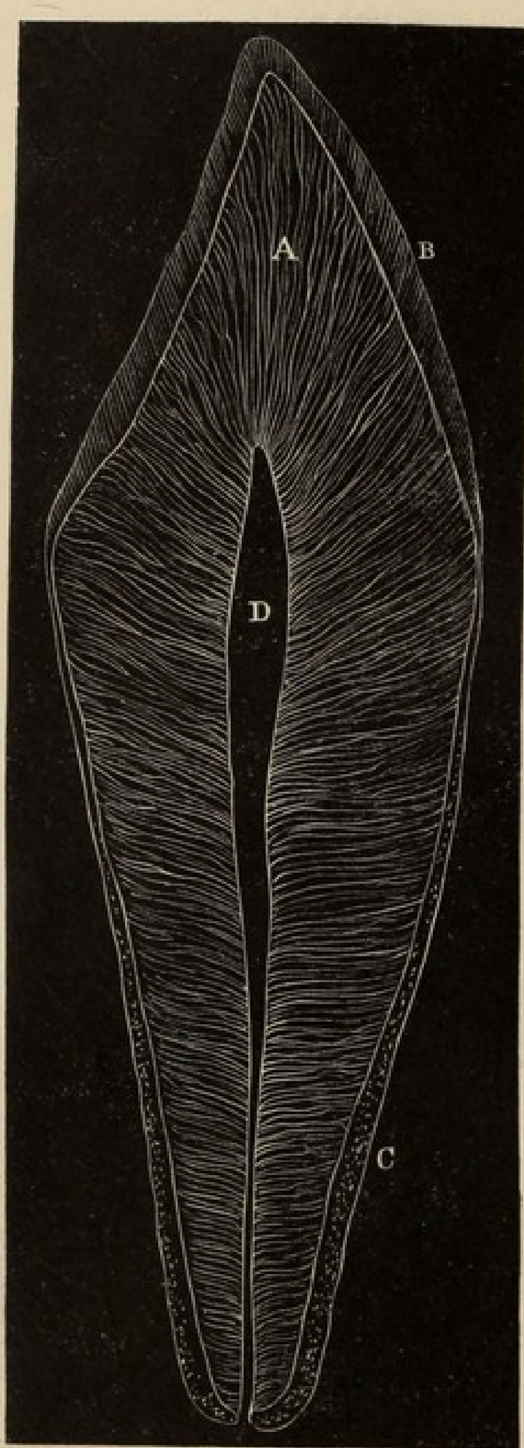
As we have the extremes of form in teeth, the one adapted for simply piercing, the other for grinding, so we have corresponding extremes in form of maxillary articulation; the one admitting of motion in the vertical plane alone, in which articulation the jaw can be opened and closed only, the other allowing motion not only in the vertical, but also, to some considerable extent, in the horizontal plane, in which form of articulation the teeth, being closed upon the food, are moved laterally. In this action, the surface of the opposing teeth rub forcibly upon each other, and reduce to small particles the interposed food. In the carnivora, where lateral motion is not required, the condyle of the inferior maxilla is narrow from behind forward, broad laterally, and is closely embraced by the glenoid cavity, which is not larger than is required for the reception of the condyle. In many of the herbivorous animals, on the contrary, the condyle is broad, from behind forwards, and is received in a large flat glenoid cavity, in which it can move forward and backward as well as upon its axis.

In producing the lateral motion, one condyle is moved towards the posterior margin, and the other is advanced towards the anterior margin of the glenoid cavities. In the human subject is found a form of articulation intermediate between the two extremes, and is thus in strict harmony with the teeth, which are of intermediate development between the carnivora and herbivora.

In the infant, prior to the eruption of the teeth, the maxillary articulation, admits of scarcely any lateral motion, which inability arises from the glenoid cavity being but slightly larger than the received condyle.

In old age, after the loss of the teeth, the lateral motion, from want of use, is much diminished, if not altogether lost. After the loss of the teeth, and the consequent absorption of the alveolar processes, the distance between the chin, and nose,

Fig. 13.



Longitudinal Section of a Canine Tooth.

A. The dentine.
B. The enamel.
C. The cementum. Magnified between four and five diameters.
D. The pulp-cavity.

on closing the jaw, is shortened, and, as ordinarily computed, to the extent of an inch and a half. In this state, when the mouth is opened, the under jaw is seldom depressed lower than to the point which it occupied in the closed state, when armed with teeth. The condyles are, therefore, seldom advanced to the anterior margin of the articular cavity, and, as parts out of use cease to be capable of use, so the absence of necessity for use is followed by inability.

Thus the loss of the teeth operates as a cause in diminishing the power of motion in the aged jaw, first, in destroying the necessity for lateral motion, and secondly in diminishing the amount of the vertical action of the jaw.

The structure of the teeth.—Of the various tissues of which the human frame is built up, none are more beautiful or more instructive to the seekers of physiological knowledge than those forming the teeth; and fortunately, at the same time, none are more easy of demonstration, if the microscope be used in the investigation. As I before stated, the dental tissues are three —namely, dentine, or tooth-substance, enamel, and cement, or, more properly, tooth-bone.

The enamel invests the more prominent parts of the crown, from which points it gradually diminishes in thickness till it terminates in a line on the neck of the tooth. The cement, or dental bone, is thickest at and near the end of the root, and gradually becomes thinner as it advances towards the crown of the tooth. (Fig. 13.)

In a tooth that has been used for some little time, the cement terminates where the enamel commences, but there is reason to believe that a thin layer is continued over the enamel [a]. Of these tissues, dentine, as forming the great bulk of the tooth, and thereby becoming the most important, will first demand our attention.

The pulp-cavity occupies the centre of the dentine, while on its surface are superimposed the enamel and the tooth-bone, the former investing the crown, and the latter the surface of the

[a] NASMYTH.

fang. These two tissues form a layer of variable thickness in different parts of the tooth.

If the enamel and cement be removed from a tooth, and the dentine alone allowed to remain, still the tooth retains much of its original shape, losing most at the two extremities, while, in point of size, the loss sustained is comparatively slight; thus showing the dentine to constitute by far the greater portion of the tooth.

We will now pass to a separate consideration of these three dental tissues.

DENTINE is made up of two distinct parts, *dentinal tubes* and a uniting medium—an *intertubular tissue*. The tubes have distinct parietes, which nearly or quite equal in thickness their calibre, and although usually empty, yet sometimes even in healthy dentine, appear to contain a minutely granulated substance. Their arrangement is radiate, the centre of radiation being the pulp-cavity, or a vascular canal. Each tube commences on and contributes its share to form the wall of the pulp-cavity, or of a vascular canal, from which point it advances in an *undulating* course towards the surface of the tooth; the general direction being nearly rectangular with the surface from which it started. If a single tube be traced through its whole length, it will be found to have made two or three large bends, and in addition to these, which are called the primary curves, a vast number of small undulations; these latter are termed the secondary curves.

Fig. 14.

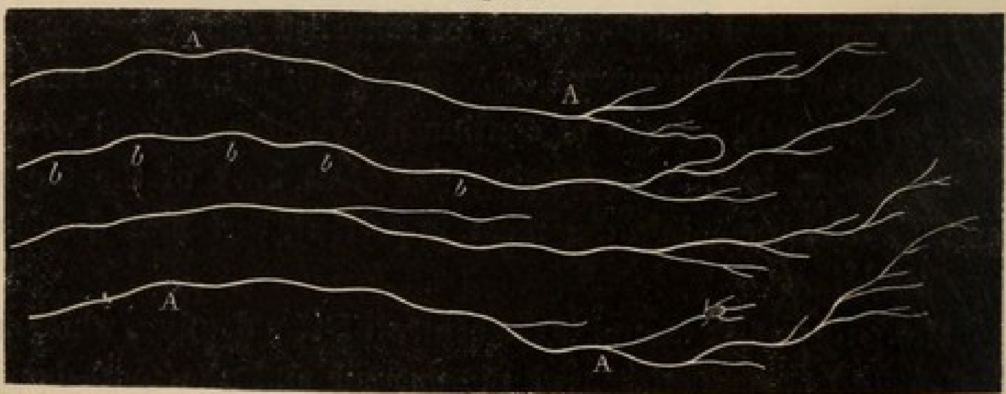


Diagram of the Dentinal Tubes,

Specially in reference to A, the primary curves; and *b*, the secondary curves. The secondary curves are far more numerous than represented in the diagram.

In their course, the dentinal tubes give off branches, and these, meeting with others of similar character, anastomose, and thus form frequent connections, throughout the whole substance of the tooth. The nearer the tubes approach the enamel, or the cementum, the more frequent are their branchings, till at last they terminate either by anastomoses with adjoining tubes, or pass into the external structures,—or else terminate in a dilatation,—or become so extremely minute, that they are lost to the sight. (Figs. 16 and 17.)

Such are the general characters of the dentinal tubes. They are subject, however, to many modifications. Those which pass to the enamel differ slightly, in their comportment, from those which go to the cementum. Then, again, those situated near the end of the fang vary from those near the neck of the tooth.

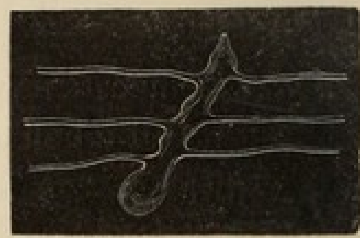
These modifications we must now consider.

The dentinal tubuli of the crown of the tooth are best seen in a vertical section through the pulp-cavity, reduced sufficiently thin to be examined by transmitted light. In this situation, the tubes at their commencement are so closely packed, as to leave but little room for intertubular tissue; as they advance, however, in their divergent course towards the surface, and become further separated from each other, the individual tubes may be traced to their terminations, and the intertubular tissue recognised.

In well-developed dentine, the tubes in the crown of the tooth are distributed at tolerably regular intervals. Those, however, which are destined to pass towards the masticating surface are rather more closely placed at their commencement, than are those which go towards the sides of the tooth. Their divergence is also pretty uniform throughout their whole course; and the primary and secondary curves are well marked. Very few of the coronal tubuli give off branches, till they have arrived close to the enamel: then they divide into two branches, and one or both of these may subdivide, and then terminate; but the subdivision is not constant. The absence of branches from the dentinal tubes in the crown of the tooth constitutes their greatest peculiarity, and also distinguishes the human tooth from most others. In the teeth of many of our domestic animals, the coronal tubuli give off innumerable branches. In the human tooth, too, a few tubes may be found that give off single branches about midway between the pulp-cavity and the enamel. These coronal branches very commonly recurve, and anastomose with similar branches from neighbouring tubes.

Cells are but seldom found in the coronal dentine. They are, however, occasionally met with, and when present are usually large and elongated, and placed at an angle with the tubuli, which latter run into them. The occurrence of cells in this part of the tooth is in well-formed teeth unusual, while, in imperfectly developed teeth, they are very numerous and irregular in size and shape; hence their presence in any case must be regarded as an indication of imperfect development. (Fig. 15.)

Fig. 15.



A large Cell lying across the course of the Dentinal Tubes ;

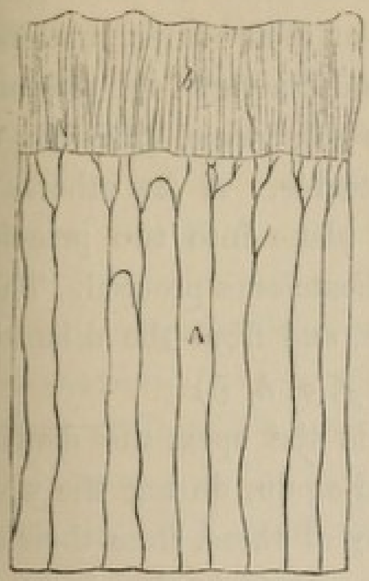
With the tubes entering and corresponding ones passing out, as though continuation of those that entered. From the coronal dentine. Viewed by reflected light. Magnified about 150 diameters.

The coronal tubuli suffer but little diminution in size, till they divide, and then the branches conjointly are larger than the parent tube. Sometimes, indeed, two tubes unite near the enamel, and, from the larger tube so formed, two or three minute ones are given off. (Fig. 17.)

In some specimens, however, the tubes, during the greater part of their course, are subject to slight dilatations. These occurring at short and tolerably regular intervals, and in a number of neighbouring tubes, at similar points in their course, give a striated appearance to a moderately thick section, if viewed by transmitted light. The striæ are of course transverse to the direction of the tubes, and are short, extending, perhaps, across twenty or thirty tubes, and then stop short.

The terminal branches, having arrived at the line of junction between the dentine and enamel, are there lost, or recurve and

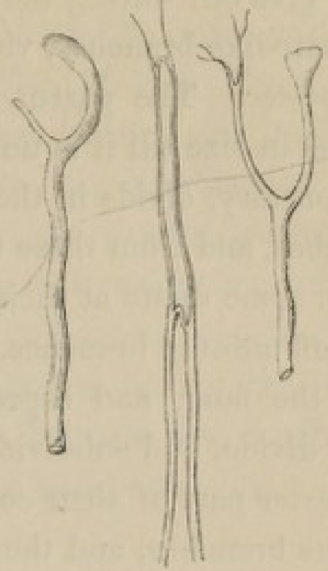
Fig. 16.



A Section of the Enamel and the Dentine at their Junction.

A. The dentine.
B. The enamel. Showing the termination of the dentinal tubes. Viewed by reflected light, and magnified about 100 diameters.

Fig. 17.

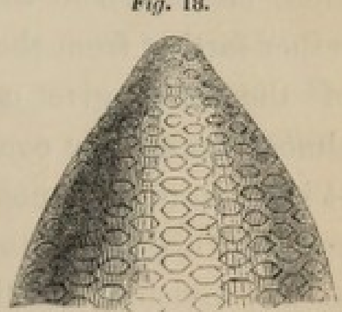


Diagrams showing the Terminations of the Coronal Dentinal Tubes ;

Viewed by reflected light, and magnified about 450 diameters.

anastomose with contiguous tubes, or pass across the line of junction into the enamel, or else end in a dilated extremity near the surface of the dentine. (Figs. 16, 17, and 21.)

Fig. 18.



The Coronal Surface of Dentine previous to the Development of the Enamel ;

Showing the hexagonal depressions which receive the ends of the enamel fibres.

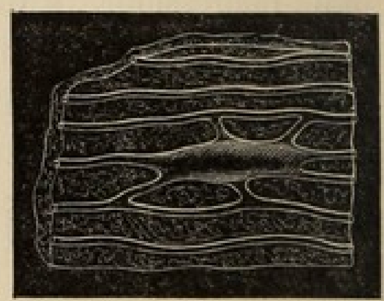
The coronal surface of the dentine, previous to the development of enamel, is marked by numerous shallow hexagonal depressions, while, on the corresponding surface of the pulp-cavity, the open ends of innumerable tubes are found. (Fig. 18.)

In the tubuli which occupy the neck of the tooth, we find the first modification of character from those of the crown, and this increases in degree the farther we recede from the crown, and advance towards the end of the fang. Instead of pursuing an uninterrupted course, till within a very short distance of the termination of the dentine, and then dividing into two secondary branches, like those of the crown, the tubes of the neck of the tooth give off, during the latter third of their course, numerous fine hair-like branches, visible only under a very high magnifying power. The parent tube, at the same time, gradually decreases in size till it is no longer traceable. A few others, on the contrary, divide in the horizontal plane into two principal branches, and from these the more delicate ones proceed. Then, again, some dilate at their extremities, and from the dilatation give off minute branches. (Fig. 21, *f*, *g*, *h*, *i*.)

In the fang, and especially towards the apex, the dentinal tubes divide, and subdivide, again and again, during the whole or greater part of their course. Many of these, from their numerous branches, and the small angle at which they leave the parent tube, resemble a leafless branch of willow. Sometimes the branches are given off from one side only of the parent tube; more commonly, however, they proceed from both sides. In other cases again the primary tube gives off alternate minute branches from each of the secondary curves, and from these again even lesser branches start.

The tubes situated in the middle part of the fang, usually begin to throw off branches in about the middle of their course; those situated near the neck of the tooth commence dividing rather farther from the pulp-cavity, while others near the apex of the fang give out branches almost from their commencement. It is by no means uncommon, however, for a primary tube, previous to any division, to dilate, receive branches from other primary tubes into the dilatation, again contract, and resume its original course. (Fig. 19.) The division into secondary branches, as stated by Mr. Bowman, occurs mostly in the horizontal plane.

Fig. 19.

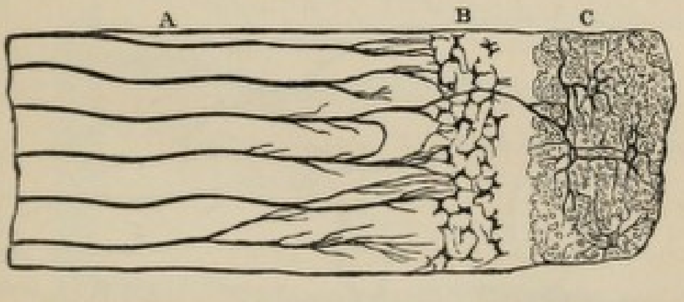


A Longitudinal Section of Dentine, as viewed by Reflected Light:

Showing a dentine tube, dilated, and forming communications with contiguous tubes. Taken by the camera lucida. Magnified about 350 diameters.

In the fangs of teeth, the anastomosis between the tubes is far more frequent and general than in the crown. The occurrence of radiating cells (similar to the cemental cells) amongst the tubes, and especially towards the outer surface of the dentine, is not uncommon. (Fig. 21, *h.*) The terminal branches of the dentinal tubes, that occupy the neck and fang of the tooth, are either lost in the intertubular tissue, or they may be traced into radiating cells situated amongst the tubes, or terminate by anastomosing with adjoining tubes, or else pass into the interspaces that exist between the large granules that form the outer surface of the dentine of the fang, or they pass across the line of junction between the dentine and cementum, and communicate with the cemental cells.

Fig. 20.



A Longitudinal Section of Dentine and Cementum, as viewed by Transmitted Light.

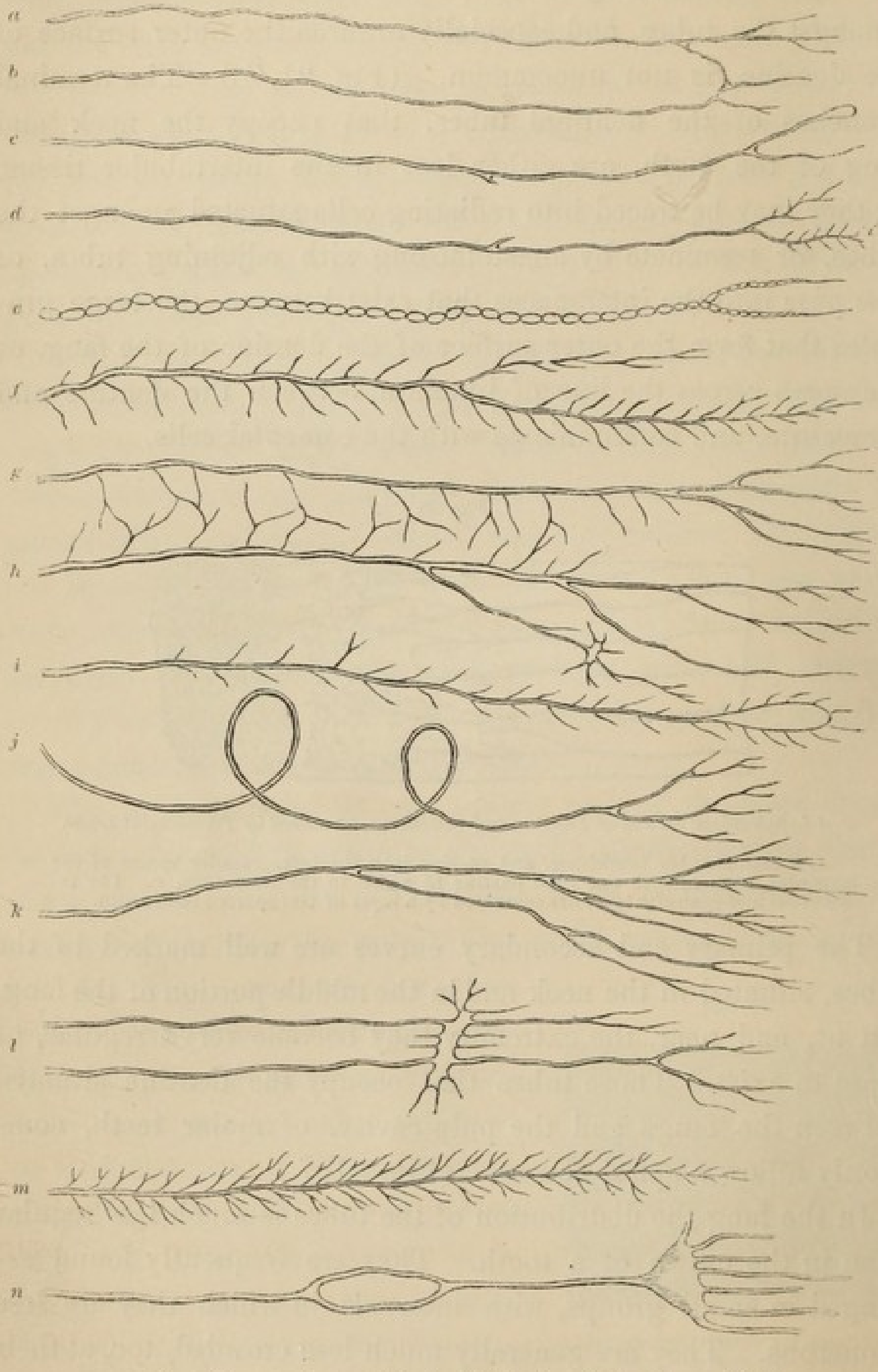
A. Dentinal tubes branching, and passing into the intergranular spaces of the granular layer B, with one tube passing to a cell in the cementum C. The cementum and granular layer are separated by a layer of transparent cementum.

The primary and secondary curves are well marked in the tubes, situated in the neck and in the middle portion of the fang, but at, and near, the extremity they become very irregular, or cease to exist. Those tubes that occupy the dentine situated between the fangs and the pulp-cavity, of molar teeth, commonly follow a spiral course. (Fig. 21, *j.*)

In the fang the distribution of the tubes is much less regular than in the crown of a tooth. They are frequently found arranged in small groups, with intervals in which they are less numerous. They are generally much less crowded, too, at their commencement in the pulp-cavity in the fang, than in the crown.

I have told you that the point of greatest diameter of the dentinal tubes is at their commencement on the walls of the pulp-

Fig. 21.



A few of the many forms of Dentinal Tubes found in the Human Tooth.

a, b, c, d. Tubes from the coronal dentine.
e. A tube marked by transverse indentations, arising probably from imperfect development.
f, g, h, i. Tubes from the upper and middle portion of the fang.
j. A spiral tube from between the fangs and the pulp-cavity.
k, l, m, n. Tubes from near the end of the fang.

cavity, though, in their course previous to the division of the trunk into branches, they suffer but little loss in calibre.

When measured by the micrometer, the internal diameter of the largest tube is about the $\frac{1}{10000}$ of an inch, and the diameter, including the parietes, $\frac{3}{10000}$ of an inch. The dentinal tubuli, when examined in their length with a low magnifying power, and by transmitted light,—that is, when the object is placed between the light and the eye,—appear as dark lines; but, if a high power be used, then they are marked by two dark lines, with a narrow line of bright light interposed. In some few instances, the light appears to be prevented from passing through the central line of the tube, by the presence of granular matter in its interior, but it is an exception to the usual condition.

Fig. 22.

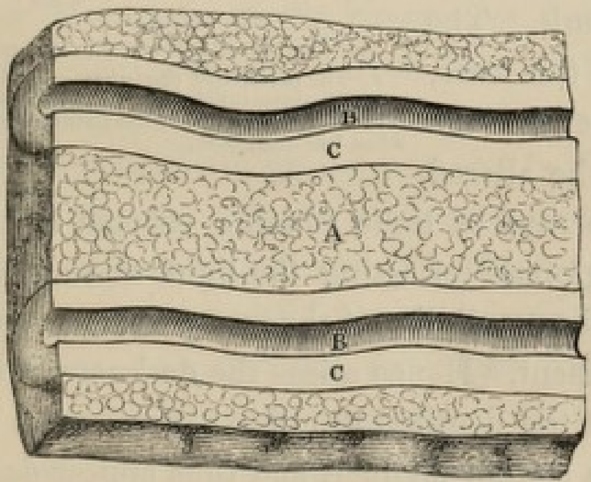


Diagram of a Longitudinal Section of Dentine, from a Human Tooth.

A. The intertubular tissue composed of coherent granules.
B, B. The interior of the tubes laid open.
C, C. The parietes of the tubes, showing the tube tissue. Magnified 1000 diameters.

In many animals, especially in fish, the tubes are so large, that this appearance of a light and two dark boundary lines is seen even with a low magnifying power. The teeth of the wolf fish afford a good example. If, in human dentine, a transverse section of the tubes, at their commencement, be viewed with a high power, the ends of the tubes will be seen; the area and the parietes, with the surrounding intertubular tissue. (Figs. 22 and 23.)

The dark line so constantly seen with a low power is, I think, no proof that solid matter is contained in the tube, for the appearance described may be exactly imitated by introducing minute globules of air into a fluid, and then placing it on the field of the microscope, when, by transmitted light, each air globule will be bordered by a dark line, while the centre is light. If the globule of air be very small, it will appear altogether dark. The dark line, in this case, is dependent for its origin upon the altered course of the rays of light, which is effected by the curvilinear form of the globule refracting the light at such an angle, that it precludes the possibility of the rays passing through the lenses of the instrument. Hence arises the darkness of the object. I conceive that the dentinal tubuli, when occupied by air, refract the light in a similar manner, and thus appear dark.

Fig. 23.

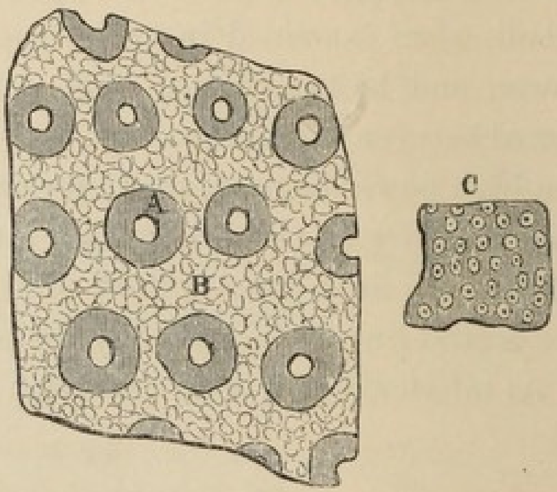


Diagram of a Transverse Section of Dentine.

A. The parietes of the tubes.
B. The intertubular tissue. Magnified 1000 diameters.
C. The appearance of the tubular and intertubular tissue when less magnified.

If the dentinal tubes be examined by reflected light—that is, if the section be placed upon a dark ground, and the light be made to fall upon it instead of passing through, as in the former experiment—then the tubes will be seen as opaque white lines placed in a transparent medium. This appearance would at first sight seem to indicate, that the tubes are filled with solid granular contents; however, in this as in the former instance, the appearance can be imitated without the presence of granular matter. If a transparent substance, as glass, be taken and reduced to powder, and the powdered mass be examined by reflected light, it will appear as an opaque white substance, studded with transparent particles. In this instance the opacity is clearly due to the reflection from the minute particles being at such angles that the rays of light pass external to the field of the glass. The dentinal tubes have, probably, a similar effect on the light.

But they may be rendered perfectly transparent if filled with transparent substances of greater density than air. This may be effected by immersing sections in Canada balsam, or spirits of turpentine. In each of the foregoing methods of demonstrating the dentinal tubes, the areas only are seen; but if a section be taken external to, but parallel with, the length of the pulp-cavity, (in which cases the tubes will be cut transversely,) then the parietes of the tubes will be seen with the intertubular tissue, in which they are impacted. (Fig. 23.)

In the year 1837 I was engaged in examining the structure of teeth, and then came to the conclusion that the dentinal tubes contained an amorphous salt of lime. My opinion was grounded on the following experiment:—After preparing a thin section of human tooth, I placed it in the field of the microscope, and then added a little diluted muriatic acid. No sooner was the acid in contact with the section, than evidence of chemical action was rendered visible by the appearance of bubbles of gas, and these emanated not only from the external surfaces of the section, but also from the interior of the tubes, from which bubbles of gas were seen issuing in quick succession. When the action ceased, the tubes no longer presented the appearance of opaque dark lines, but were indistinctly seen filled with transparent fluid.

At the time, much struck with the result of the experiment, I was led to the opinion, that the gas generated in the tubes was produced by the decomposition of their solid contents, which I supposed to be carbonate of lime; however, upon more extended observations, I was induced, from the examination of teeth in which the tubes are large, and also from the examination of the tubuli of the human tooth with a high power, to modify my first opinion, and was compelled to adopt the views advanced in the former part of the lecture, and to regard the evolution of gas from the tubuli as evidence of the facility with which fluids are admitted into their interior, and to consider that the source of the gas existed in the decomposition of the parietes of the tubes rather than of their contents.

I have since found that, by a little management, fluids, when added to a dry section already in the field of the microscope, may be seen entering and traversing the tubuli.

In the temporary, and not unfrequently in the permanent teeth, the tubes, instead of presenting an uninterrupted line, present on their surface numerous indentations, just as though they were composed of a series of hollow beads, which were united and made to communicate with each other by small apertures. (Fig. 21, *e.*) This appearance has led Mr. Nasmyth to conclude that the teeth instead of being composed of tubes are made up of baccated fibres[a]; of these he gives a drawing, separated from the intertubular tissue and from each other. This appearance, however, admits of another explanation, which will be given after the development of the dentine has been explained.

In the teeth of old people that have fallen out without being decayed, the fangs, or some parts of them, are commonly translucent, like horn. If a section through these parts be examined, it will be found that the dentinal tubuli have become filled with solid matter, similar in character to the surrounding tissue. The tubes can scarcely be recognised. The whole mass is equally transparent, and closely resembles a section of healthy dentine, which has been thoroughly permeated by Canada balsam, or bees' wax.

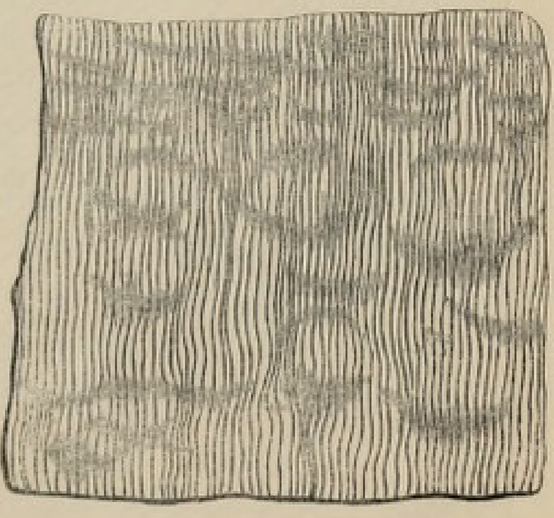
In tracing the structure of dentine in the teeth of various animals, we find the dentinal tubes assume every conceivable form of branching; sometimes the branches are few, in others extremely numerous. In one instance given out from one side of the tube only, in another from each side; but, whatever the modification in the number or form of the branches given out, the primary tube always commences by an open extremity

[a] *Memoir on the Development of the Teeth, by* ALEX. NASMYTH. 1842.

on the walls of the pulp-cavity, or upon the walls of a canal for a blood-vessel; and the direction taken by the tubes is invariably a direct line from the surface on which they have commenced; and where new branches are thrown out there is frequent anastomosis between them. This holds good in every tooth, and in all parts of each tooth, that I have examined.

In many sections of dentine a faint appearance of a coarse reticulated structure will be seen. It looks as though the elements of the pulp had been held together by an areolar tissue, composed of laminæ with circular interspaces; and that this tissue had become calcified with the pulp. If it were withdrawn from the other elements of a tooth, it would then closely resemble cancellous bone. In a very finely developed tooth, the appearance in question is not seen, or if seen, but very dimly; but, in those of more faulty formation, it is in places distinct. The tubes do not seem to be in any way interfered with; they pass on uninterrupted. Mr. Owen has described an appearance which slightly resembles this; he supposes the dentinal pulp to have consisted of large cells, and that their shadowy outline may be seen in the dentine[a].

Fig. 24.



Dentine, with faint Areolar Markings.

It is, I think, more probable that the areolar markings are connected with a tissue that is subject to imperfect development, or is abnormally persistent in those of defective constitution.

Before going farther, I must bring to your notice a very curious and important condition of the dentine, probably consequent on imperfect development of the tissues of

[a] *Odontography*, p. 463.

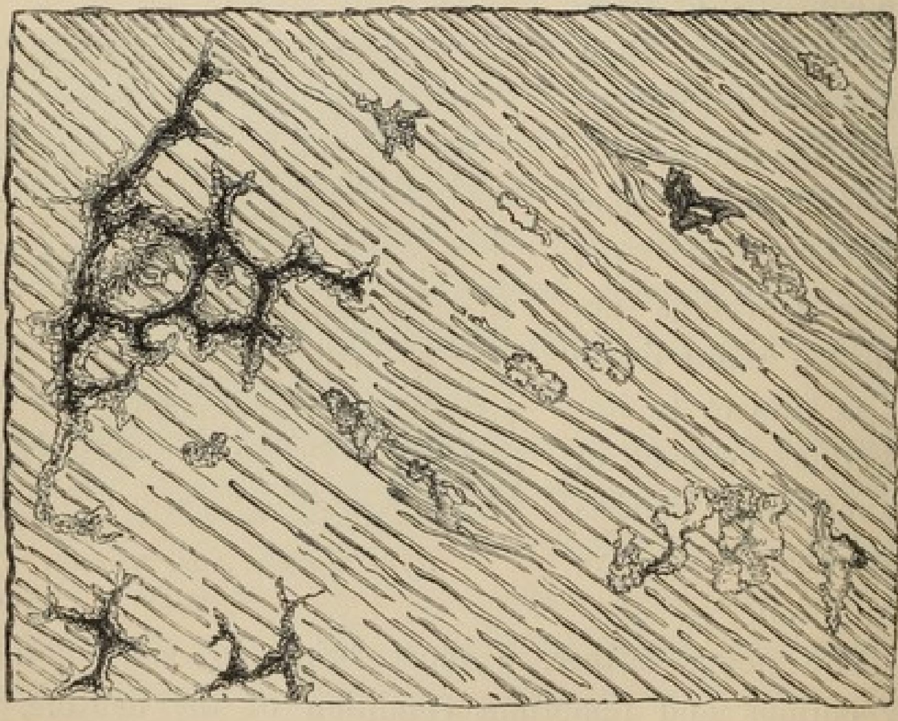
the dentinal pulp. For it is present in teeth that bear external marks of defective formation. Such are found in those of strumous diathesis, and are usually distinguished by transverse grooves, or other irregularities in the shape and surface of the crown, and by discolouration and opacity of the enamel. In teeth possessing these characters, the dentine is occupied by large irregular cavities, arranged in a line, parallel with the outer surface of the tooth, or scattered through the whole mass. The cavities are in form, such as would exist between spherical bodies of various sizes, placed so as to touch each other only at points. Their boundary lines are, therefore, circular, or segments of circles of unequal dimensions. In some teeth these cavities are so numerous that a tolerably thin

Fig. 25.

A Molar Tooth from the Lower Jaw,

The surface of which is indicative of imperfect formation of the dental tissues, and especially of the dentine and enamel. This specimen was taken from a strumous girl, of 15 years of age, and exhibits in an unusual degree the external signs of imperfect development of the tissues.

Fig. 26.



A Longitudinal Section of Imperfectly Developed Dentine, as seen by transmitted Light.

In this specimen the tissue is occupied here and there by large irregular cells. The surface of the tooth from which this was taken resembled that expressed in Fig. 25.

section is thereby rendered quite opaque. The surface of the walls is nodulated by the granules of the intertubular tissue. This, with the peculiar form of the cavities, completely obstructs transmitted light; hence their dark appearance. On some occasions the cavities have become filled with Canada balsam during the examination, and then the interiors could be seen. In extremely thin sections, one wall may alone remain, which then is perfectly transparent, even more so than the surrounding tissue. The dentinal tubes either terminate in these cavities, or turn out of their way, and pass by them [a]. (Fig. 26.)

In old, long worn teeth, these peculiar spaces are generally absent; in most teeth that have decayed they are present in a greater or less number, while in those that decay early in life they are abundant.

In a tooth that I removed from a great sufferer from rickets, the cavities existed in every part of the dentine; more commonly, however, they occupy the crown only, and in a narrow contour line, not far distant from the enamel.

The temporary are not more exempt than the permanent teeth from this faulty condition of the dentine.

The first permanent molars are more frequently the subjects of this condition than any other teeth.

Dentine that is hollowed by these abnormal cavities is much lighter than that which is well formed, and, after being dried, will absorb one-fifth more water.

When we come to the development of the dental tissues, these points will again occupy our attention; and will a third time come before us, in connection with the subject of dental caries.

[a] Mr. Owen possibly alludes to this condition in *Odontography*, p. 464. If so, his views, both as to the nature of the structure and its producing cause, are quite at variance with those, which a close investigation of the subject has compelled me to adopt.

LECTURE III.

THE INTERTUBULAR TISSUE.—CAVITIES IN THE INTERTUBULAR TISSUE. —VASCULAR CANALS IN DENTINE.—CONVERSION OF THE PULP OF OLD WORN TEETH INTO DENTINE.—EFFECTS OF MADDER ON DENTINE. — CHEMICAL ANALYSIS OF DENTINE.—STRUCTURE OF THE ENAMEL.—STRUCTURE OF THE CEMENTUM.—RELATIONS OF THE DENTAL TISSUES TO EACH OTHER, AND TO BONE.

At our last lecture we were engaged in considering the dentinal tubes; we shall now give our attention to the uniting medium of the tubes.

The second part composing the dentine is the intertubular tissue, which occupies the spaces between the tubuli, every where surrounding and investing them, and thereby contributing greatly to render the whole dentine a solid dense mass, the area of the tubes and cells being the only hollow portions. It would be difficult to estimate, beyond mere guess, the relative amount of this structure in a tooth, as distinguished from the parietes of the tubes, since the quantity varies somewhat in different parts of a tooth. Thus in the coronal dentine, near the pulp-cavity, the tube-tissue preponderates, while in the dentine, near the surface of the fang, the intertubular tissue forms the larger element.

In a section either of the crown or of the fang, made near the pulp-cavity, so as to cut transversely the dentinal tubes, before they have

Fig. 27.

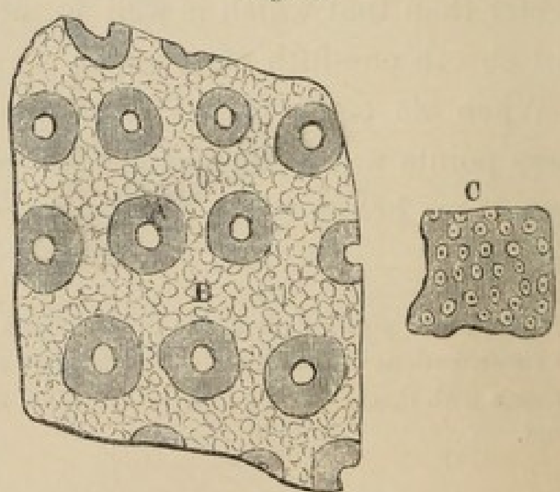


Diagram of a Transverse Section of Dentine.

A. The parietes of the tubes.
B. The intertubular tissue. Magnified 1000 diameters.
C. The appearance of the tubular and intertubular tissue when less magnified.

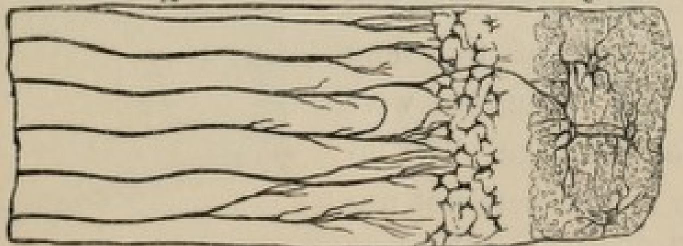
suffered any diminution in size, the intertubular tissue may be plainly distinguished from the parietes of the tubes. If, however, the section be extremely thin, the recognition will be difficult; or, if acid be added to the section, then the distinction will be lost, though before the addition it was ever so plain.

The intertubular tissue is itself made up of minute granules, closely united. (Fig. 27.)

In the dentine situated near the pulp-cavity, a granular appearance can alone be recognised, and even this can scarcely be seen in some specimens. Near the periphery of the dentine, however, the granularity is more marked, and the individual granules may be seen and even measured. They are spherical, somewhat irregular in size, varying in different specimens, and in the same specimen, from the $\frac{1}{10000}$th to the $\frac{3}{10000}$th of an inch in diameter. The granules are united to each other by the interposition of a second substance, which is recognisable only at those points where from their spherical form the granules do not touch each other.

At and near the surface of the fang, when the tubes have become very small in size, the uniting medium is often partially absent, hence we have intergranular spaces, of such form and size as would occur between partially united spherical granules. In addition to these we have a few oval branching interspaces.

Fig. 28.



A Longitudinal Section of Dentine and Cementum, as viewed by Transmitted Light.

A. Dentinal tubes branching and passing into the intergranular spaces of the granular layer, B, with one tube passing to a cell in the cementum C. The cementum and granular layer are separated by a layer of transparent cementum.

These intergranular spaces give to this part of the tooth a general appearance of granularity; so that in viewing a section through the pulp-cavity, in the length of the tooth, on looking to the fang, we see at first sight the dentinal tubes.

These diminish in size, are succeeded by a layer of granular-looking tissue, and lastly comes the cementum, which forms the surface of the fang.

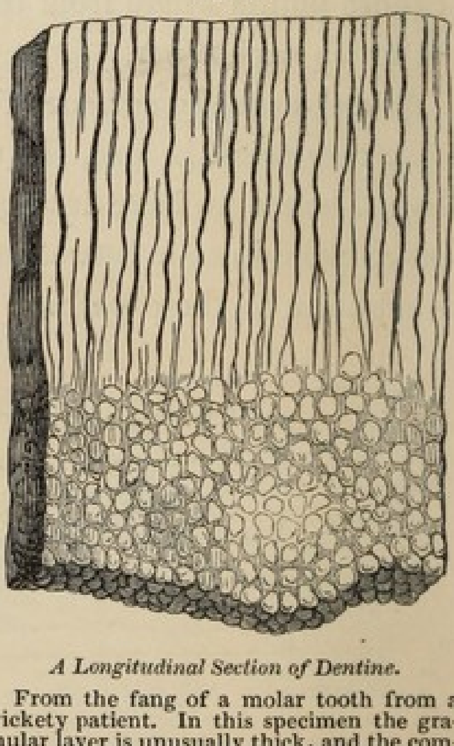
In a paper read before the Royal Society in June, 1838 [a], I described the peripheral dentine of the fang, as the granular layer of the fang.

With the intergranular cells many of the terminal tubes communicate, as do others that come from the cemental cells. There does not, however, seem any recognisable provision for direct communication between the cells themselves; though in many instances they run into one another, yet in others they do not; and then, we do not find branches thrown out to establish a connection.

This point will, however, be further examined when the relations of the dental tissues are considered.

From a girl 18 years of age, who had, — and still suffered from rickets, I removed a first molar tooth of the lower jaw. On examination, it was found that the fangs had no cementum —that they were composed of dentine alone. In this tooth, the intertubular tissue was every where distinctly granular, and near the surface of the fang the individual granules were very distinct and large. The intergranular spaces were not numerous. The surface of the dentine of the fang, and hence of the fang itself, in this peculiar case, is nodulated. (Fig. 29.)

Fig. 29.



A Longitudinal Section of Dentine.

From the fang of a molar tooth from a rickety patient. In this specimen the granular layer is unusually thick, and the component granules large, while the cementum is altogether absent.

We have seen that the parietes of the pulp-cavity, under

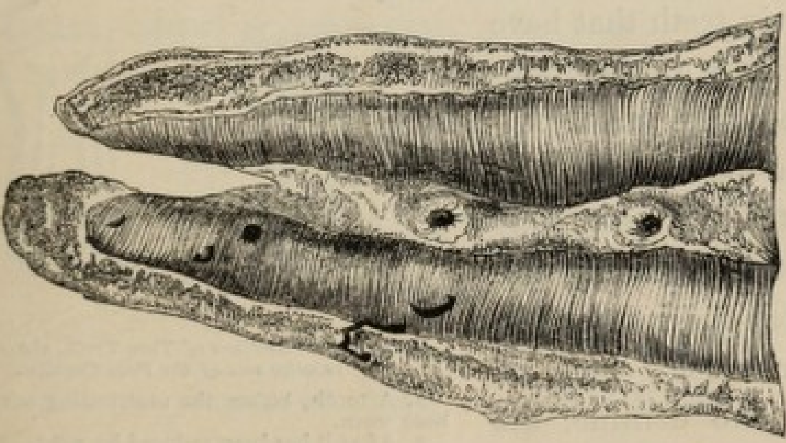
[a] *On the Structure of Teeth, the Vascularity of those Organs, and their Relations to Bone.* By John Tomes, Esq.—*Proceedings of Royal Society*, June 21, 1838.

a high magnifying power, present a surface perforated by innumerable minute pores, each pore being surrounded by a circular line, and a tissue intervening between the circular lines of the various pores. The coronal surface, on the contrary, presents a series of minute depressions of hexagonal form. In addition to these, this surface is marked by larger undulations. Into the minute depressions the ends of the fibres of the enamel are received.

At present, the dentinal tubes and cells, and the pulp-cavity, have alone been described as existing in the dentine; but, in addition to these, we have, in many instances, canals for vessels traversing the tissue, just as we have the Haversian canals perforating bone. In the teeth of man, these vascular canals are never numerous, and occur only in a few specimens. I have seen eight or ten sections only in which the dentine is vascular.

At the present time I have several such specimens in my possession. Generally the vascular canals pass through the fang, from the outer surface into the pulp-cavity, or vice versâ. In one case

Fig. 30.

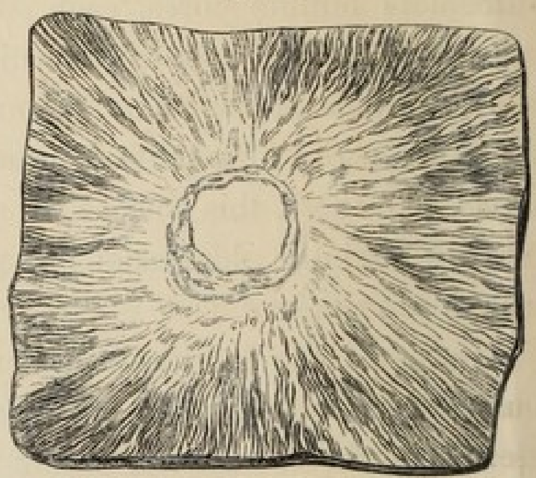


A Longitudinal Section of the Extremity of the Fang of a Tooth
In which the dentine and cementum are pierced by vascular canals. The cementum is unusually thick.

I found a canal passing through the dentine that lies between the fangs of a molar tooth, into the body of the pulp-cavity. In each instance, many of the neighbouring dentinal tubes have terminated by open mouths on the surface of the canal, and in one case the canal was clothed on one side with a thin layer of cementum. (Fig. 31.)

In some animals, however, teeth are found in which the dentine is, in all cases, vascular; the teeth of the walrus offer an example, as do those of the kangaroo and the rabbit. In those instances of vascular canals traversing human dentine, which have come under my observation, their direction has been from the pulp-cavity towards the surface of the root of the teeth. It must be borne in mind, that at present we have been speaking of the dentine alone, and not of the cement, which is generally vascular.

Fig. 31.

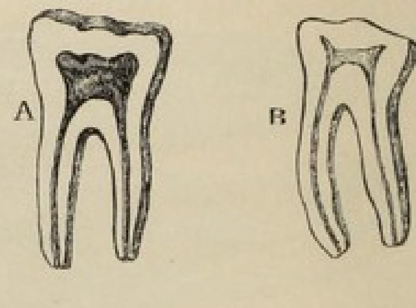


A Section of Dentine from the Middle Portion of the Fang, external to the Pulp-Cavity,

Traversed by a vascular canal, one-half of the circumference of which is lined with cementum. Viewed by transmitted light, and magnified about 150 diameters.

In the teeth of old persons, or in teeth that have been much worn, the pulp-cavity becomes greatly diminished in size, or wholly obliterated, by what may be called a secondary development of dentine. The pulp, in such cases, is formed into dentine, the new uniting or not with the previously formed tissue. Such dentine is usually traversed by vascular canals, around each of which the characteristic branching tubuli are arranged radially, as those of the body of the tooth were arranged round the pulp-cavity. (Fig. 33.)

Fig. 32.

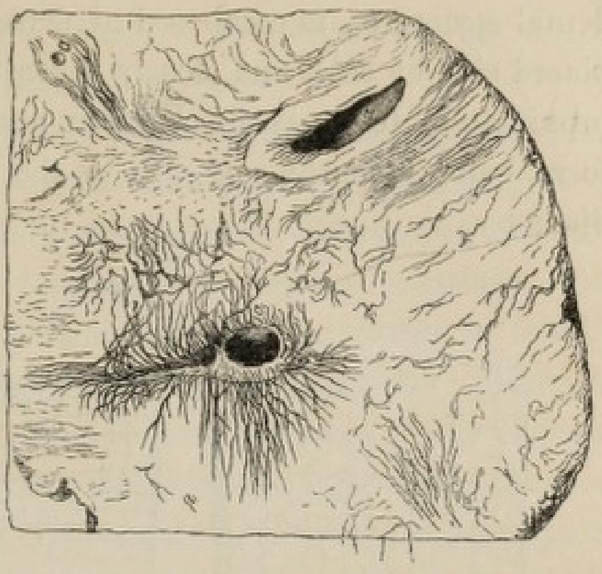


Longitudinal Sections of Two Teeth, showing the relative size of the Pulp-Cavities.

A. A tooth, before the masticating surface has been worn.
B. After it has been reduced by wear.

Like bone, the dentine is coloured by feeding the animal on madder. After mixing a large proportion of madder in the food of a young pig about six weeks old, for a period of three

Fig. 33.



Section of newly formed—or secondary Dentine, from the Pulp-Cavity of a curious Tooth.

a, a, a. Vascular canal in the dentine. The dentine from which this was taken closed up an opening into the pulp-cavity, occasioned by caries, and is similar to that which fills the pulp-cavity when the crown is worn.

weeks, the animal was destroyed, and the teeth, on examination, were found deeply coloured. A section showed that the dentine of the pulp-cavity, as well as the cement of the surface of the fang, had been equally affected with the osseous tissue of the skeleton. But I could not discover that the colour extended further in the tubular than in the inner tubular tissue. Neither did the opaque line which marks the interior of the tubes, as seen by reflected light, seem coloured.

Chemically, the dentine is, according to Bibra, composed of the following organic and inorganic substances.

DENTINE.

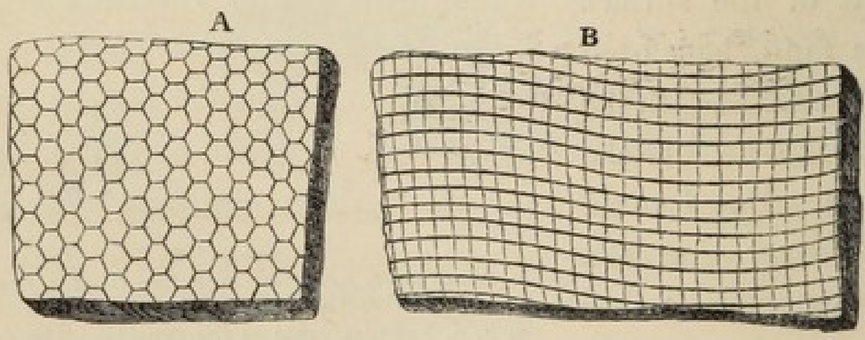
Incisors of an adult Man.

Organic substances	28·70
Inorganic substances	71·30
	100·00

	Molars of an adult Male.		*Of a Female aged 25.*
Phosphate of lime, with a trace of fluate of lime .	66·72	..	67·54
Carbonate of lime . .	3·36	..	7·97
Phosphate of magnesia .	1·08	..	2·49
Salts	0·83	..	1·00
Cartilage	27·61	..	20·42
Fat	0·40	..	0·58
	100·00		100·00

Structure of the enamel.—The enamel, the hardest of the dental structures, is composed of dense semi-transparent fibres, placed side by side, and closely united. Their form is an approximation to a six-sided prism, and their size tolerably uniform, being from the $\frac{2}{10000}$th to the $\frac{3}{10000}$th of an inch in diameter.

Fig. 34.



Sections of Enamel.

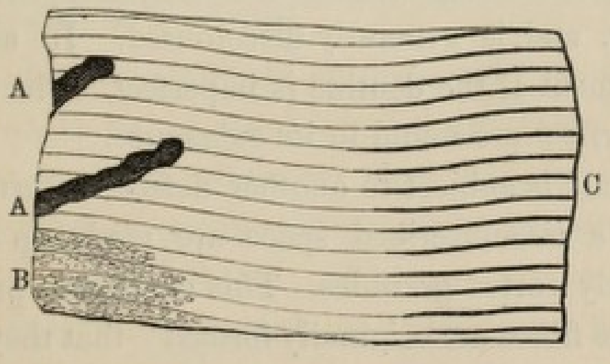
A. Transverse section, showing the hexagonal form of the fibres.
B. A longitudinal section, showing the fibres in their length, and the transverse markings, viewed by transmitted light. Magnified 350 diameters.

The direction taken by the enamel fibre is, for the most part, vertical to the surface of the dentine upon which it rests; those, therefore, which proceed from the flat surface of the crown, will rise vertically, while those from the lateral surface of the tooth will be horizontal. Where the coronal surface of the dentine is concave, the enamel fibres of the opposite sides of the concavity form with each other angles, and meet at their external ends, or are bent out of their course. This juncture is frequently imperfect, and leaves a fissure, under which the dentine, being less protected from external influence than on the other parts of the crown of the tooth, is more frequently attacked by disease. The fissures on the crown of the molars are often subject to this defect of development. The ends of the enamel fibres are received into the shallow hexagonal depressions of the coronal surface of the dentine, from whence, in their course, they describe frequent curves. Neither are the curves in one plane only; on the contrary, where the enamel is thick, the fibres are bent about in each direction. Near the neck of the tooth where the enamel is thin a single fibre may be traced through its whole course. There it makes but one or two curves, and these mostly in one plane.

The direction taken by neighbouring fibres is not, however, at all times perfectly parallel; indeed, they often diverge, or cross each other at considerable angles. Presuming that the fibres that start from the surface of the dentine continue their course to the surface, large spaces would necessarily be left by their divergence. No such space, however, exists. Fibres of shorter length exist and occupy these positions. The curves, also, seem less regular than those formed by the dentinal tubes. Near the dentinal surface of the enamel, small linear interspaces not unfrequently exist between the fibres. With these the terminal branches of the dentinal tubuli often communicate.

In the same situation we commonly find elongated cavities, of irregular outline, larger than the enamel fibres themselves, and lying at angles with them. (Fig. 35, A.) Such cells

Fig. 35.



Section of imperfectly developed Enamel, viewed by Transmitted Light.

A. Large cell near the coronal surface of the enamel.
B. Granular fibres.
C. Imperfect union of the fibres.

are common in old worn teeth. Hence their presence cannot be detrimental.

The enamel fibre is not in all cases solid, but has running through the whole, or part of its length, an extremely minute cavity. This is best seen in newly developed enamel, but a trace of the canal may sometimes be seen in that of adult teeth. Interposed between the fibres of the tissue under consideration, are the remains of the membrane in which the development has taken place, and which, when hardened by the reception of earthy matter, serves to connect the fibres. This tissue, however, is not traceable except in imperfectly developed enamel, unless by the aid of acids.

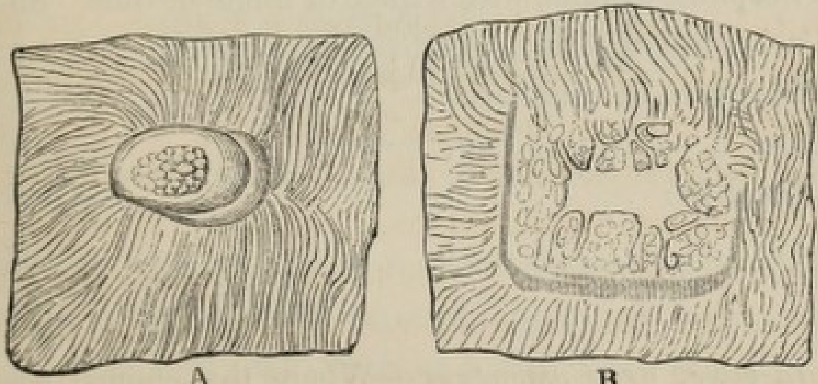
The individual fibres of the enamel appear to be developed in sheaths of membrane, and united to each other by the adhesion of the sheaths and subsequent calcification of the membrane, in common with the enamel fibre itself. When the development is perfect, the lateral union between the fibres is marked by fine delicate lines; but, when imperfect, the lines are large and course, and the enamel has an opaque, opaline appearance, or else is discoloured. (Fig. 35, c.) The imperfect union occurs in patches, sometimes small, sometimes large, in one case, following the course of a bundle of fibres, from the dentine to the surface of the tooth, in another, stopping short of the surface.

The teeth in which this imperfection of development exists in a considerable degree have the external appearance of being ill-formed. The surface of the enamel is irregular, pitted, or grooved transversely, and is generally discoloured. In all such cases the development of the dentine is imperfect. The large cavities I have described are found in its substance.

The enamel is subject to another defect of formation. The fibres over a circumscribed space are made up of ununited, or imperfectly united granules. This condition, probably, indicates how the fibres are originally formed—that they are made up of innumerable minute granules united and rendered one substance, and then made solid by the addition of the earths. While in the case before us the lime may have been added before the granules had united, and afterwards the power of union had ceased. (Fig. 35, b.)

I have yet to notice another peculiarity in the condition of the enamel. In several sections, cavities of irregular form have been found in the substance of that texture. In one example the fibres radiate from it; in another, they are broken up into large granules in its neighbourhood, while in other specimens their course is interrupted. But in most instances the enamel about these cavities is discoloured, and the discoloration extends towards the outer surface; and in one there is considerable disorganisation, extending to the surface, which is broken down, thus marking the existence of decay. These, with other faulty conditions of the dental tissues, will fall more directly under our notice, when we treat of the predisposing causes of caries.

Fig. 36.



Section of imperfectly formed Enamel, viewed by Transmitted Light.
A. A cell containing granules, with the enamel fibres radiating from it.
B. A radiating cell, surrounded by granulated enamel, with a radiate arrangement of the surrounding enamel fibres.

Mr. Owen has described the occurrence of layers of cells in the dentine which follow the external form of the tooth; these he calls contour lines. Contour lines are also found in the enamel, and are here produced by a slight imperfection in the union of the enamel fibres. If these exist to any extent, either as to number or strength, the tooth must be regarded as of imperfect development.

Transverse markings are usually observable upon the surface of the enamel fibres, but they are sometimes indistinct. Their nature, though little understood, is probably connected with the development of this substance. They occur at pretty regular intervals, but these vary in extent in different specimens; the average interval is about the $\frac{2}{10000}$th of an inch. Though generally transverse, like the striæ of muscle, they are sometimes oblique (Fig. 34, B.), and, in a few specimens that I have examined, obviously depended on alternate dilatations of the individual fibres. An appearance resembling transverse lines is frequently seen in a specimen, that is traceable to the obliquity of the section, by which lines at equal distances are formed by the cut edges of the enamel fibres.

The enamel in the incisors yields to chemical analysis 3·59 of organic, and 96·41 of inorganic matter.

ENAMEL.

Molars of an Adult.

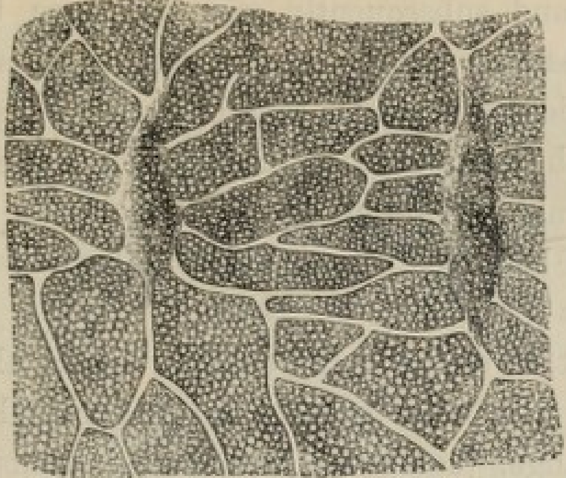
Phosphate of lime, with a trace of fluate of lime	89·82
Carbonate of lime	4·37
Phosphate of magnesia	1·34
Salts	0·88
Chondrine	3·39
Fat	0·20
	100·00

Tooth-bone, or Cementum.—Where the enamel ceases to encase the dentine, the cement commences in a layer, gradually increasing in thickness to its termination at the apex of the root. Though, as before stated, a very thin coating is continued over the crown of the tooth investing the enamel; yet the amount is so small (and even this disappears so quickly after the tooth comes into use) that its existence may be regarded rather as rudimentary, than as holding any importance in the human teeth [a]. In many animals the cement is continued over enamel in a thick layer, and acts an important part in uniting into a solid tooth a series of lesser ones, or in filling up spaces between highly developed tubercles, and thus producing a continuous surface. The molar teeth of the elephant afford us a good example.

In structure, the tooth-bone, or cement, is similar to osseous tissue, its substance being composed of minute granules closely united. The individual granules are about the $\frac{1}{10000}$th of an inch in diameter.

[a] *Memoir* read before the Medico-Chirurgical Society, by ALEXANDER NASMYTH, Esq., January 22, 1839.

Fig. 37.

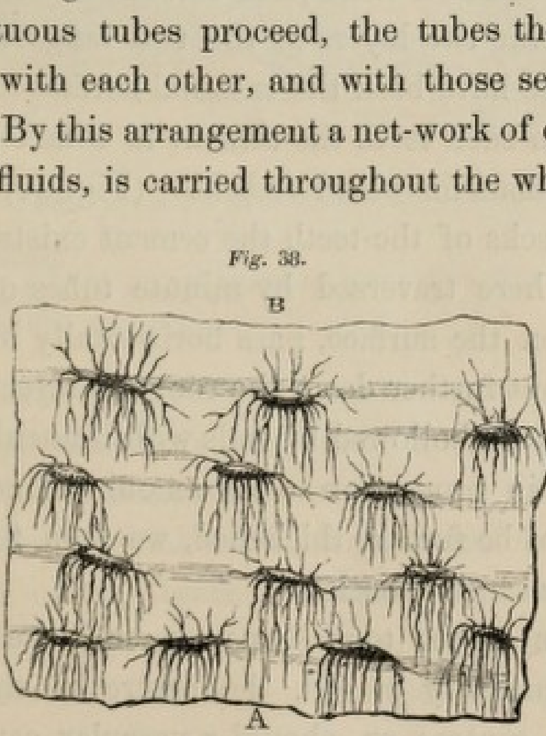


A Section of Cementum,

Showing the cells and their branches, and the granular character of the intercellular tissue.

Scattered through the so-formed tissue are cells from which numerous tortuous tubes proceed, the tubes themselves freely anastomosing with each other, and with those sent from neighbouring cells. By this arrangement a net-work of cells and tubes, permeable by fluids, is carried throughout the whole mass.

Fig. 38.



Section of Cementum,

Showing the general character, with the arrangement of the cells and laminæ, viewed by transmitted light.
A. The periosteal surface.
B. The dentinal surface.

When the cement exists in any quantity, it is traversed by canals for blood-vessels. I have several specimens of healthy molar teeth from the human subject, in which these canals exist. In one specimen, two canals enter from the surface, anastomose, and subsequently give off three branches. In other instances I have found a canal ending in a dilatation, as though occupied by a vessel, that had turned upon itself and gone out by the same channel through which it entered.

This general description of the structure is equally applicable to tooth-bone and osseous tissue. I will now confine my observation to the former.

The cement, in encasing the dentine, follows the curved surfaces of the fangs, often uniting in one conical mass two or even three fangs, just as we have seen it cement many lesser teeth or denticles into one large one. The roots of the second and third lower molars, and the dens sapientia of the upper jaw, have not unfrequently their fangs thus connected. (Fig. 9, *c.*)

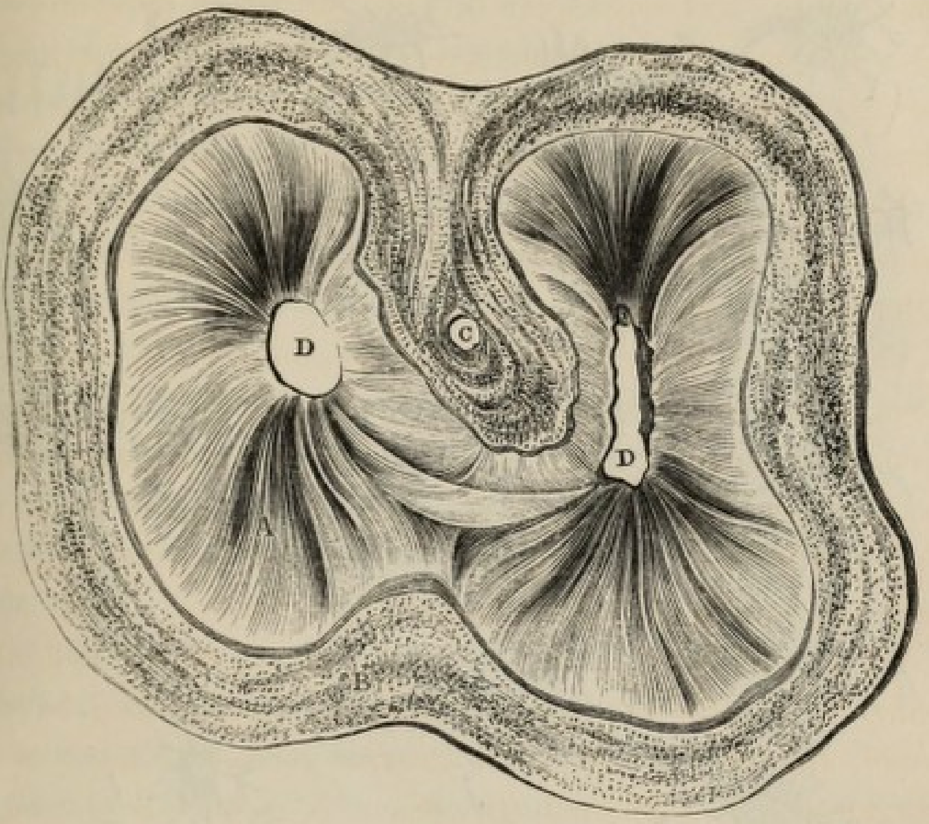
Where such a union exists, the amount of cement is double, being, in fact, the two layers of the two fangs united by what would otherwise have been the external surface of the folds of cementum. In such teeth the cement is commonly pierced by one or more canals for blood-vessels. (Fig. 39, *c.*)

Upon the necks of the teeth the cement exists, but in a thin layer, and is here traversed by minute tubes only, and these, commencing on the surface, pass horizontally inwards towards the dentine; but further down the root the layer thickens, and then the cement is hollowed by cells with branching tubes, their number being in proportion to the amount of cement. If the layer of cement be further thickened, we then find it provided with canals for blood-vessels.

In arrangement the tooth-bone presents the appearance of laminæ concentrically placed, the centre of the tooth being their common centre; or, should a vascular canal exist, it is surrounded by concentric laminæ—in this respect resembling, in its laminated arrangement, osseous tissue. (Fig. 39, *c.*) The cells are scattered through the cement with some degree of regularity, generally, though not always, following a course as though placed between concentric laminæ.

The majority of the radiating tubes of the cells pass, either

Fig. 39.



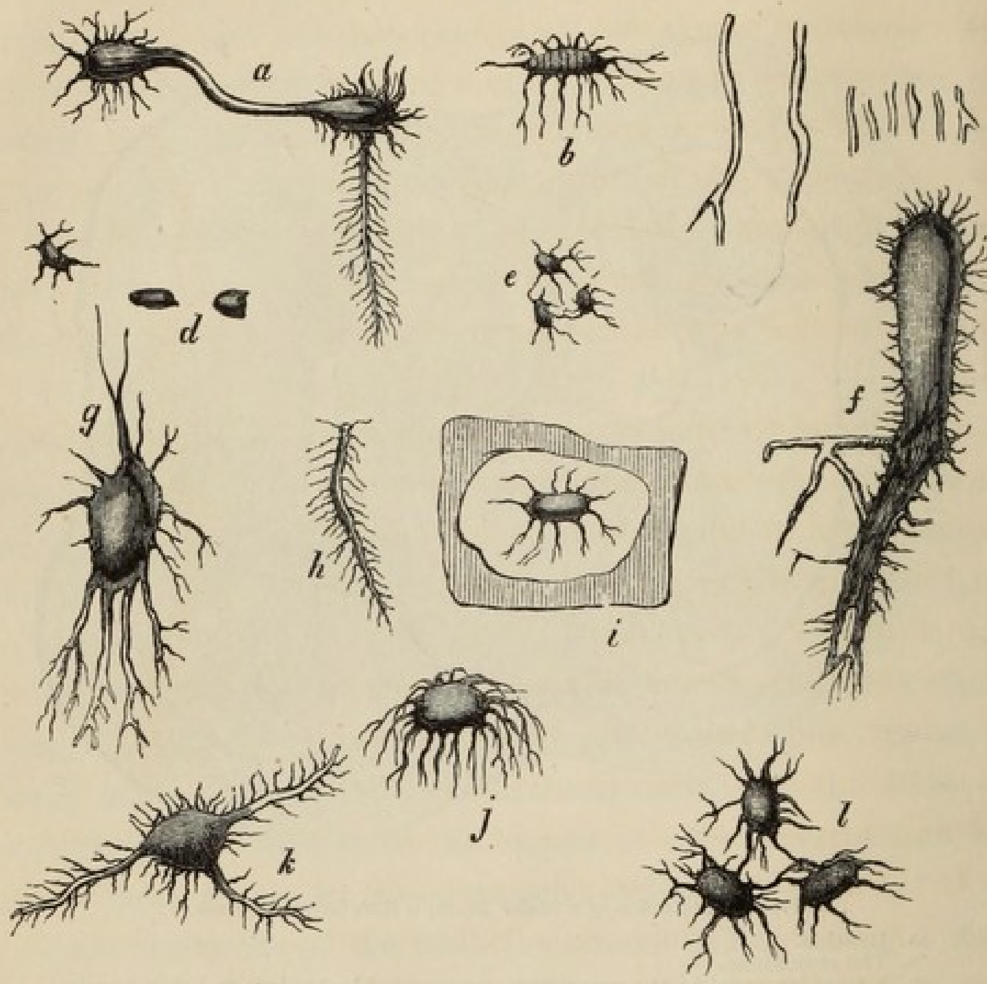
Transverse Section of a Molar Tooth, a little below the Neck.

A. Dentine.
B. The cementum.
C. A vascular canal in the cementum, surrounded by lamina, and thus forming a transverse system.
D, D. Pulp-cavities of the fangs.

towards the surface of the tooth, or, when such exists, towards the surface of a canal for a blood-vessel. Many branches also go towards the dentine, and anastomose with the terminal branches of the dentinal tubes, while a few follow the course of the length of the tooth, anastomosing freely with tubes pursuing a like direction. Frequently, however, a cell with its tubuli resembles a tuft of moss, the tubes taking in a mass one direction only, and that towards a surface upon which blood-vessels pass. (Fig. 40, *j*.)

In size the cells have very little uniformity, varying from the $\frac{6}{10000}$th to the $\frac{14}{10000}$th of an inch. The form is generally oval, sometimes round, and occasionally fusiform, but they may be found of any imaginable form, so great is the variety. The inner walls are minutely nodulated. To this irregularity of

Fig. 40.



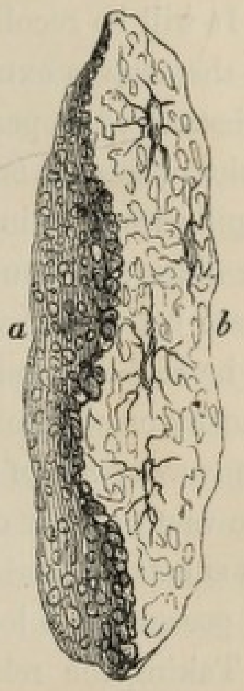
Various forms of Cells found in the Cementum.

surface is due the dark aspect of the cells, when examined by transmitted light. The traversing tubes are large at their commencement, but quickly assume a smaller diameter, which they retain to their termination. (Fig. 37.) Mixed with the cemental cells I have occasionally found tubes, which pass across the cement towards the surface of the tooth, and though equalling in size the dentinal tubuli, and no doubt performing similar functions, present the peculiarity of having fewer branches. (Fig. 40.) Occasionally, however, the smaller tubuli of the cells enter them.

In many specimens there is no distinguishable difference between the cemental tissue immediately surrounding the cells, and that further off; but in others (perhaps in half) each cell, or cluster of cells, is enveloped in a tissue more transparent than that situated at a greater distance. The clear tissue that encircles the cells is defined and well marked, and its outline is indicated by a waved line. (Fig. 40, *i.*)

The outer surface of cement is nodulated. The granules project, and thus give a surface such as would be formed by half-imbedded fig-seeds. Indeed, the whole intercellular cemental tissue may be compared to a mass of coherent fig-seeds, or to oolite.

Fig. 41.



Section of Cementum,
Showing the nodulated character of the periosteal surface.

In some teeth, indeed in some parts of most teeth, the more prominent granules are arranged in lines, which, being crossed by others, give a reticulated surface to the cementum.

Of the three dental tissues, the cement is softest, and contains the largest amount of animal matter, analysis giving 29·42 of organic matter, and 70·58 of inorganic.

In the teeth of lower animals, especially in the Edentata, in which enamel is absent, the cement forms a larger portion of the tooth. The cement when exposed is highly sensible to the touch, unless from any cause it has lost its vitality. When from recedence of the gum a tooth is unprotected, pressure with the nail upon the exposed surface will produce severe pain, which sometimes endures a short time after the removal of the cause.

Having described separately the dental tissues, I will now give you some account of the properties they possess in common, of their relation to each other, and of their relations to the vascular system.

The tube tissue, the granules of the intertubular tissue, the granules of the cementum, the fibres of the enamel, and the hardened membrane that unites the enamel fibres, are all (so far as we can see) clear, structureless, homogeneous elements, like a clear fluid made solid. So far they are similar, but in their refractive power they are dissimilar, and by this difference alone we are able to distinguish the one from the other, when the elements of the several tissues are placed in the field of the microscope.

It will be recollected, that, strictly speaking, all tissues are in themselves extra-vascular, that vessels do not permeate their substance, but pass only between their fibres, laminæ, or granules, whatever be the structure of the tissue. Thus, in muscles, capillaries pass in the interstices between the primitive muscular fibres; in bone they pass between the laminæ; and in the brain between the tubes and granules. But we regard a tissue to be highly organized or not, in proportion to the relative frequency or absence of capillaries and vessels in the interstices. Thus we speak of the highly organized tissue of the brain, from the vast number of capillaries which traverse, at short intervals, its substance; while from their absence we regard the cornea as possessing a lower degree of organization.

Taking the relative frequency of vessels in a tissue, as an index of the degree of its organization, teeth will be placed near the bottom of the scale, but different grades will be assigned to their three component tissues.

All that seems necessary for the healthy existence of a tissue is the proximity of a vascular current; more or less close to the individual elements, according to the character of the particular texture in question. But, in tissues where frequent interspaces for vascular currents would interfere with the functions, we find in the absence of vessels a special arrangement providing for the due nutrition of the part. In no instance are these arrangements more beautiful than in osseous and dental structures; for, in each of these, their functions require that there should be great power of mechanical resistance. In the tooth we find that the centre is hollowed in the form of an arch, in which lie, free from injury, the dental vessels and nerves, while the tubes and fibres of the dental substance are placed vertical to the surface of the arch, thus giving to the whole, and each tube or fibre, the position in which their greater power of resistance exists, and at the same time providing for the nutrition of each part by the permeability of the tubes, which, passing from the vascular surface, radiate, and, by their branching, pass to every part of the tooth, not even excluding the enamel.

To return to the consideration of the relative degrees of organization of the dental tissues. The cement, or tooth-bone, when collected in any amount, is possessed of vessels, as well as with cells and radiating tubes, in connection with the vascular surfaces. To this element of the tooth we must, in accordance with the above plan, give the highest place. The dentine, possessing sometimes, though not constantly, vessels, has in all cases its tubes or capillary pores opening directly upon a vascular surface; this, then, must be considered as the second, while the enamel, itself without vessels, is only connected with a vascular surface by the intervening dentinal tubes, and holds the third, or lowest degree of organization of the three dental tissues.

If the relative density of tissues be in proportion to the low degree of vitality, still the dental substances will hold the above arrangement. Again, if the relative sensibility of tissues be regarded as an index of their degree of vitality, still the same places must be accorded to the cement, dentine, and enamel.

It is a law of nature, that in passing from one form of organized matter to another no sudden transition shall be made, but that the individual changes shall be so gradual as to be almost imperceptible.

This law we find beautifully exemplified in the gradual change of structure in passing from the cement to the dentine, and from the latter to the enamel.

The cement and dentine possess so many properties in common, and are often so like each other, that in some specimens it is difficult to determine to which of the two tissues the various parts belong. Thus, in the cementum, we find tubuli terminating in open mouths upon a vascular surface, such as the surface of the root of a tooth, while in the dentine we observe the presence of cells with radiating tubes: indeed, we see the dentinal tubuli themselves taking the form of cells with tubular branchings. In the tooth of the kangaroo the two tissues are fairly mixed. Numerous vascular canals pass from the pulp-cavity to the exterior of the tooth, and each canal has scattered round it cemental cells, the radiating tubes of which either pass into the canals, or connect themselves with the dentinal tubes. Some few specimens, taken from the fangs of human teeth, exhibit the two tissues fairly intermingled,—tubes with distinct parietes lie amongst the cemental cells, and anastomose with them.

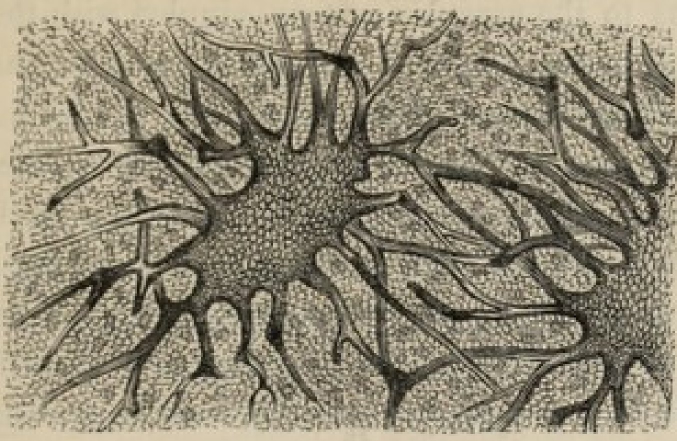
From the facts which I have laid before you, we are led to infer, that the dentine is but a modification of the cement; that the dentinal tubes are but elongated cemental cells, and that this elongation is necessary to enable the tooth to perform its allotted part in the animal economy.

In tracing the relations existing between the dentine and enamel, we find the change in passing from one structure to another equally gradual.

For illustrations recourse must be had to the teeth of fish, in which the two structures very nearly resemble each other. In man, the tubes send branches into the enamel, but the two structures, being each highly developed, present points of marked dissimilarity.

From what has already been said of the dental tissues, it will be seen that the area of the tubes, of the cemental cells, and of the tubes or interspaces of the enamel, form no part of the tissues themselves, but are in fact spaces in them. These spaces, we have seen, are of characteristic form in each tissue, and we have considered their relations, &c., &c. It now remains to say a few words on the structural relations of the dental to other tissues. Before going to this point, allow me to state, in a few words, the ultimate structure of osseous tissue, in order that, in comparing the dental structures with each other, we may understand their relations to the tissues to which they are most nearly akin.

Fig. 42.

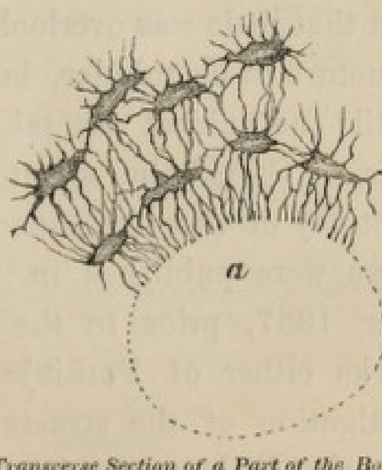


Two Cells of Osseous Tissue, seen on their surfaces;

Showing the disposition of their pores, and the granular aspect of the tissue both on and around their walls. Magnified 1200 diameters. Drawn from a preparation of the cancelli of the femur.—From TODD and BOWMAN'S *Physiology.*

Bone is composed of extremely minute granules closely united to each other, and so disposed as to form laminæ. The laminæ are concentrically arranged, the inner layer forming the parietes of a tube for the transmission of one or more vessels. Between, or in the lines of the laminæ, cells of an oval or round shape, flattened on their sides, occur, from which proceed numerous minute branchings—tubes which are directed either to a vascular surface, on which to end by an open mouth, or advance towards other tubes, with which to anastomose, thereby connecting the cells. (Fig. 42.) Thus, in bone, as in the cementum, and in dentine, and indirectly in the enamel, we find a set of capillary tubes, commencing upon a surface, bathed by vascular currents, and passing into the structure, there to establish a perfectly continuous network of tubes; so that a fluid entering at one point may find its way through the whole mass. That this arrangement is subservient to the

Fig. 43.



Transverse Section of a Part of the Bone surrounding an Haversian Canal;

Showing the pores commencing at the surface, *a*, anastomosing and passing from cavity to cavity. Magnified about 300 diameters.—From TODD and BOWMAN'S *Physiology.*

nutrition of the texture is sufficiently apparent, when we consider its relations to the vascular system, coupled with the fact, that these tubuli must be filled with fluid, even by atmospheric pressure, and that the only source of fluid is the blood. (Fig. 43.)

That the tubes do contain fluid is proved by the following experiments. After removing several teeth, I carefully wiped the external surface; I then broke the tooth, removed the pulp, and made the surface dry. The fragments of dentine and cement (the enamel having been in great part broken off) were then placed in a warm room to dry, and in the course of a few hours lost one part in eight by weight, without having suffered any loss in bulk. On repeating this experiment with another batch of teeth, I found they lost only one part in twelve; and, in a third experiment, seventy grains lost only four grains.

From these considerations it is seen that osseous and dental tissues are, in the form and arrangement of their cells and tubes, very closely allied. But the relations of the ultimate tissues are yet closer; for dentine and cementum, and probably enamel, are built up, like bone, of more or less spherical granules, the difference in the tissues being in the arrangement of the granules, and in the relative quantity of earthy matter with which they are impregnated.

Till lately, little was known upon the structure of the teeth, and that little was overlooked. Luenooke made out the dental structure to be tubular, but his observations were disregarded until[a] the subject was taken up by Purkinje. Professor Retzius, of Stockholm, about the same time, pursued the minute anatomy of the teeth, and with similar results to Purkinje; these were published in Stockholm in 1836. Late in the year 1837, prior to the appearance in this country of the works either of Purkinje or Retzius, I commenced the investigation of the structure of the teeth, under the impression that little or nothing was known upon the subject. The

[a] *De Penitiori Dentium Humanorum Structura Observationes.* Breslau, 1835. *Metetamata circa Dentium Evolutionem.* Breslau, 1835.

whole of my time which was not occupied on lectures, or necessary professional study, (I was then a pupil at King's College,) was devoted to the pursuit of dental anatomy, and in a short time I found many points, as I then thought, quite unknown. After I had worked up the subject, so far as human teeth were concerned, and examined the teeth of all the common animals, I became acquainted with Professor Owen, who, after examining many of my preparations, and accepting a few, mentioned, in his lecture at the College of Surgeons in 1838, my researches in terms of great commendation, as having confirmed those of the continental anatomists, and in some points extended further than they. I drew up an account of my researches in a paper, entitled "On the Structure of the Teeth, the Vascularity of those Organs, and their relation to Bone," which was read before the Royal Society, June 21st, 1838, having been presented by Thomas Bell, Esq.[a] This was the first account written upon the structure of the teeth in this country; and, in addition to the confirmation of Purkinje's and Retzius' views, it contained several new points. The most important of these was the vascularity of the tubular structure[b].

At a later date, in the same year, Professor Owen read a paper on the structure of the teeth before the British Association. Shortly afterwards Mr. Nasmyth published a work on the same subject, which contained a full account of Retzius' views, together with a detail of the results of his own researches.

[a] Proceedings of the Royal Society, June 21st, 1838. *London Medical Gazette*, Feb. 16th, 1839; and July 10th and 31st, 1840. *Lancet*, July 25th, 1840. *Dublin Medical Press*, Aug. 19th, 1840.

[b] The evidence on which these claims are founded may be seen in the periodicals referred to in the preceding note.

LECTURE IV.

DEVELOPMENT OF ANIMAL TISSUES FROM NUCLEATED CELLS.—DEVELOPMENT OF THE TEETH FROM PAPILLÆ COMPOSED OF CELLS.—THE PAPILLÆ DERIVED FROM MUCOUS MEMBRANE.—THREE STAGES OF DENTITION; FOLLICULAR, SACCULAR, AND ERUPTIVE.

Now that we have become acquainted with the dental tissues in their perfect state, we will proceed to trace them through their various stages of development.

If we take an egg of the common fowl, and carefully in water remove first the shell, and then the albumen or white, a small circular spot of a whitish colour may be seen on the surface of the yolk. This, the germinal membrane, is composed of a number of spherical or oval bodies—cells, each having a proper coat, which incloses numerous lesser spherical bodies, called the nuclei. The nuclei again contain other still smaller bodies, called the nucleoli.

From these so formed tri-celled bodies (called nucleated cells), all the tissues of the adult animal are developed. Filling the interspaces left by the spherical cells is a colourless homogeneous fluid, described under the name of plasma. With the commencement of incubation the nucleated cells increase in size by the rapid growth of the inclosed cells, till the investing coat divides, and the inclosed ones are liberated. These in their turn give birth to others; the process of development being repeated until the germinal membrane has greatly increased in size. At a specific time the cells begin to arrange themselves definitely for the formation of the tissues. Each tissue requires a peculiar modification of the cellular development, which, taking place gradually, may be seen at various stages of formation, from the simple nucleated cell to tissues in which the form of the elementary cell is no longer observable. Thus, in fibrous tissue, the formative cells are developed in length, and the original form is lost, while in cartilage they preserve their oval figure, are placed side by side, and become separated by an intermediate tissue, which is supposed to be developed by their coats. Thus, we have growth taking place prior to the existence of vessels; not, however, without the presence of an animal fluid. This fluid, the plasma, bathes the surface of the nucleated cells, and is probably furnished by the yolk.

Having given you briefly an outline of the process of development generally, we shall be prepared to examine with advantage the modifications which pertain to the formation of the teeth. But our attention will be first directed to what may be termed the development of the physical form of teeth, apart from the development of the individual dental tissues.

For our knowledge of this branch of the subject, we are principally indebted to Mr. Goodsir; and, as the matter of this lecture is in great part borrowed from his memoir, I shall follow the arrangement adopted in his description; beginning with the earliest appearance of the dental organs, and tracing their progressive development through its various stages up to their perfect state [a].

As early as the sixth week of uterine existence, when the human embryo is scarcely an inch in length, preparation for the dental development may be seen. On opening the cavity, which can hardly at this period be called a mouth, so rudimentary is its state, a groove is found bounded anteriorly by the lips, and posteriorly by a lobe, of semicircular shape (the rudiment of the future palate). This groove is called the primitive dental groove, and in it the first stage of dental formation takes place. At the seventh week of uterine life a slight projection of the mucous membrane, at the bottom of the groove, on each side of the arch, is observable, and which soon increases in size, and forms a papilla. This papilla is the primary condition of the tooth-pulp, and is composed of an aggregation of cytoblastic cells. At this early stage vessels do not

[a] *Edinburgh Medical and Surgical Journal*, vol. li.

go into the papilla, but form loops under it in the mucous membrane. However, as the papilla increases in size by the growth of the cytoblasts, in the manner already described, the vascular loops become elevated into its substance, always, however, lying a certain distance below the surface. This, the first formed, is the follicle of the anterior temporary molar: those of the upper appear a short time before those of the lower jaw.

About the eighth week, a second follicle is formed, anterior in situation to the one first spoken of, and is accompanied by a growth in the form of a notched lamina, proceeding from the external wall of the dental groove.

At the ninth week of fœtal life, the papillæ for the development of the incisive teeth make their appearance, and are bounded, anteriorly, by the external wall of the dental groove, in the form of notched laminæ.

With the tenth week, the papilla for the posterior temporary molar, is developed in the dental groove, posterior to those already described.

Thus, at the tenth week of fœtal existence, we have in the dental grooves twenty papillæ, corresponding to the twenty temporary teeth. As the papillæ grow, the walls of the dental groove increase, and send out laminæ towards each other, which, meeting, unite and form septa. By these means the papillæ are inclosed in follicles (cells with open mouths).

The development of septa commences around the first molar about the tenth week, and is principally effected by the development of processes from the external wall of the dental groove. A similar follicular development takes place around the canine papillæ. During the eleventh and twelfth weeks septa pass from the outer to the inner side of the anterior portion of the dental groove, and in so doing inclose in well-developed follicles the incisive papillæ. By a similar process the posterior molar papillæ are follicularised; still, however, leaving behind an open portion of the dental groove.

Considerable changes ensue during the thirteenth week, especially in the shape of the papillæ, which, instead of remaining as hitherto simple rounded blunt masses, each of them take a characteristic shape. The incisive assume in some degree the shape of the incisor teeth, the canines become simple cones, and the molars resemble cones flattened transversely.

The papillæ, from their more rapid growth, protrude from the open mouths of the follicles, while the depth of the latter is relative to the length of the fang of the future tooth; the canine follicle, therefore, is at this period the deepest.

Simultaneous with the change of shape in the papillæ is the development of opercula, or lids to the follicles. The incisive follicles have two opercula; one larger, anterior, and rather external; the second smaller, posterior, and internal. There are three for the canines, one external, and two internal; four or five for the molars, each corresponding with a tubercle, while the edges of the opercula correspond with the fissures on the grinding surface of the tooth.

At the fourteenth week the inner lip of the dental groove has increased in size, and applies itself in a valvular manner to the outer lip.

The relative rapidity of growth between the papillæ and the follicles is now reversed, and the former recede into the latter. The opercula, from their increased size, now almost hide the papillæ.

With the termination of the fourteenth week, the primitive dental groove, having performed its part in the animal economy, in furnishing the ten milk papillæ, is succeeded by the secondary dental groove, which is situated on a higher level, and is destined to furnish the papillæ of the permanent teeth, excepting, however, the molars. The secondary dental groove gradually appears in the form of small crescent-shaped depressions, immediately behind the inner opercula of each of the milk follicles.

Those of the centre incisors appear first, followed by the laterals, canines, anterior bicuspides, and posterior bicuspides. About this time the opercula close the mouths of the follicles, but without adhering; shortly, however, adhesion takes place, first closing the anterior follicles, then the laterals, the others following in succession. Between the fourteenth and fifteenth week, the opercula and lips of the now extinct adherent groove become flocculent and rough, excepting, however, the depressions for the ten permanent teeth. By the adhesion of the opercula the follicles have become sacs, and the inclosed papillæ are now recognised as the pulps of the milk teeth. The crescent-formed depressions, developed in the posterior walls of the milk follicles, now constitute the secondary dental groove, or cavities of reserve, for furnishing the papillæ of the ten anterior permanent teeth; and by a process similar to that by which the milk papillæ were developed in the primitive dental groove.

It will be recollected that a posterior portion of the primitive dental groove, after the formation of the papilla of the second milk molar, remained open and unoccupied. This portion is subject to no alteration till the expiration of the sixteenth or seventeenth week, when the development of the papilla and follicle for the anterior permanent molar commences, the site being immediately behind the sac of the posterior milk molar. The cavities of reserve for the ten anterior permanent teeth now exist as minute compressed sacs lying between the milk sac and the surface of the gums.

From the time of the closure of the milk follicles the pulps gradually assume their peculiar shape, and those destined for the formation of the molar teeth are divided at the base for the development of their several roots. With these progressive changes, the sac growing faster than the pulp, an intervening space is formed, in which is developed a soft granular substance, which for a time increases in quantity, and is adherent to the inner surface of the sac, but not to the pulp, though closely applied to the surface of the latter.

In describing the course of the vessels of the pulps, I cannot do better than use Mr. Goodsir's own words :—

" Each branch of the dental artery, as it arrives at the fundus of its destined sac, sends off a number of radiating twigs, which run in the substance of the cellular submucous tissue (which constitutes the outer membrane of the sac) towards the gum, from which others proceed to inosculate with them. The combined twigs then ramify minutely in the true membrane of the sac, without sending the smallest twig into the granular substance. The dental branch, after giving off these saccular twigs, divides into a number of contorted ramifications between the base of the pulp and the sac, from which smaller *ramusculi* are transmitted into the pulp itself. In the case of the molars, the main branches divide into three secondary branches, one for each of the secondary bases. From these three sets of saccular twigs, three packets of contorted pulp vessels take their origin."

After the conversion of the incisive follicles into sacs, and the change in form of the pulps, the follicle of the first permanent molar is converted into a sac, which then receives granular matter. In the conversion of this follicle into a sac, a portion between the continuous surface of the gum and the sac remains inadherent, thus forming a second sac with collapsed sides. This, lined with mucous membrane, is a cavity of reserve for the formation of the second permanent molar and the wisdom tooth. The next step in the process of development is the appearance of caps of tooth-substance upon the tips of the pulps, and is accompanied with a diminution of the granular matter of the sacs. Ultimately the granular matter is reduced to a thin layer, and at last, when the pulp is perfectly capped with tooth-substance, disappears altogether, leaving the interior of the sac with a villous appearance, like mucous membrane.

These changes bring us to the seventh or eighth month.

During the interval between the fourteenth week and eighth month, the cavities of reserve for the ten anterior permanent teeth gradually recede from their position between the milk sacs and the gums, to points posterior to the milk sacs.

About the fifth month, the distal extremities of the four anterior cavities of reserve having dilated, the rudiments of the permanent papillæ are seen in a small fold, lying across the base of the cavity, the direction corresponding with that of the cutting edge of the future tooth. At this time the cavities of reserve resemble in shape a pear, the smaller end being directed towards the surface of the gum. At the small extremity two folds appear, one anterior, the other posterior, and together round off the extremity of the sac. These folds are rudimentary opercula, and are lost with the obliteration of the smaller portion, which they cut off for the larger division of the sac. With the obliteration of the distal extremity, the cavities are converted into closed sacs, and continue to recede deeper in the gum behind the temporary sacs, imbedding themselves in the submucous tissue of the milk sac. We have now arrived at a stage of dental development which has often been described, but of which Dr. Blake was the first to give a distinct account. This author, finding the temporary sacs with lesser ones implanted in their posterior walls, was led to conclude that the permanent tooth pulp is formed from the temporary by a gemmiparous process. Subsequent writers, including Mr. Fox and Mr. Bell, but excepting Hunter, have, prior to the publication of Mr. Goodsir's excellent paper, held similar opinions. The more extended and accurate observations of the latter author have, however, led to the explosion of the gemmiparous hypothesis.

About the fifth month the septa are formed between the external and internal wall of the primitive dental groove, and ossification takes place in them, first forming little bridges, which, by the end of the sixth month, form complete partitions. Thus, at the termination of the sixth month of uterine life, the alveoli are formed. As the milk sacs increase in size, the alveoli increase also, and little niches are formed in their posterior walls for the reception of the permanent sacs. The permanent sacs, when formed, increase in size more rapidly than the jaw, from which want of concordance in growth, the sac of the first permanent molar, at the eighth month, retreats into the maxillary tuberosity, where it is found completely imbedded, and occupying a higher level than the other sacs. In thus moving backward, the cavity of reserve placed between it and the gum is dragged out to an increased length, and with it the surface of the gum is drawn upwards and backwards, thereby producing a dimple in its surface.

About the time of birth, the fangs of the incisors begin to be formed. Three separate actions are concerned in this development, viz., first, elongation of the base of the pulp; second, deposition of dentine upon it; third, adhesion of the contiguous portion of the sac to the surface of the so formed dentine.

When the development of the roots of the milk teeth is advancing, the permanent sacs increase in size, together with the containing crypts; which, from a growth of their edges, form an osseous partition between the temporary and permanent sacs. At this period, when the infant is eight or nine months old, the maxillary arch having increased in size, the permanent molar begins to descend from its elevated position in the tuberosity, and the cavity of reserve to resume its original position and size.

Commonly the central incisors pass through the gum (or are cut, as it is more frequently called) about the eighth or ninth month, and in the following manner. The crown of the tooth being perfected, and the formation of the fang advanced by the triplex action already described, an action is set up by which the edge of the tooth passes through the gum. Here, then, terminates the saccular stage of the tooth, the sac having been opened by the passage of the tooth through the gum. It must be borne in mind, that, with the development of dentine for the fang, the sac becomes adherent to its surface, but not to the surface of the enamel; a probe might be passed down the surface of the enamel to the neck of the tooth, so soon as the sac is opened by the edge of the tooth. When once the tooth is cut, growth progresses rapidly. The tooth, however, appears to grow more rapidly than it really does, and from the following cause. The sac being opened, and its inner surface thereby rendered continuous with that of the gum, a strong disposition to contract seems to come into force in that portion lying against the enamel, and as the gum constitutes one fixed point, and the adhesion of the sac to the neck of the tooth the other, the crown is, as it were, lifted out of the gum by the shrinking of the sac between these two points. As a consequence of this movement, the distance between the unfinished end of the fang and the fundus of the alveolus is lengthened. The socket now rapidly adapts itself to the neck of the tooth, to which it becomes accurately moulded. The pulp elongates itself, and diminishes at its base, till, at the completion of a tooth, it has diminished to the size of a thread, and is constituted, principally, of the dental vessels and nerves.

As the temporary teeth have advanced towards the surface, the sacs for the permanent teeth have receded behind them, and have become inclosed in proper bony crypts, from each of which a foramen proceeds. In the sacs for the front teeth, these foramina open immediately posterior to the milk teeth, but those for the bicuspids open into the alveoli of the milk molars. From the apex of each sac, a fibrous cord proceeds through the foramen to join the gum near the neck of the corresponding milk tooth, excepting in those under the milk molars, in which the fibrous cord unites with the periosteal lining of the temporary alveolus. These cords, or gubernacula, as they are sometimes called, are formed of the obliterated portion of the pulp follicle, which, it will be remembered, was rendered external to the sac by the development and subsequent closure of the opercula. It seems the union of the two sides is sometimes incomplete, so that the cord is in fact a tube closed at its two extremities. The gubernaculum lengthens as the sac recedes from the surface, and disappears only after the tooth passes through the gum. From observing the position and the disappearance of the gubernaculum, many have supposed that it leads, or directs the developing tooth, to its proper situation in the alveolar arch. Mr Goodsir makes the following observation, when speaking of the use of the cords and foramina: —" The cords of communication which pass through these foramina are not tubular, although in some instances a portion of the unobliterated intra-follicular compartment of the original little cavity of reserve may be detected in them ; they are merely those portions of the gum which originally contained the lines of adhesion of the depressions for the permanent teeth in the secondary dental groove, and which have been subsequently lengthened out in consequence of the necessarily retired position in which the permanent teeth have been developed during the active service of the temporary set.

The cords and foramina are obliterated in the child, either because the former are to become useful as "gubernacula," and the latter as "itinera dentium;" or much more probably in virtue of a law which appears to be a general one in the development of animal bodies; viz., "*that parts or organs which have once acted an important part, however atrophied they may afterwards become, yet never altogether disappear so long as they do not interfere with other parts or functions.*"

The sacs of the permanent teeth derive their vessels first from the gums, but afterwards from the milk sac; and as the sac sinks deep into the alveolus they receive their vessels from the proper dental canals. When speaking of the development of the first permanent molar, it was stated that, after the closure of the sac, a space or cavity lined with mucous membrane was left between the sac and the surface of the gum; also, that the cavity was stretched backwards as the sac receded into the tuberosity of the jaw, and that when the sac with the increase of space is placed in the line of the alveoli, the cavity again contracted and occupied its former position. This position, however, is soon changed, for at the seventh or eighth month the cavity enlarges and elongates posteriorly, dips back behind the sac for the first permanent molar, and then gives birth to another papilla—the papilla of the second permanent molar.

In the formation of this sac a cavity of reserve is, however, left, just as in the formation of the sac of the first permanent molar. This cavity is elongated, and again contracts as it is dragged by the new sac backwards towards the tuberosity; and again, as in the former case, comes forward as the sac descends into the line of the alveoli, when, by the growth of the jaw, sufficient alvolar room is afforded. About this period the cavity of reserve for the third time enlarges posteriorly, dips backward behind the sac of the second molar, and forms a papilla and sac, for the development of the wisdom tooth. The so formed sac for the wisdom tooth recedes, as did the anterior molar, into the tuberosity of the maxilla. The cavity of reserve now exists but as a line, which extends through the gum over the permanent molars, marking the points where it formerly existed as an important organ of development.

At present we have been describing the dental development as it occurs in the upper jaw. In the lower maxilla the process is similar, the primitive dental groove appearing first at the side of the jaw, and afterwards advancing towards the centre. The papilla of the first milk molar is the first to appear, then that of the canine, followed by those for the incisors. In the development of the permanent molar the coronoid process there receives the sacs, as the tuberosity did those in the upper jaw. The cavities of reserve for the permanent molars are, however, formed from an unclosed posterior portion of the secondary dental groove, and not from the primitive dental groove, as in the upper jaw. In point of time, the appearance of the papillæ is a few days later in the under than in the upper jaw.

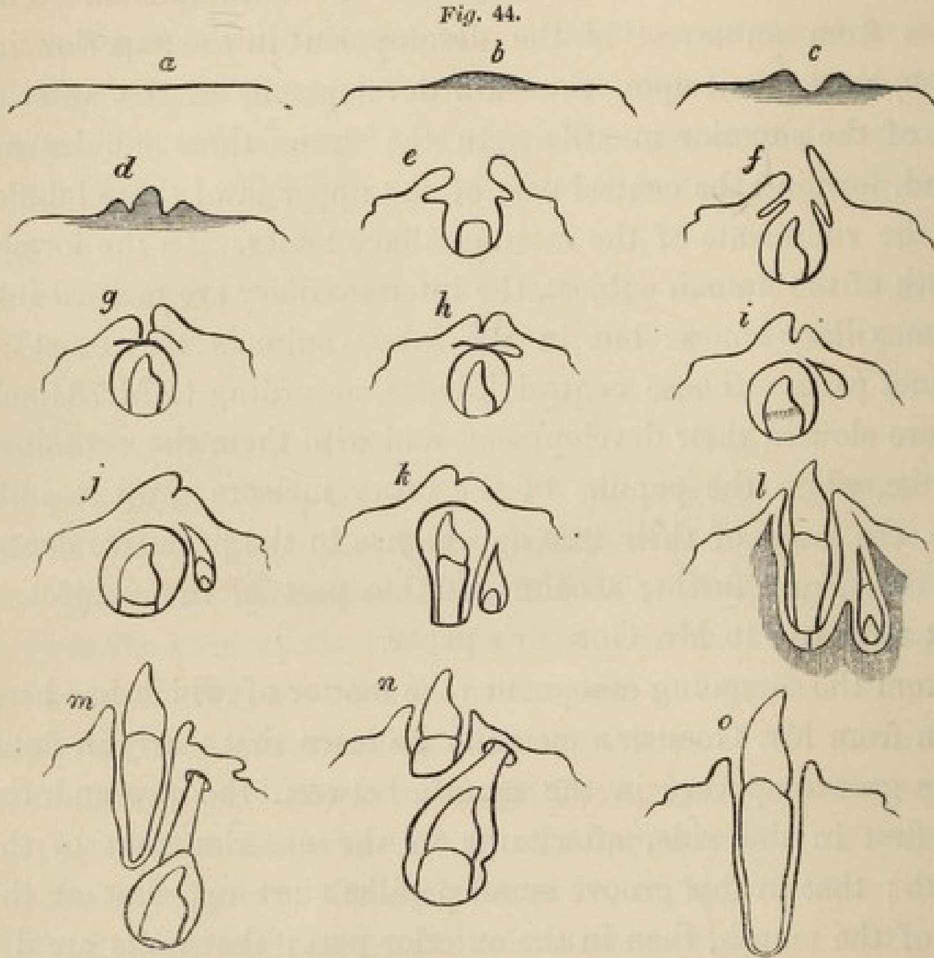
Mr. Goodsir divides dentition into three stages. First, the follicular, in which stage is included the papilla, when it existed as a simple prominence from the mucous membrane, and extends to the closure of the opercula. Second, the saccular, which commences with the closure of the opercula, and ends with the passage of the tooth through the gum. Third, the eruptive, which commences when the tooth appears through the gum, and extends to the period when the permanent teeth are fully developed.

These three stages, when considered in reference to any particular tooth, are well defined, but when viewed in reference to the whole set, or the two sets, they are intermingled; thus, when one tooth germ is in the saccular, another is in the follicular stage; again, when the temporary teeth are in the eruptive, the permanent teeth are in the saccular condition.

It will have been observed, in the foregoing statement, that though the papillæ of the upper incisors are the first to appear, yet that the lower incisors are the first to be completed. This arises from an arrest in the development in the superior incisors, consequent upon the slow development of the anterior part of the superior maxilla. In the fœtus three lobules are found, forming the central part of the upper jaw; these lobules are the rudiments of the intermaxillary bones. In the formed mouth of the human subject, the intermaxillary are merged into the maxillary bones: but in the lower animals they exist as distinct parts. These central lobules, according to Mr. Goodsir, are slow in their development, and with them the contained papillæ, while the papillæ of the lower incisors grow steadily from the time of their first appearance in the primitive dental groove. For a further account of this part of the subject, I must refer you to Mr. Goodsir's paper.

From the foregoing statement (the matter of which has been taken from Mr. Goodsir's memoir) we learn that, early in fœtal life, a groove appears in the mouth, between the jaw and the lips, first in the side, afterwards in the anterior part of the mouth; that in this groove small papillæ start up, first at the side of the mouth, then in the anterior part; that walls are developed from the external boundary of the groove, inclosing the papillæ in cells, and that afterwards coverings, or lids, are developed. We also learn, that from the posterior surface of the milk cells, secondary cells are formed, which go through stages like those by which they have been preceded, and give birth to the permanent teeth. We further learn that the milk teeth are formed in three distinct divisions—a molar, a canine, and an incisor; that the molar is the first, the canine the second, and the incisor the third to appear; but that the first molar is developed before the second, and the first incisor before the second; also, that the rudiments of the teeth appear in the upper jaw before the lower. In the closing of the follicles the process commences at the anterior part of the dental groove, and proceeds backwards. In the permanent teeth, the papillæ, excepting those of the anterior molars, appear first at the median line, and in succession backwards.

Fig. 44.



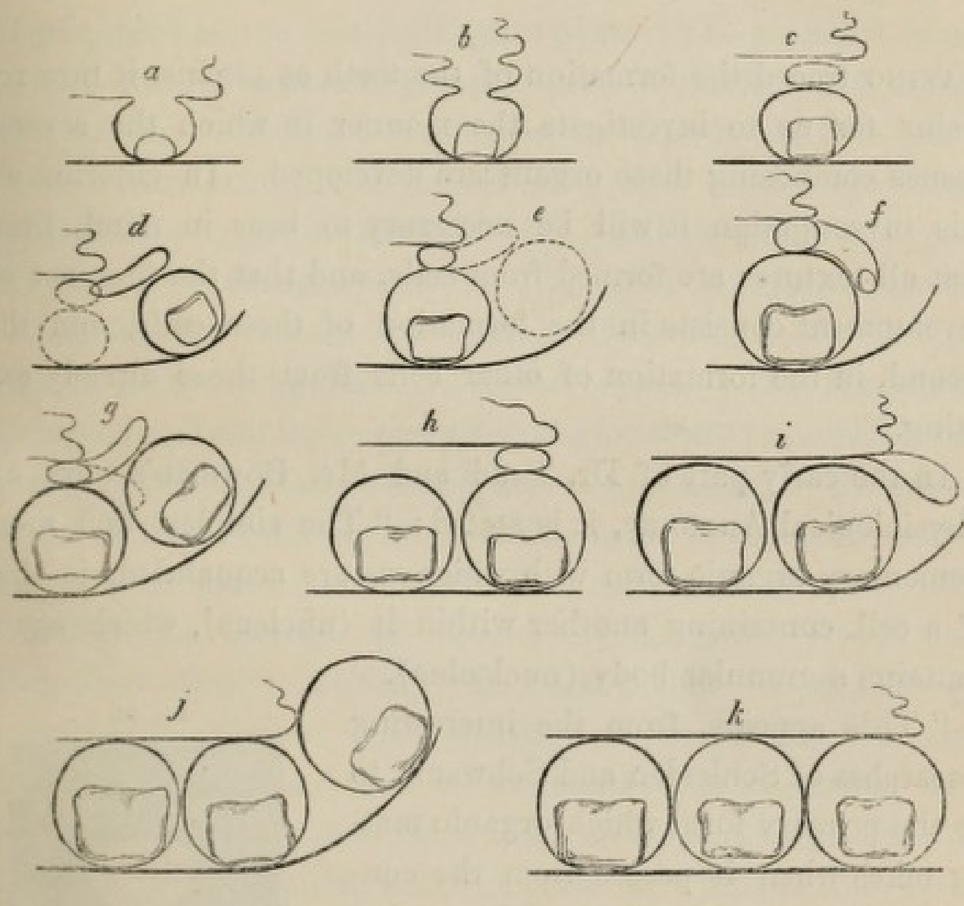
Diagrams illustrative of the Formation of a Temporary and its Corresponding Permanent Tooth from a Mucous Membrane.

(From Mr. Goodsir.)

A. Mucous membrane.
B. Mucous membrane with a granular mass deposited in it.
C. A furrow or groove on the granular mass (primitive dental groove).
D. A papilla on the floor of the groove (a tooth germ).
E. The papilla inclosed in a follicle in the bottom of a groove (the latter in the condition of a secondary dental groove).
F. The papilla acquiring the configuration of a pulp, and the sac acquiring opercula. The depression for the cavity of reserve behind the inner operculum.
G. The papilla become a pulp, and the follicle a sac, in consequence of the adhesion of the opercular lids. The secondary dental groove in the act of closing.
H. The secondary groove, adherent except behind the inner operculum, where it has left a shut cavity of reserve for the formation of the pulp and sac of the permanent tooth.
I. The last change rendered more complete by the deposition of the granular body (the enamel tooth), deposition of tooth-substance commencing.
J. The cavity of reserve receding from the surface of the gum, and dilating at its distal extremity, in which a pulp is forming. Rudimentary opercula developing near its proximal extremity, and dividing it into a follicular and extra-follicular compartment.
K. The temporary tooth acquiring its fang by the triplex action described in the lecture, and its sac approaching the surface of the gum.
L. The temporary tooth sac again a follicle; free portion of the sac becoming shorter, and the fang of the tooth passing from the bottom of the socket.
M. The temporary tooth completed; the free portion of the sac become the vascular border of the gum; the adherent portion become the periosteum of the fang. The permanent tooth sac removed from the gum, but connected with it by the gubernaculum passing through the foramen behind the temporary alveolus.
N. The fang of the permanent tooth lengthening, and the crown approaching the gum. The fang of the temporary tooth undergoing absorption.
O. The perfect permanent tooth.

From these researches it is thus apparent that the organs for the development both of the temporary and permanent teeth are derived from the mucous membrane of the mouth, and that the papillæ of the temporary and permanent teeth have each a perfectly independent origin.

Fig. 45.



Diagrams illustrative of the Formation of the Permanent Molar Teeth in the Non-adherent Portion of the Primitive Dental Groove.

(From Mr. Goodsir.)

A. The non-adherent portion of the primitive dental groove.
B. Papilla and follicle of the first permanent molar on the floor of the non-adherent portion, which is now a portion of the secondary dental groove.
C. The papilla and follicle of the first molar become a pulp and sac. The lips of the secondary groove adhering, so that the latter has become the posterior or great cavity of reserve.
D. The sac of the first molar advanced along a curved path into the substance of the coronoid process or maxillary tuberosity. The cavity of reserve lengthened out or advanced along with it.
E. The sac of the first molar returned by the same path to its former position. The cavity of reserve again shortened.
F. The cavity of reserve sending backwards the sac of the second molar.
G. The sac of the second molar advanced along a curved path into the coronoid process or maxillary tuberosity. The cavity of reserve lengthened for the second tissue.
H. The sac of the second molar returned to the level of the dental range. The cavity of reserve shortened for the second time.
I. The cavity of reserve sending off the pulp and sac of the wisdom tooth.
J. The sac of the wisdom tooth advanced along a curved line into the maxillary tuberosity or coronoid process.
K. The sac of the wisdom tooth returned to the extremity of the dental range.

LECTURE V.

THE DEVELOPMENT OF THE DENTINAL PULP AND ITS CONVERSION INTO DENTINE.—THE ENAMEL PULP AND ITS CONVERSION INTO ENAMEL.—THE CEMENTAL PULP AND CEMENTUM.

HAVING traced the formation of the teeth as organs, it now remains for us to investigate the manner in which the several tissues composing these organs are developed. In entering on this investigation it will be necessary to bear in mind, first, that all textures are formed from cells, and that the first act of development consists in the formation of these cells, and the second, in the formation of other cells from those already existing.

In the early part of Dr. Todd and Mr. Bowman's work on Physiological Anatomy, it is stated: "The simplest and most elementary organic form with which we are acquainted, is that of a cell, containing another within it (nucleus), which again contains a granular body (nucleolus).

"This appears, from the interesting researches of Schleiden and Schwann, to be the primary form which organic matter takes when it passes from the condition of a proximate principle to that of an organized structure.

Fig. 46.

Primary Organic Cell; Showing the cell-membrane, the nucleus, and the nucleolus.—From TODD and BOWMAN'S *Physiology.*

"The bodies of some animals, and of some plants, are composed almost entirely of cells of this kind: and, in the earlier development of the embryo, all the tissues, however dissimilar from each other, consist at first of nucleated cells, which are afterwards metamorphosed into the proper elements of the adult texture."

At a later page they say, that at an early period "the embryo consists of an aggregate of cells, and its further growth takes place by the development of new ones. This may be accomplished in two ways: first, by the development of new cells within the old, through the subdivision of the nucleus into two or more segments, and the formation of a cell around each, which then becomes the nucleus of a new cell, and may in its turn be the parent of other nuclei; and secondly, by the formation of a granular deposit between the cells in which the development of the new cells takes place. The granules cohere to each other in separate groups, to form nuclei, and around each of these a delicate membrane is formed, which is called the cell-membrane. The nuclei have been named cytoblasts, because they appear to form the cells; and the granular deposit in which these changes take place, is called the cytoblastema."[a]

This creative process is beautifully illustrated in the development of the several parts of the dental organs. Thus, the papillæ springing up from the primary dental groove are principally composed of nucleated cells, cells capable of producing, by the growth of the contained nuclei, other cells similar in character, and in purpose, to those from which they have been formed. The dental papillæ increase in size by the formation of new cells from those already existing. In a short time the papillæ are contained in follicles; still, although much increased in size, they are mainly composed of nucleated cells connected by a homogeneous transparent thick fluid, a blastema or plasma. In the base of the papillæ, when inclosed in follicles, blood-vessels are formed; they, however, are not immediately concerned in the cellular development, but probably, by transudation through their coats, furnish the homogeneous plasma which is immediately concerned. In process of time, the precise period varying in the different teeth, the follicles become sacs.

The papilla, which is now designated the pulp, assumes the shape of the future tooth, and commences to fulfil the ultimate purpose of its existence, in the formation of dentine. Previous to the development of tooth-substance the inner sur-

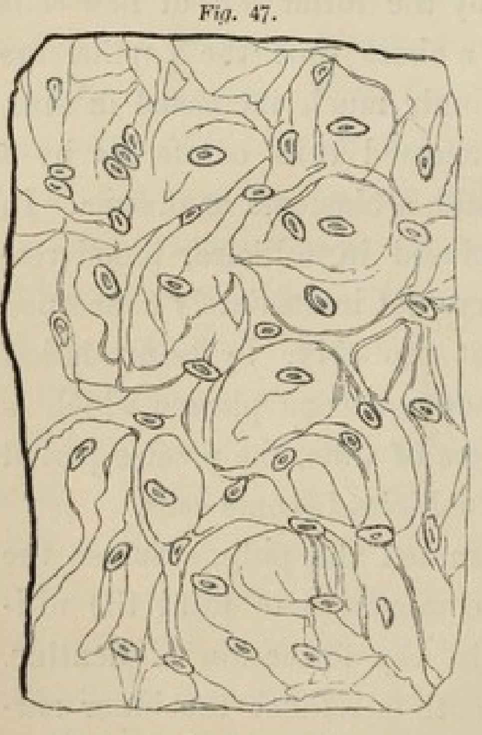
[a] *The Physiological Anatomy and Physiology of Man.* By R. B. Todd, M.D., F.R.S., and W. Bowman, F.R.S. Pages 9 and 49, vol. i.

face of the sac becomes separated from the surface of the pulp, the intervening space being occupied by a soft gelatinous granular matter. This is the formative pulp for the development of the enamel. At this stage of dental formation we have a closed sac containing two formative pulps, one for the development of the dentine, the other for the formation of the enamel; the former in the shape of the crown of the future tooth, the latter forming a cap over the dentinal pulp. At a later period we have a matrix for the formation of the cementum.

The dentinal pulp, from its earliest appearance to the time of its transition into dentine, is mainly composed of a series of nucleated cells, united and supported by plasma, is supplied with vessels, and, during the greater part of its existence, with nerves.

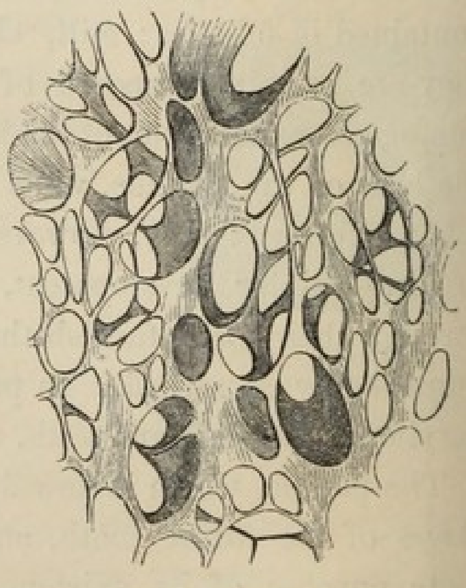
In addition to these elements, there is one other, that pertains to the pulp, prior to the commencement of those changes which prepare for its conversion into dentine. This element is a fine areolar tissue. A meshwork of delicate fibres and bands of homogeneous matter, in the thicker part of the walls of which are scattered here and there nucleated cells; while

Fig. 47.



The Dentinal Pulp in its first stage;
Composed of plasma, an areolar tissue, and nucleated cells.—From TODD and BOWMAN'S *Physiology*.

Fig. 48.



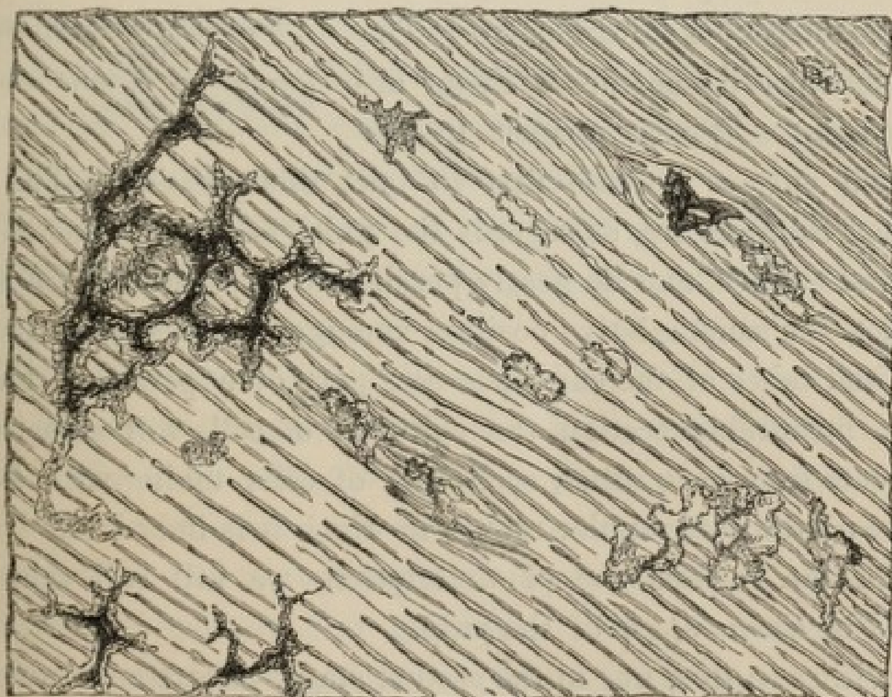
Portion of Areolar Tissue, inflated and dried;
Showing the general character of its larger meshes. Each lamina and filament here represented contains numerous smaller ones matted together by the mode of preparation. Magnified 20 diameters.—From TODD and BOWMAN'S *Physiology*.

the meshes are occupied by a thick, clear, homogeneous fluid or plasma; and in this are a number of nucleated cells. (Figs. 47 and 48.)

In order to examine the pulp when in this early stage of development, very thin sections must be taken from the part most distant from that where calcification has begun, or is about to begin; or any part of the pulp may be examined at a very early period of its existence. Then, with a high magnifying power, the conditions I have described will be recognised; and, in addition, loops of capillaries, with their convexities directed towards the coronal surface of the pulp, will be seen.

I am not aware that the dentinal pulp when thus constituted has been before described. It is, however, when in this stage, an important subject for examination; since it is more than probable that a partial persistence of the areolar tissue occasions that imperfection in formation of the dentine to which I drew your attention in a past lecture. (Fig. 49.)

Fig. 49.



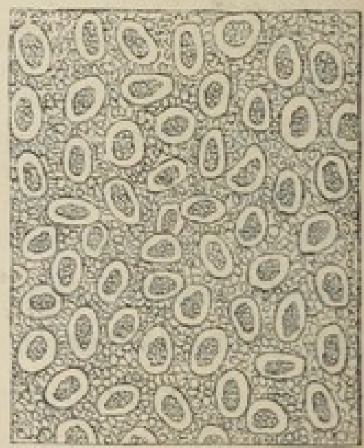
A Longitudinal Section of Imperfectly Developed Dentine, as seen by transmitted Light.

In this specimen the tissue is occupied here and there by large irregular cells. The surface of the tooth from which this was taken, resembled that expressed in Fig. 25.

I shall presently recur to this point, and, to avoid circumlocution, will call this the *first* or *areolar stage* of the dentinal pulp.

If we take sections from the pulp, intermediate between the coronal surface and the point I have described, the microscope will show them to be composed of nucleated cells, and a subgranular uniting medium. The cells appear to have almost homogeneous coats that inclose a cavity which is commonly occupied by granular matter.

Fig. 50.



The Dentine Pulp in its second stage;

Composed of nucleated cells and subgranular plasma.

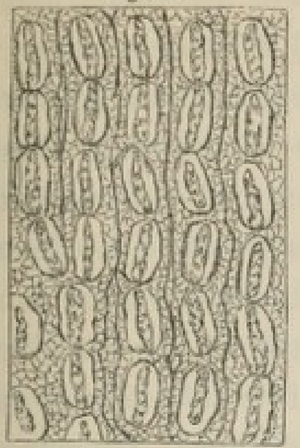
In this, the *second* or *cellular stage* of the dentinal pulp, the cells have no definite arrangement as regards each other, but are thickly scattered, at pretty regular intervals, throughout the whole section. The pulp, too, is something firmer in this than in the earlier stage.

Immediately preceding the conversion of the pulp into dentine, its elements undergo a third change. The component cells acquire a linear arrangement. Those nearest to the coronal surface are the first to take this position. The so-formed columns are, as regards the pulp, nearly vertical to its coronal surface, and lie nearly parallel to each other; holding, in fact, the same relative position amongst themselves as do the dentinal tubes of the corresponding part of a perfected tooth. In a favourable section the columns of cells will sometimes separate from each other, each line of cells taking with it its share of the subgranular matter in which it is imbedded.

For the convenience of description, we will call this the *third* or *linear stage* of the pulp.

Neither in this, nor in the second stage, have I been able to find more than the faintest trace of the areolar tissue, which forms a conspicuous part of the pulp in its earlier stage of formation.

Fig. 51.

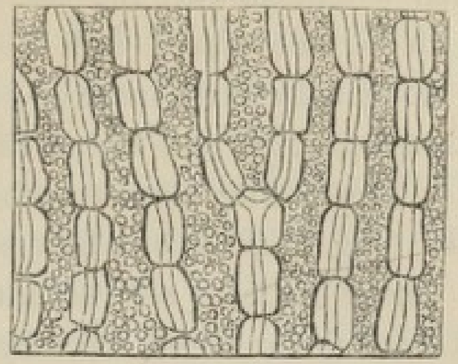


A

The Dentine Pulp in the early part of the third stage.

The cells arranged in lines.
A. Two lines of cells uniting to form one.

Fig. 52.



A

The Dentine Pulp in the third stage.

The cells placed end to end, and becoming confluent, and the internal cavities becoming continuous with each other, at or immediately before the conversion of the pulp into dentine.
A. Two lines of cells uniting to form one. Showing the manner in which the branches of the dentinal tubes are developed.

The blood-vessels, too, become rare in the second stage, and wholly disappear in the third.

I have assumed this arbitrary division into stages, for the sake of facilitating the description. In the advanced dentinal pulp, you will find the three conditions, not separated from each other by distinct hard lines of demarcation, but beautifully blended the one with the other—passing from the one extreme of condition to the other so gradually that the transitions are not at first recognised, and when fully recognised are again lost in the gradations towards a further change.

The linear arrangement of the cells commences in those nearest the coronal surface of the pulp, first at its apex, afterwards at its sides.

Those cells on and near the surface are the larger, the relative size decreasing the further they are removed from the surface. The lesser cells, however, increase to an equal size to the larger ones, when the time for their calcification arrives. Intermediate and connecting laterally the lines of cells is the subgranular and now firm gelatinous tissue, corresponding in position to that described as the plasma, with which it is identical, but is now further developed. Each cell after falling into line divides into two or more in its length, and each division elongates. A central nucleus or space is seen in each cell, which lengthens with the cell. The cells by their increased length become placed end to end, and ultimately unite; and the elongated central space of each individual, by a further development, joins and opens into those of the super-imposed cells; thus forming a central tube common to the linearly united cells. (Fig. 52.) At or a little before this period of development the earthy matter is received into the cellular or rather tubular and intertubular tissue, whereby the gelatinous matrix, having assumed the required form, is converted into tubular and intertubular tissue; in other words, into dentine. In some instances the linearly arranged cells have two or even three central cavities, but these, in the progress of development, become joined in one. Sometimes they appear empty, at other times occupied by granular matter. In either case they are usually described under the name of nuclei.

So soon as the cells have begun to receive the earthy constituents, they become adherent to the previously formed mass of dentine, and then undergo the final development into tubes. Thus it happens, that the dentinal pulp, when separated from its cap of dentine, brings with it few, if any, of the calcifying cells.

Covering the pulp is a transparent membrane closely united to the external cells. This membrane, which forms the exterior of the dentine, is the first to undergo calcification. (Fig. 54.) Upon its external surface are developed the hexagonal pits for the reception of the ends of the enamel fibres, each pit corresponding to the end of a line of cells.

The progressive stages of development are very readily observed in the molar teeth of the hog, or in a kitten, at birth. In each of these animals, and in the calf, I have examined the formative pulps, and from these examinations I have given this description, and have made my illustrative diagrams.

Calcification begins on the surface of the pulp, commencing at the apex or apices, and gradually extends down the sides and towards the centre. As the more external and larger cells become hardened, the inner ones increase in size, assume the linear arrangement, and they in their turn become converted, by the addition of the salts of lime, into dentine, till at last the great bulk of the pulp is transformed, leaving only a comparatively small portion, which, with the nerves and blood-vessels, occupies the central cavity of the tooth.

In the progressive development of dentine from without inwards, two of the more external unite with one of the more internal lines of cells. The two central canals also unite and form one. By the frequent repetition of this process of union between the contiguous cellular lines, as they proceed inwards and towards the centre of the pulp, the number of tubes are gradually diminished, and the trunks of the dentinal tubes are formed. (Figs. 51 and 52, A.) Here, then, we have the ordinary manner of growth reversed. The branches are formed first, and the trunks are developed from the union of the branches.

The structure composing the walls of the cells prior to the addition of the phosphate of lime, is, as far as has at present been seen, homogeneous; further investigation will, however, probably show it to be minutely granular, and similar to the ultimate structure of the intercellular tissue of bone.

The cells, after their confluence and impregnation with lime and subsequent adhesion to the mass of already formed dentine, may still for awhile be distinguished, their perfect conversion into tubes being gradually completed.

The most external cells of the coronal dentinal pulp fall into lines, and contribute to form the ultimate branches of the coronal tubuli. The peripheral cells of the dentinal pulp of the fang do not, however, fall into lines, but exist as a coherent mass; excepting a few only, and these contribute to form those branches of the tubes that pass into the cementum. Many of the peripheral cells are like large granules, having no nuclei, while others have nuclei which become developed into cells, with which the terminal branches of the dentinal tubuli communicate. Other irregular cells are formed by intervals existing between the larger granules at the time of their calcification. (Fig. 28.)

Between the areolar stage of the pulp and perfected dentine are two intermediate stages of development, and upon the perfectness with which these are, successively, effected, does the perfectness of the matured dentine depend. But should calcification take place before the areolar stage has been succeeded by the cellular, and this by the linear stage of the pulp, then we shall have dentine of imperfect formation.

And this mischance does sometimes happen. I have shown you dentine in which the tubular structure is imperfect, the tubes are interrupted by the occurrence of irregularly shaped cells, formed after the mould of the areolar tissue. In some specimens, portions of the calcified areolar tissue may be recognised; while, in others, cells similar in form (just as though it had been withdrawn) are found. (Fig. 49.) It would seem that the areolar tissue had become absorbed, and, the cells not having taken its place, areolar spaces were left.

The development of the dentine or ivory has been investigated by Mr. Nasmyth, who gives the following account. "On examining the internal structure of the pulp generally, the number of minute cells presenting themselves is very remarkable; they seem, indeed, to constitute the principal portion of its bulk. These vesicles vary in size from the smallest perceptible microscopic appearance, probably the ten-thousandth of an inch in diameter, to one-eighth of an inch, and are evidently disposed in different layers throughout the body of the pulp." [a]

At another place, he says, "The formative surface of the pulp displays a regular cellular arrangement, which I have denominated reticular, and which may be described as resembling a series of skeletons of desiccated leaves." [b]

When speaking of the formation of the ivory from the cells, Mr. Nasmyth says, "At an early stage of dental development the reticulated or cellular appearance of the pulp is particularly beautiful.

"When merely a thin layer of ossific matter has been deposited on its surface, it may with great facility be drawn out en-

[a] *Memoir on the Development and Organization of the Dental Tissues*, by ALEX. NASMYTH, August, 1839, p. 39.
[b] Page 42.

tire, together with the former, laid in a glass, compressed, and then examined with the high powers of the microscope. The different layers of cells may be seen, and the transition into ivory may be observed."[a]

From these extracts it will be observed that Mr. Nasmyth had upon this subject a clear idea, to which he gave distinct expression: first, that the pulp is composed of cells; and secondly, that the dentine or ivory is formed of these cells by the imbibition of earthy matter. A few months subsequent to the appearance of Mr. Nasmyth's paper, Mr. Owen wrote a paper on the development of the teeth, in which he advanced views in the main similar to those originated by Mr. Nasmyth. Mr. Owen, however, in his work "Odontography," gives a more distinct account, and goes much further into the subject of the development of the dental tissues, than does Mr. Nasmyth in his published memoir.

Mr. Owen gives the following account of the formation of dentine. The pulp is described as being composed of nucleated cells, suspended and united by a subgranular plasma. The cells are more numerous near the surface of the pulp, where they are arranged in lines vertical to its external surface. At or near the surface, the nucleus of each cell divides in two in its length, thus forming two cells; each of the so-formed cells has a nucleus of its own. These cells become again divided, but in the second instance the division is transverse. Thus, within a parent or primary cell, four lesser cells are formed by the division of its nucleus. The primary cells may, however, give origin to a far greater number of secondary cells than four. The primary cells, being placed end to end, become confluent, as do the secondary cells. The nuclei of the secondary cells also increase in length, and join those of the cells situated at either end in the same line.

Neither the primary nor secondary cells are, however, arranged in a perfectly straight line, but in their union describe slight

[a] *Memoir on the Development and Organization of the Dental Tissues*, by Alex. Nasmyth, August, 1839, p. 46.

curves; the primary corresponding with the primary, and the secondary with the secondary curves of the dentinal tubes. When the pulp cells have adopted the linear position, become confluent, and the nuclei arranged in continuous lines, they receive the calcareous salts, and are thus converted into the tubular element of dentine. The nuclei of the secondary cells are described as receiving at the time of the calcification of the cells a subgranular matter, rendering them opaque. With the imbibition of the earthy salts, the confluence of the cells becomes perfect, and the filled nuclei become so united as to form continuous filled tubes. At the same time, the intercellular substance receives the hardening salts, and thus the pulp becomes perfect dentine. The description of which I have endeavoured to give a slight outline is in itself very complete. Those who would become acquainted with it in detail, I must refer to Mr. Owen's work [a].

For myself, I have been enabled to confirm some of the opinions advanced. I have, however, been unable to satisfy myself of the invariable existence of the primary and secondary cells, and of the latter being permanently contained in the former. I have often seen the appearances that have led to the adoption of the quoted opinion. They are, however, to the best of my belief, attributable to the persistence and calcification of the areolar tissue. Then, again, I am by no means satisfied that amorphous subgranular salts are deposited in the tubes in any case, much less in all. On the contrary, I am disposed to think that the granular contents, when present, are the remains of the granular matter that is seen in the cavities of the cells prior to their calcification.

I think that I shall be able to show you that the pulp is a modification of cartilage, modified to suit its peculiar position and function, and that the development of dentine is in every way similar to the development of bone. These points must, however, be left till we have completed our investigation of the dentinal formation. You will recollect that I described the more external portion of the dentine of the fang as made of

[a] *Odontography.*

cells in a granular base. This is the first formed, and here the cells of the pulp, instead of increasing in length, preserve their original figure, or widen, and the nucleus, or cavity, if any exist, remains unaltered, or perhaps increases a little in size; it does not unite with any other, but maintains, when calcified, its permanent cellular condition. Neither do the cells attain the same size, or arrange themselves in lines, preparatory to calcification, as do those of the more internal parts of the pulp. These cells may, therefore, be considered as the elements of tubes arrested in their development. A few of the cells have, however, branching tubes proceeding from their circumference; in these instances they have assumed the form of bone corpuscles. At the periphery of the dentine, the intertubular matter is comparatively abundant, and highly granular.

Mr. Nasmyth considers what I have described to you as dentinal tubes, to be baccated fibres, and not tubes. It is very obvious how the baccated appearance arises, namely, from the individual pulp-cells, which have by their union contributed to form the tube, preserving the convexity of their centres, and at the same time preserving a constriction at the point of junction—an appearance constantly seen in process of development, prior to the perfect confluence and calcification of the cells; so that the baccated appearance may be regarded as an arrest of development; the accession and completion of a final process before the preparatory process has been perfected; thus producing abnormal formation of the tissue. The intertubular tissue Mr. Nasmyth describes as composed of cells of characteristic form. In the human subject, he says, they are somewhat square, and occupy, in single lines, the intervening space between the fibres. From his description they may be compared to square bricks, which are imbricated and closely united, as in a building; could the fibres, or what we consider tubes, be withdrawn, we should still have remaining a series of tubes, which, for illustration, we may compare with chimneys built of bricks. The bricks would represent the square cells of the intertubular tissue, and the chimneys themselves the canals occupied by the fibres. I am unable, from my own observation, to confirm any of these views of dental structure.

I will now, for the sake of comparing the two tissues, osseous and dental, and their relations in development, describe to you shortly the structure of temporary cartilage, and the formation of bone.

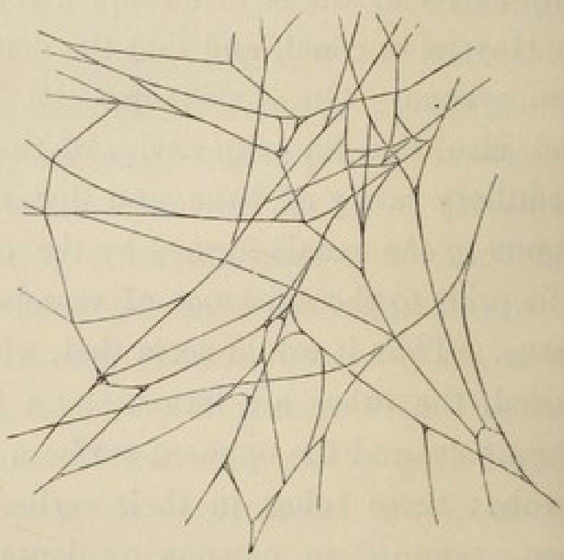
Early in the development of the embryo, a series of transparent oval cells, with central nuclei, arrange themselves side by side. In the process of growth, the individual cells become separated by the interposition of a subgranular matter. Thus we have formed temporary cartilage, consisting of nucleated cells called cartilage corpuscles, imbedded in a dense elastic uniting medium. This is analogous to the pulp of the tooth, the main point of difference being, that the uniting medium, or plasma, of the latter is soft and gelatinous, while in the former it is firm and dense. When the temporary cartilage is about to be converted into bone, the cells arrange themselves into lines, not, however, by separate individuals moving from one part to another, but by the development of cells from parent cells in linear series, and this at right angles to the surface, where ossification is proceeding. Here, then, we have a process exactly similar to the arrangement in lines of the cells of the pulp before calcification. Immediately prior to ossification, the cartilage cells increase in size, and the central nuclei become granular, and appear as though inclosed in distinct cavities. At this formative stage we have enlarged cells arranged in lines, with an intermediate tissue separating each cell from its fellow, and also the lines or columns of cells from each other. In this intercellular tissue, we find the counterpart of the intercellular tissue of the dental pulp, and in each of these the calcareous salts are received, and at the same time, or a little before, the tissue becomes granular. At this stage the cartilage cells, uniting by their ends, have the opposed walls absorbed, and are thus formed into tubes, which is the rudimentary condition of the Haversian canals. During these changes the parietes of the cells receive ossific matter, and in the process become, like the intercellular tissue, minutely granular. Each cartilage corpuscle has a central nucleus, or cell, containing one or more spherules or granules; these become more distinct as the cell enlarges, but when the cells have, by their union, formed tubes, the granular contents of the nuclei are lost. Possibly they adhere to the walls of the cells, and are concerned in the development of the bone corpuscles. Around the circumference of the tubes, developed in the manner I have described, corpuscles or bone-cells appear, and with them their radiating tubes, the latter being directed towards the tube or canal, which ultimately becomes an Haversian canal. In comparing the development of dentine with that of bone, we find that at first sight the pulp-cavity of the former bears a very striking resemblance to an Haversian canal, and that the dentine resembles an Haversian system. On considering the subject more carefully, we find, also, that the pulp-cavity of the tooth is analogous to the medullary cavity of bone, and that the dental tubuli are analogous to the canals formed by the confluence of the cartilage cells prior to the existence of vessels in newly formed osseous tissue. Thus it would seem that, where a tubular tissue is required, the tubes are formed by a linear confluence of cells. The nuclei and the opposed surfaces disappear, thereby leaving a tube; these tubes, in their earliest stage of formation, whether examined in osseous or dental tissues, have circular indentations both on the external and internal surfaces, marking the line of junction of the individual cells, but as development proceeds they disappear. And, further, it would appear that the so-formed tubes may either retain their original character, or may become canals for vessels. This observation is equally applicable either to bone or vascular dentine. It should, however, be recollected, in making the comparison, that the cells of temporary cartilage, immediately before ossification, are larger than those of the dental pulp at a similar period.

Structure of the enamel pulp, and its subsequent conversion into enamel.—We learn from Mr. Goodsir that, immediately after the conversion of a dental follicle into a sac, a granular substance is deposited in its interior, that the quantity is greatest at first, and is afterwards gradually lessened; and that ultimately, when the pulp begins to be cased with dentine, it is reduced to a thin layer, and at last disappears altogether, leaving the interior of the sac with a villous appearance, resembling mucous membrane.

In this narration the pulp is described in two conditions of its development, the first and the third.

When in the granular condition, described by Mr. Goodsir, the enamel pulp is composed of very fine structureless fibres, which proceed from the membrane of the sac, and course about in every direction, crossing each other at all angles. When treated with acetic acid, they comport themselves much as do the elastic fibres of serous tissue. (Fig. 53.) These fibres, however, form but a very small portion of the whole pulp. A thick but transparent fluid occupies their interstices, and floating loose in this fluid are peculiar nucleated cells. The fluid, however, forms more than nine-tenths of the whole mass.

Fig. 53.



Yellow Fibrous Element of the Areolar Tissue of Serous Membrane.

From the mesentery of the rabbit, treated with acetic acid. Magnified 300 diameters.—From TODD and BOWMAN'S *Physiology*.

Minute blood-vessels freely traverse the enamel pulp in this, its *first* or *reticular stage*. (Fig. 54, *b*, *b*.)

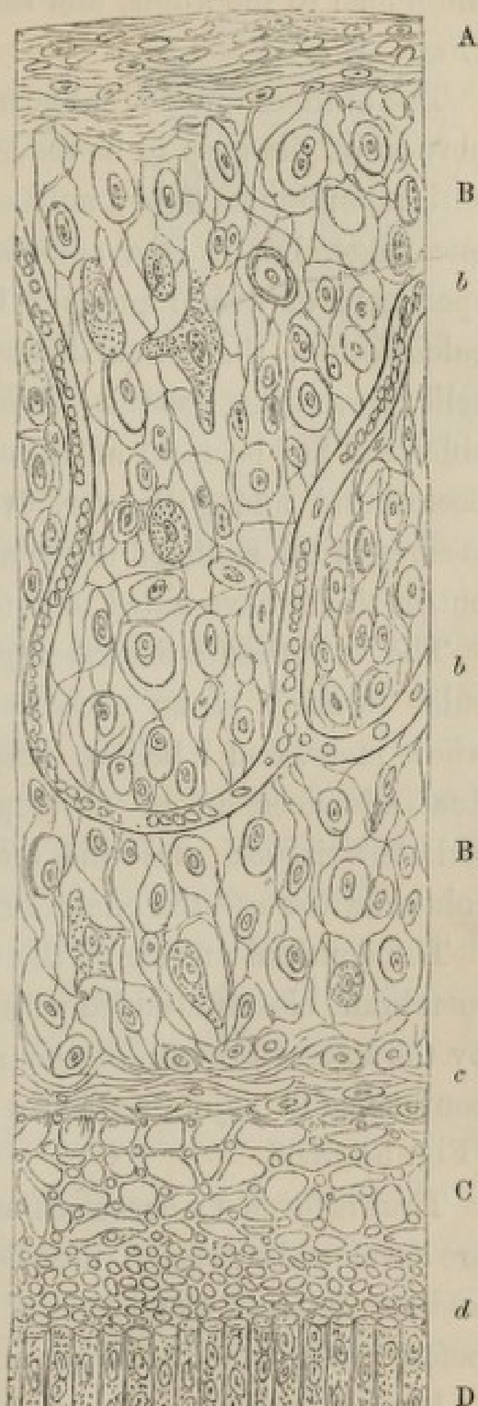
The fluid or plasma resembles in consistence the albumen of a common fowl's egg, and, like it, will run off an inclined surface, and the cells roll down in the stream. It has a sticky feel to the fingers, like a strong solution of gelatine.

The cells that float in the plasma are large, varying from the $\frac{4}{10000}$th to the $\frac{1}{1000}$th of an inch in diameter. They are very transparent, have distinctly marked nuclei, and these again contain nucleoli. Both the cells and the nuclei are mostly of an oval figure, and the latter measure from the $\frac{1}{10000}$th to $\frac{4}{10000}$th of an inch in their largest diameter.

These large, oval, nucleated cells are tolerably abundant in an early stage of the pulp, but, as it ages, they greatly increase in number, and are joined by lesser ones, that resemble their nuclei. (Fig. 54, B.)

On or near the dentinal surface of the enamel pulp, a stellated areolar tissue is developed, presenting a very peculiar and characteristic appearance, like to no other areolar tissue that I am acquainted with. It has been described, and figured, in Todd and Bowman's Physiological Anatomy, and consists of short transparent fibres that radiate from central nuclei, take a straight course, and join other nuclei that are similarly circumstanced. This tissue, when first formed, may be compared to a piece of netting,

Fig. 54.



Vertical Section of the Enamel Pulp, showing the several stages of its existence.

A. The coat of the sac of the enamel pulp.
B. The reticular condition of the pulp, formed of nucleated cells; fluid; and filaments of fibrous tissue.
b, b. A blood-vessel.
C. The stellated tissue.
c. The graduation of the reticular into the stellated tissue.
D. The columnar tissue.
d. The basement membrane, graduated from the stellated tissue.

the nuclei to the knots, and the fibres to the intervening string. (Fig. 54, *c.*)

The authors quoted, suppose the whole mass of the granular portion of the pulp to be made up of stellated tissue, infiltrated with albuminous fluid; and such is, undoubtedly, the case at one stage, but it is a comparatively late one. In the many specimens of dental pulps I have examined previous to their calcification, the reticular tissue, with the fluid and floating cells, have been present. While, on the other hand, when calcification has been far advanced, the stellated tissue has alone been found, and still later, even this has been absent. The meshes of the stellated tissue are occupied by albuminous fluid; but in this I have failed to detect free cells.

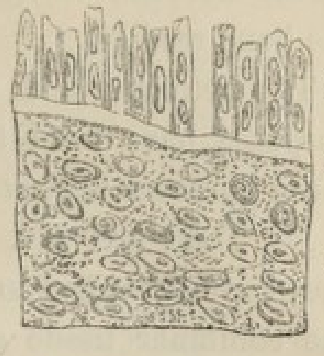
The two tissues described graduate into each other, the reticular forming at an early period nineteen-twentieths of the whole mass, and I believe originally all of it. With the gradual advancement of development it disappears, leaving the stellated tissue; and this too, at last, yields its place to a columnar tissue—the enamel matrix.

The dentinal surface of the stellate tissue is converted into a membrane closely studded with nuclei, and this is effected partly by the lateral growth of the stellate fibres, and partly by the confluence of adjoining fibres and nuclei into a flat membrane. (Fig. 54, *d.*)

Thus is formed a basement membrane, with nuclei, from which are developed columns; these lie between the basement membrane and the external membrane of the dentinal pulp; and this, too, before calcification of either pulp has commenced. (Fig. 55.)

If a tooth sac be carefully opened, about the time, or a little before calcification commences, a large amount of gelatinous matter will adhere to the inner surface of the membrane of the sac—this is the enamel pulp in its primary stage. A little of the gelatinous matter will also adhere to the dentinal pulp; but beneath this is a thick film, which you will discover to be stellated tissue—the dentinal surface of which will be clothed with columnar tissue. Sometimes the columns, or parts of them, remain adherent to the dentinal pulp. (Fig. 55.)

Fig. 55.



Section of the Enamel and Dentinal Pulp prior to the commencement of Calcification in either.

A. The dentinal pulp.
B. The outer membrane of the dentinal pulp.
C. The enamel pulp, in its final stage of development.

Here, then, we have existing at one time three formative tissues; the first to be transformed into, or give place to, the second, and the second into the third, and that into enamel.

It will be well to try to understand how these transformations are brought about.

If the large floating cells be carefully examined, many will be found that are flattened, and throw out processes, some two or three, the nuclei retaining a central position. It seems natural to suppose that the stellated tissue is formed by many of these radiate cells, the arms of which have come together and united, or that nuclei are developed in the arms, and themselves throw out similar appendages; and that by a repetition of this process the tissue is formed.

That the stellated tissue is formed from cells cannot be doubted. We know of no tissue that is not, and this would hardly be an exception to a rule from which we know of no departure.

Connecting the reticular and the stellated portion of the enamel pulp is a transition part, composed of an accumulation of delicate fibres, similar to those that lie amongst the nucleated cells, but here they are collected into bundles. In and about this point the development of the stellated tissue seems to be carried on. (Fig. 54, *c.*)

I have already told you how the fibres of stellated tissue contribute to form the basement membrane, and the nuclei the columnar organ. (Fig. 54, *d.*)

If we examine the enamel pulp, when the whole of the crown of the dentinal pulp has been capped with dentine, then we find the villous surface described by Mr. Goodsir, and, external to this, the fibrous coat of the sac, which is also the periosteum of the alveolus, though at this period it leaves the surface of the bone readily.

The reticular and stellated tissues have disappeared, their purposes have been fulfilled, and they cease to exist. What those purposes were we can but conjecture.

Dr. Todd and Mr. Bowman suppose the office of the one they have described to be mechanical—that it holds a space for the columnar tissue and the dentinal pulp to grow into, and protects them, too, from mechanical injury during their growth. That it does this is obvious, but it is probable that it does much more.

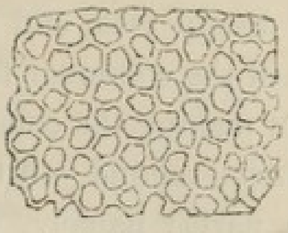
The reticular tissue is intersected with vessels, is infiltrated with gelatinous fluid, and its meshes occupied with developmental cells. Through these vessels, and through the fluid, and afterwards through the meshes of the stellated tissue, the nutriment destined to reach the columnar tissue must pass. There is, apparently, no other pathway, unless it goes through the dentine, and this is not probable. It seems not unlikely, that the two more external may prepare the nutriment fluid, in its passage through them, for the peculiar wants of the columnar tissue, and for the development of the enamel. They lessen as that purpose is being fulfilled, and disappear when it is effected.

I have spoken of the enamel pulp and enamel matrix. The latter term has been applied by Dr. Todd and Mr. Bowman to the columnar tissue, and the former to the stellated tissue; we will also include, in this term, the reticular tissue.

We will now direct our attention to the enamel matrix in its more perfected form, and to its conversion into enamel.

It will be remembered that the external surface of the dentine is formed of a dense transparent structure, indented on the surface with rude hexagonal depressions. (Fig. 15.) Upon this the enamel rests. The external surface of the dental sac is composed of submucous membrane; while the internal surface, to which the enamel matrix is adhering, is formed of a transparent homogeneous membrane, divided on its internal surface with hexagonal cells or depressions. Into these depressions the cells of the enamel matrix are received, and from which they proceed in columns towards the surface of the dentine, where they terminate in the hexagonal pits. The cells composing the enamel matrix are slightly larger than those of the dentine pulp, are more transparent, and the nuclei less distinct, clear, and without granules. In the columns they are strongly united, and seem to be contained in excessively fine membraneous sheaths. The lateral union between the columns is slight. If the tooth sac be carefully opened at a favourable period, the enamel pulp adheres to the inner surface of the sac, and, under the microscope, presents, when placed in fluid, a flocculent appearance, produced by the columns of cells, the free extremities of which float about like the villi of the small intestines of carnivorous animals. The columns vary from the $\frac{2}{10000}$th to the $\frac{3}{10000}$th of an inch in diameter. Each column is seen to be attached to an hexagonal depression, and while the cellular composition of the columns is very distinct, the membrane to which they are fixed seems structureless, resembling the basement tissue of mucous membrane. Upon the external surface of this, which might be called the basement tissue of the enamel matrix, vessels ramify, and here only—none pass through into the matrix.

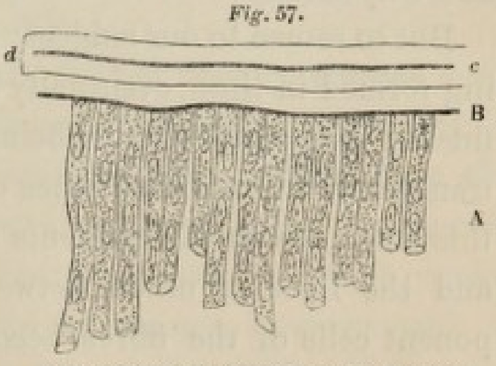
Fig. 56.



Basement Membrane of the Enamel Pulp.

I may here again call your attention to the fact illustrated in the subject before us, that the development of tissues goes on without the immediate presence of vessels. It is true they existed in considerable numbers in the earlier stages of the enamel pulp, but as that organ

Fig. 57.



Vertical Section of the Enamel Pulp when fully formed.

A. The columnar tissue.
B. The basement membrane.
C. The layer of vessels external to the basement membrane, and in the coats of the sac.
D. The coats of the dental sac, in which the vessels ramify.

diminished in size, and progressed in development, they gradually disappeared, and are altogether lost when the pulp has assumed the columnar form, and becomes the matrix.

In making the comparison with mucous membrane, I should, perhaps, remind you that the latter is composed of two separate parts; namely, of a transparent basement tissue, and of an imposed layer of epithelial cells, which are placed upon, and probably formed by, the basement tissue. In mucous membrane the cells which form the external protective surface are constantly wearing off, and being replaced by others. In the enamel pulp they receive earthy matter, and become extremely hard, form a thick coat, and are to the more organized dentine what the epithelial cells are to the mucous membrane; differing, however, from the former in durability. This modification of the mucous membrane is extremely interesting, for you must not forget that the inner surface of the sac has been formed by a duplicature of mucous membrane. After the enamel is perfected, the tooth passes through the gum, and the mucous membrane, on again forming part of the free surface, resumes its original structure and function. For an excellent account of the structure of mucous membrane I would refer you to an article, written by Mr. Bowman, in the Cyclopædia of Anatomy and Physiology.

But to return to our subject: the cells, being formed in lines, eventually become confluent; the points of union being sometimes transverse, and at other times oblique. At this stage the earthy elements are received, and the lines of union between the component cells of the fibres become less distinct, and are eventually lost, leaving a continuous fibre. The nuclei, from the first, very small, are altogether lost in the formation of the fibres, or exist as very fine tubes passing through the length of each. The lateral union between the fibres is at

Fig. 58.

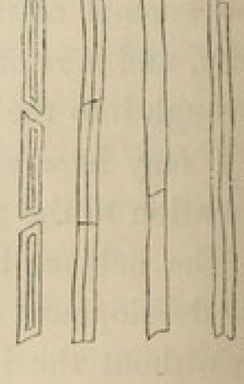
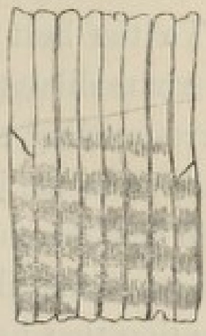


Diagram of Enamel Fibres in progressive stages of development, from the cells of the columns.

this stage very slight, so that a fragment of newly formed enamel may with great readiness be reduced to powder. The powder so obtained is, by the aid of the microscope, seen to be composed of enamel fibres disunited laterally. Even when a tooth passes through the gum, the lateral union is not very strong. We see a proof of this in the broken surface produced by the pressure of the forceps on teeth that have from want of sufficient alveolar space been removed soon after their appearance. The enamel, however, continues for a considerable time to increase in density, and at length becomes so hard that it is with difficulty that a steel instrument is made to produce any effect upon its surface. Recently developed enamel, from the innumerable interspaces between the fibres, is very opaque or pearly. These interspaces, however, become gradually less numerous, and at last, in perfectly formed enamel, are almost entirely lost. Thus we have what may be termed a progressive growth towards the perfecting of the tissue of the enamel after the appearance of the tooth through the gum; a fact which has, I think, been overlooked, especially by those who have considered that the dental tissues are devoid of vitality.

Fig. 59.



Recently formed Enamel, marked by Striæ, consequent on slight dilatations in the fibres.

Mr. Lintott states that "each enamel fibre is invested by a thin sheath of membrane, which is divided into a number of small oblong spaces, by little partitions sent inwards from the internal surface of the membrane; so that, when the enamel fibre is closely examined, it appears marked, at pretty regular distances, by transverse lines, the interspaces between each of these lines being occupied by a minute crystalline hexagonal block, and the other fibre being composed of a continuous series of such blocks."[a] The existence of transverse marking in the enamel fibre is unquestionable; but this manner of accounting for them cannot, I think, be supported. If these

[a] Lintott *on the Structure and Pathology of the Human Teeth.*

transverse laminæ of membrane existed in the adult fibre, we should expect to find them in the columns of the enamel matrix, and in young enamel, but in neither of these can I discover the slightest trace of their existence.

To the best of my belief, the transverse striæ are due to the alternate dilatation and contraction of the fibres, each dilatation corresponding to the centre of a formative cell, and each contraction to the junction of two cells. (Fig. 59.)

When on the structure of the enamel, I mentioned several kinds of faultily formed tissue. There are others I did not mention that have a close connection with caries, and we may advantageously postpone their consideration till we get upon the diseases of the dental tissues.

The cemental pulp and its ossification.—You will remember it was stated in a previous lecture, that with the commencement of the formation of the fang of the tooth, the capsule becomes adherent to its surface. The adhesion is effected between the inner surface of the cement pulp and the external surface of the dentine of the neck and fang; the development of the fang portion of the dentinal pulp and the cemental pulp being consentaneous.

The enamel pulp and the dentine pulp attain the full size of the parts for the development of which they are destined, before calcification of their substance commences. Not so, however, with the cement pulp; this increases on the external surface as calcification is progressing from within outwards, the former action supplying and keeping slightly in advance of the latter.

The cemental pulp is composed of nucleated cells, extended through a granular base, diffused in fibrous tissue, and each is gradually lost in the more external fibrous tissue of the coat dental sac and periosteum of the alveolus. The nucleated cells, as regards general character and use, are analogous to those of the other dental pulps, but in appearance more closely resemble the nucleated cells of temporary cartilage. They are oval in shape, have their long axes placed transversely, and at right angles to the length of the tooth.

When so arranged, the nuclei being transparent, present the appearance of cavities, which, indeed, they ultimately become. The parietes of the cells, and the interposed granular tissue, receive the phosphate and other salts of lime. The cells, with the intervening blastema nearest the surface of the dentine, are the first to be ossified; and the action commencing on the inner, is gradually extended towards the outer surface of the cement pulp, till the whole is ossified.

Near the neck of the tooth, where the cemental pulp exists only as a thin layer investing the dentine, blastema is alone present, but, as the layer thickens progressively towards the end of the root, the nucleated cells appear. If we examine a single cell, or corpuscle, as these bodies are commonly called, we shall find that at its first appearance it is small, with one or two nuclei; that it gradually increases in size; the nuclei, also increasing, are succeeded by a cavity; that the walls of the cell, with the surrounding blastema, receive the salts of lime; and that, lastly, the radiating tubes are developed.

The cemental pulp, when first developed, seems to have entangled in its substance some of the fibres of the inclosing sac. Whether these fibres are ultimately removed, or become identified with the blastema, remains to be decided; but it is highly probable that they become modified, and ultimately calcify with the surrounding parts.

In development, the cemental pulp bears a very close analogy to the progressive formation of cartilage for the development of the flat bones, surrounding which, at the various stages of growth, we find a thin border of cartilage, in which the osseous tissue is developing. This border of cartilage increases on the outer surface, while it decreases by conversion into bone on the inner surface.

The osseous layer of the fang is very liable to hypertrophy, which state we are accustomed to speak of as exostosis. In these cases an action is set up whereby new cemental pulp is formed, and transformed into cement. The action is accompanied by inflammatory symptoms, and resembles in its results that action which produces thickening of bone, which also is generally ascribed to inflammation. As dental exostosis constitutes a disease, we shall come to the subject in a future lecture.

I have now given you some account of what may be termed the new views upon dental development, most of which have arisen from microscopic investigation. I will now occupy your time for a few minutes in describing the old, and now discarded, views. In doing so, I shall not quote the various authors who have written upon dental development, or their peculiar theories. Such a course would be out of place in these lectures; but I will give you a slight outline of the opinions which were generally held.

Nothing definite was known of dental formation prior to what we now recognise as the saccular stage. The sac was described as consisting of two lamellæ, each vascular, and connected to the inclosed pulp only at its base. The pulp was stated to be covered by an extremely delicate vascular membrane, supposed to be derived from the periosteum of the jaw. At the fourth month the tops of the pulp were found coated with tooth substance, which was regarded as a secretion for the external membrane of the pulp, and lying in contact with the inner membrane of the sac.

The tooth itself was supposed to be composed of a series of superimposed laminæ, secreted by the membrane of the pulp, which, becoming exhausted by its action, progressively diminished in bulk, and gave place to the secreted substance. At length the secretion of tooth substance ceases, and then a cavity is left, which is lined by its proper membrane; which I presume was supposed to be that which has been described as the secreting organ. This membrane of the pulp is, I doubt not, that which I have described to you as the first to undergo ossification; and, when so changed, forms the base for the reception of the enamel fibres. In the formation of the enamel the inner membrane of the sac was supposed to be solely concerned; this was described as becoming more vascular, thickening in substance, and, after undergoing these preparatory changes, pouring out a thick fluid, which consolidates, and afterwards becomes hard by a process resembling crystallization. The external lamina of the sac was considered to be the organ for the secretion of the cementum.

Much has been written upon the membranes of the teeth: Mr. Bell divides these into deciduous and persistent. The deciduous membranes are two only—the two comprising the sac. The persistent membranes are three in number: first, the lining membrane of the dental cavity, and the secreting membrane of tooth substance; second, the periosteum of the root; and third, the periosteum of the alveoli. The periosteum of the maxillary bones was considered as the origin of the three persistent membranes. These views, which for many years were received as established, are now superseded by those advanced by Mr. Goodsir, and these have, I believe, been confirmed by subsequent investigations made by other anatomists.

In a former lecture, when tracing the analogy between the teeth and the mandibles of birds and tortoises, I mentioned that there was considerable similarity in the mode of development. Mr. Owen has found that the bill of the tortoise is developed in separate parts by papillæ, similar to the papillæ of the teeth. The parts, at first separate, become confluent as the process of formation advances; so that at birth the papillary origin is no longer traceable.

LECTURE VI.

ERUPTION OF THE TEMPORARY TEETH.—GROWTH OF THE JAWS.—ERUPTION OF THE PERMANENT TEETH.—THE TEETH AN INDEX TO THE AGE WHEN BETWEEN SEVEN AND THIRTEEN YEARS.—THIRD SET OF TEETH.—SUPERNUMERARY TEETH.—BLOOD-STAINED AND JAUNDICED TEETH.—HEREDITARY CHARACTER OF TEETH.—FORM OF THE TEETH AND PALATE AS NECESSARY TO VOICE AND SPEECH.

Eruption of the temporary teeth.—The next subject for our consideration will be the eruption of the temporary teeth. Teething, as this process of nature is not uncommonly denominated, is alike interesting to the physiologist and to the medical practitioner. To the one the absorption of the gum and dental sac in making way for the growing tooth, forms an interesting subject for observation; to the other, the time and the signs which precede and accompany the eruptions of the teeth, are matters of interest, as an acquaintance with these enables the practitioner to answer the oft-repeated questions, "When should the teeth be cut? Why are they not? Will any harm come as a consequence of the late appearance of the teeth?" and a thousand other such questions suggested to the minds of those who have the care of children.

We have seen that, as early as the sixth week of intra-uterine life, dental development commences. From that period the growth of the dental apparatus, in common with the other organs of the body, steadily progresses. At a definite period of infancy, the teeth, unlike the other organs of the body, are perfected and grow no more. Previous to the completion of the fang, the crown, which is already perfected, appears through the gum, after which the root is rapidly developed. But before the body of the tooth can assume its ultimate position in the alveolar arch the super-imposed gum must be removed. This action proceeds gradually, and without any manifest inconvenience to the healthy infant, until the mucous membrane alone remains over the surface of the crown of the tooth, when slight symptoms, characteristic of local irritation, manifest themselves. These are not, however, invariably present; for it sometimes happens that teeth are cut, without any attendant irritation—their coming is unobserved until the tooth has passed through the gum.

How the absorption of the gum is called into action, whether by the pressure of the tooth, or by the laws regulating development, and thus preparing a passage for the tooth so soon as space is required, is a point as yet undetermined.

Prior to the appearance of a tooth the superimposed gum increases in breadth, becomes turgid, and feels hot to the touch. Accompanying these symptoms there is an increased flow of saliva, which constantly escapes from the mouth; the child thrusts whatever may be placed in its hands to the mouth, and frequently bursts out in a fit of crying, when any foreign substance has come in contact with the gum. The breast is often suddenly relinquished, and again seized; in a word, we have just such symptoms as we should expect would arise from an irritable and sore gum. The child is more fretful than usual, and has sudden fits of crying, starts in its sleep, which is liable to be disturbed. The cheeks are occasionally flushed, the stomach and bowels are likely to become deranged also, as manifested by ejection of the food, or diarrhœa. A dry hard cough sometimes attends the eruption of each tooth. Even these symptoms of teething are, however, in some instances absent; a condition we should naturally expect, when it is considered that dentition, though frequently attended with suffering, is in itself a healthy action, and therefore, when accompanied with perfect health throughout the body, would necessarily be unattended with indisposition.

Dissection has shown that the papillæ of the milk teeth are not developed all at one time, but in succession, one following the other. From this we might suppose that the teeth would appear through the gum, in the same order in which the papillæ appeared in the maxillæ. The temporary teeth do appear in pairs, but not in the same order, as the papillæ have been seen to take their respective places in the primary dental groove.

About the sixth, seventh, or eighth month after birth, the central incisors of the under jaw appear through the gum. These are in a week or two succeeded by the corresponding teeth of the upper jaw.

In a month or six weeks after the eruption of the central incisors we may expect the lateral incisors to make their appearance; those of the upper jaw being evolved first. About the twelfth or fourteenth month, the anterior molars of the under jaw are cut, and shortly afterwards those of the upper maxilla. The canines appear between the sixteenth and twentieth; and between the twentieth and thirtieth month the second milk molars pass through the gum. Thus, according to this statement, the twenty milk teeth are complete by the thirtieth month. You must not, however, expect to find in all instances this regularity either as to the time or order of the eruption of the teeth.

Authors, indeed, do not agree in their statements as to the time at which the various teeth are cut. I shall, therefore, direct your attention to the table, in which is arranged, under separate heads, the time at which each tooth appears, as stated by some of our best writers upon dental surgery. I premise, that the following are stated only as the average periods at which the several teeth appear.

Authors.	Central incisors.	Lateral incisors.	Canines.	1st molar.	2nd molar.
	Months.	Months.	Months.	Months.	Months.
Fox . .	6, 7, 8 extreme cases 4 to 13	7, 8, or 9	17 to 18	14 to 16	24 to 30
Hunter .	7, 8, 9	7, 8, or 9	20 to 24	20 to 24	20 to 24
Bell . .	5 to 8	7 to 10	14 to 20	12 to 16	18 to 36
Dr. Ashburner	7th lower jaw 8th upper jaw	9th upper jaw 10th lower teeth	16, 17, 18, 19, or 20	12 to 14	22 to 30

THE ORDER OF THE FIRST DENTITION.

Authors.		Incisors.		Canines.	Molares.		
		Central.	Lateral.		First.	Second.	
Sir R. Croft.		2	3	7	5	9	Upper jaw.
		1	4	8	6	10	Lower jaw.
Dr. Ashburner.		2	4	6	5	8	Upper jaw.
		1	3	7	5	8	Lower jaw.

The temporary teeth are very rarely subject to irregularity either in position, number, or form. There are, however, cases recorded, in which the usual order has been departed from. Dr. Brown, in the American Journal of Dental Surgery, mentions an instance which came under his own observation, in which the central incisors were through at birth. This occurred in a first child, and the teeth were extracted. Afterwards two other children were born, each with the central incisors of the under jaw through. The three children were girls, and in the two last the teeth were allowed to remain.

The following occurred in my own practice. In 1846 a child five weeks old was brought to the hospital by its mother, who complained that her infant had been born with two teeth in the lower jaw, that the breast had been injured by them, and moreover, that the child's upper jaw had also suffered from their presence. On examination, I found two sharp-edged rough-surfaced incisor teeth sticking up from the centre of the lower jaw. They were ill-shaped, imperfectly coated with enamel, and loose in the gum, and stood across instead of in a line with the alveolar arch.

After removal, it was found that the fangs were not more than one-third developed. In fact the teeth had attained about the normal amount of development for the age of the child, but had been protruded through the gums before they were fitted for eruption. An after process had been effected before the preparatory one had been completed.

The child was well-formed, and of the average size; and reported to be healthy.

Dr. Crump has described, in the Transactions of the Va Society of Surgeon-Dentists, a case of full dentition at birth, seen by himself, in North Carolina. The subject was a still-born black child. The alveoli were very imperfectly ossified. A similar case is reported by Dr. Lethbridge.

Many other instances have been described in which one or more central incisors were through at birth. Duval mentions two cases, a father and daughter: in each an incisor of the lower jaw was present at birth. The same author relates a case in which the central incisors never appeared. Fouchard speaks of a child who at six years of age had only a few front teeth.

There are two cases recorded, one by Boxalli, another by M. Baumes, in which the patient reached old age without a single tooth ever having appeared.

An interesting specimen of almost edentulous jaws was exhibited by Dr. Brinton at the Pathological Society, Feb. 7, 1848. The following account is taken from the Medical Gazette of Feb. 18. "The specimen was taken from a subject in King's College dissecting-room, aged 39: no history obtained.

"The alveolar process of each superior maxillary bone was wanting; a smooth convex border occupying the lower margin of the jaw. The deficiency was so considerable, that the inferior border of the zygoma and jaw were nearly in the same line. The canine tooth was present on each side; but, instead of its ordinary vertical direction, was parallel to the maxillary bone—the ordinarily internal border being superior, and in close contact with its margin. The socket of the tooth opened anteriorly, or towards the median line, while posteriorly a depression marked the termination of its extent backwards. The points of the horizontal teeth were thus opposed to each other, and only separated by a short interval in the median line.

"The tooth of the right side was very loose when first examined, and the specimen showed much of the socket to be deficient: otherwise the two sides completely corresponded to each other.

"The loose tooth exhibited a curious curve, being bent upon itself at a right angle near the terminal third of the fang, so that this latter portion preserved the normal vertical direction. The same curvature appeared to obtain on the opposite side. The lower jaw presented nothing remarkable.

"Dr. Brinton concluded that the deformity was congenital."

Dr. Thurnam, in a paper read before the Medico-Chirurgical Society, Feb. 8, 1848, described the cases of two cousins who, amongst other bodily defects, had but four teeth.

Dr. Williams, at the same meeting, said the cases related in Dr. Thurnam's paper "recalled to his mind that of a young lady who was described to him as being without hair and without teeth. When he saw her, he found that she was not entirely so. She was fifteen years of age; her hair was fine, scanty, and white; she had scarcely any hair on her eyebrows, or lashes. She had three or four projections resembling teeth, which were decayed."

I am not aware that there is any well-attested case of malformation of a temporary tooth. We, however, sometimes see a condition somewhat analogous to malformation, in the lateral union of two teeth. Three cases of this kind have come under my observation within a comparatively short time, in two of which the central incisors of the under jaw were laterally united, and in the third a lateral incisor and canine of the under jaw were united. The line of junction was marked by a shallow groove coated with enamel. Fouchard gives two cases in which there was union between the lateral incisor and the canine; in one instance in the teeth of the upper jaw, in the other the teeth of the under jaw.

At present I have called your attention to dentition as it occurs in healthy children, unattended by any unfavourable symptoms; in a future lecture, the subject of interrupted dentition, with the concomitant disorders, will come under our consideration.

We have now traced the temporary teeth from their first appearance in the maxillæ to their completion, when they become efficient organs of mastication and articulation. This state they retain, until, with the lapse of time, the jaws increase in size, and stronger organs of mastication become necessary; nature then effects their removal by withdrawing their support, by absorption of the fangs; the crowns then, having no hold on the jaws, fall out. The spaces thus left are speedily filled by the permanent teeth, which rise up from within the alveoli.

We are accustomed to speak of the removal of the roots of temporary teeth as effected by absorption; however, there is but little known of the nature of this process. All we really know is, that the root of a tooth is removed gradually, that the process commences on the surface, and generally upon one spot only, from which it extends gradually till all the root is removed. Many writers, assuming that the tooth is absorbed by the adjoining tissue, attempt to explain how the action is produced; some believing that it arises from pressure on the temporary by the advancing permanent tooth; others, again, suppose that pressure has no such effect. The process of absorption of the fang of a temporary tooth usually commences on the surface near the apex, and produces, as its first effect, a small hollow; from this point the action spreads till the end of the fang has been exhausted; it then proceeds towards the crown, until arrested by the edge of the enamel. The tooth, having lost all hold upon the gum, falls out. We then see that even the crown has not wholly escaped the devastating force, for it is found to be hollowed out from within. In some instances absorption commences upon two points of the fang, and spreads from each.

Such is the process when effected under the most favourable circumstances. But it not unfrequently happens that absorption commences high up the fang, producing partial removal only. In the meanwhile the permanent tooth advances, and occupies the space vacated by the removal of the one-half of the fang of the milk tooth. In such instances the absorption no longer continues in the remaining half of the temporary fang; the action is arrested, and the tooth is retained, slightly displaced itself, and slightly displacing the permanent tooth.

This condition is most commonly met with in the canine teeth, though it is by no means uncommon in the incisors of the upper jaw. In the milk molars absorption goes on in the several fangs at the same time. How the absorption of the fangs of the milk teeth is effected, what is the nature of the process, or whether the process is really an active force exercised upon the tooth by the adjoining parts, or inherent in the tooth, remains at present to be determined. It is certain that, if a milk tooth be dead, the fang is not absorbed. From this it may, I think, be fairly assumed, that it is necessary that there should be vitality in the tooth for the absorption to go on. On the other hand, I have repeatedly observed, that the surface of the periosteum opposed to the wasting surface of the fang is highly vascular, and closely applied, though inadherent to that surface. On removing a milk tooth, where the whole of the fang has been removed, we find the crown excavated, and the excavation occupied by an unattached vascular papilla.

From these facts we are led to conclude, that not only must a tooth possess vitality, but also that the surface where absorption is to proceed must be unattached to, but placed in contact with, a highly vascular structure [a].

Though we seem to possess some tolerably definite knowledge as to how the absorption of fluid matter is effected in organized bodies, namely, by imbibition, yet, at present, information is wanted as to the manner in which a solid living tissue is removed; and, until this is gained, our information on the subject of dental absorption will remain indefinite.

Eruption of the permanent teeth.—The period destined by nature for the existence of the milk teeth having passed, and

[a] This Dr. Ashburner has (in his work on dentition) described as a special organ for absorption.

their removal having been effected, the succeeding permanent teeth take their place in the jaws. This period varies in the different teeth, and is subject to some little variety in each individual.

On entering upon the subject of the second dentition, we must bear in mind that the molar teeth are not preceded by temporary teeth, but are cut like the teeth of the first dentition, each molar passing through the gum so soon as, by the growth of the jaw, sufficient alveolar surface is afforded. The second dentition, in the majority of cases, commences about the seventh year, and proceeds in the following order:—

First molar	7	years.
Central incisor	8	,,
Lateral incisor	9	,,
First bicuspis	10	,,
Second bicuspis	11	,,
Cuspidatus	12	,,
Second molar	13	,,

The teeth of the lower jaw are commonly somewhat earlier by a month or two than those of the upper jaw.

At the sixth year the jaw contains both the temporary and the permanent teeth; the former in a perfect state, the latter partly formed.

In describing the development of the teeth, the relative position of the two sets was noted; but I will again call your attention to them at this particular age, since, by a knowledge of the relation of the two sets, we are enabled to understand and to treat the irregularities which sometimes occur in permanent teeth. To use the words of Mr. Bell:—" The jaws at from six to seven years of age contain no less than forty-eight teeth; namely, twenty deciduous, the whole of which are perfected, and twenty-eight permanent, in different degrees of development, within the bones.

The following is the relative position of the two sets at this period. The permanent central incisor of the lower jaw is placed immediately beneath the temporary, with its point directed a little backwards behind the partially absorbed root of the latter. The lateral incisor, not yet so far advanced, is placed deeper in the jaw, and, instead of being immediately beneath the temporary, is situated with its point between the roots of this and the cuspidatus. The permanent cuspidatus is still very deeply embedded in the bone, with its point rising between the roots of the temporary cuspidatus and the first temporary molaris. The two spreading roots of the latter encompass as it were within their space the first bicuspis, and those of the second temporary molar in like manner the second bicuspis.

Nearly a similar arrangement is found to exist in the upper jaw, excepting that the teeth are altogether more crowded. The lateral incisor is placed farther back, particularly its point; the cuspidatus is directed more outwards, as well as the bicuspides."

It has been generally supposed, that the permanent teeth are very irregular as to the time of their appearance; so much so, indeed, that no estimate of the age of a child could be formed by the number of permanent teeth present. Such, however, is not the case. Mr. Saunders, with great success, investigated the subject statistically, and has been led to the following results:—First, that at nine years of age the first permanent molars are developed. Second, that at the age of thirteen the whole of the permanent teeth, excepting the wisdom teeth, are present. In Mr. Saunders's monograph, entitled, "The Teeth as a Test of Age," is a full account of his researches. He concludes with the following paragraph:—

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

"Again, of 338 children under thirteen years of age, no less than 294 might have been pronounced with confidence to be of that age. The remaining 44 would have been considered as follows:—36 in their thirteenth, and 8 near the completion of their twelfth year."

It would seem, from Mr. Saunders's statements, that the intermediate ages between nine and thirteen—indeed, from seven to thirteen—may be estimated by examining the teeth. I am not aware that these assertions are backed by extended statistical research.

I have been, for some time past, engaged in collecting statistical facts upon the subject, but at present I have been unable to put them into definite form; however, I am prepared to corroborate the general correctness of Mr. Saunders's views.

The growth of the jaws.—We are indebted to the greatest man who has ever written on the subject of dental surgery, for our knowledge of the manner in which the jaws increase in size.

John Hunter made it known that the maxillæ, in their growth, present the peculiarity of increasing at the posterior parts only. After the eruption of the second milk molars, we find these teeth placed at the base of the coronoid process of the lower, and at the posterior edges of the upper jaw. At the age of seven, we find, on the contrary, the milk molars situated considerably in advance of these points. The jaws have, in fact, grown there; that is, anterior to the coronoid processes in the under jaw, and the tuberosities in the upper jaw. At the same time, that growth has proceeded rapidly, at the posterior divisions, no increase whatever has taken place anterior to the last milk molars, excepting some slight addition in depth and thickness.

The alveolar space found at the seventh year is, about that time, wholly occupied by the first permanent molar, which, when cut, lies close to the base of the before-named process. The maxillæ still grow, not, however, at the points between the coronoid process and the tuberosity and the last milk molars, but between the newly developed first permanent molars and these processes. So that a second space is formed in the jaw, which is, when sufficient, occupied by the development of the second permanent molar.

The growth continuing posterior to the second molar, a third space is formed, which is filled by the wisdom-tooth. The jaws then cease to grow, and change only after the loss of the teeth from age or disease.

Third sets of teeth.—Some few cases are recorded in which the permanent teeth were said to have been removed, and a third set to have taken their place. I have not in my own practice seen any confirmation of these statements, neither are dentists generally disposed to give much credit to the assertion. It would seem improbable that a third set of teeth should be formed, yet it is by no means impossible.

We see nature depart from her ordinary laws in producing irregularities in various parts of the body. I do not know, therefore, why we should regard the production of a third set of teeth as absolutely impossible. The point, however, is not likely to be set at rest, for the statement of patients cannot be depended on, as they are unable to distinguish between the temporary and permanent teeth, and dentists are not themselves likely to see from infancy to old age a patient subject to this peculiarity.

Teeth—members of the permanent set—from want of room in the alveolar arch, sometimes lie hidden in the gum, till, with the advance of age, the teeth fall out, and the gums recede; then they become exposed, and may be, and frequently are, mistaken for teeth of a third set.

Supernumerary teeth.—Thirty-two is the number of the permanent teeth; but supernumerary teeth are not very uncommon. When found, they are mostly of a conical form, single-fanged, and placed between the other teeth. I have seen a case in which a supernumerary tooth had grown between and behind the central incisors of the upper jaw. Sometimes they are placed between the molars. I believe they are far more common in the upper than in the lower jaw. When occurring between the molar teeth, the supernumerary tooth looks in form, and sometimes in position, as though it had been formed by the disunion of one of the cusps and roots of the contiguous tooth during the earlier stages of its development.

Hereditary character of the teeth.—It is a well-attested fact, that the properties of the parent are to a considerable extent transmitted to the offspring. In no part of the body is this hereditary character more frequently displayed than in the teeth, and especially as regards the external form. If the teeth of the parents be strong, and well formed, we may expect to find similar teeth in the child—unless, indeed, the child be unhealthy. Peculiarities in colour, and in position, are often transmitted. The predisposition to early decay often passes from the parent to the child. It does not, however, follow that the hereditary peculiarity in dental formation will in all cases appear; on the contrary, we sometimes see cases in which the reverse has manifestly occurred. Again, a peculiarity may not reappear in the first or even the second generation, but show itself in the third remove from the original parent. These facts are worth bearing in mind, as they often influence the treatment of the anormal conditions of the teeth. Not that the fact of a malady having occurred in the parent of a patient will of itself indicate a peculiar treatment; but you will probably learn how a remedy was, or was not, effected by the treatment adopted in this previous instance. Such knowledge you will find especially useful when similar cases have occurred in the children of one family.

Stained teeth.—It has been observed, in persons who have died from suffocation, that the teeth are in some cases stained red. This state, before the structure of the teeth was understood, was considered to be a proof of their vascularity. It was supposed that the blood imparting the colour was contained in vessels which, in these cases, were gorged by the mode of death. This, I need not tell you, is an incorrect hypothesis: vessels, when they do exist in the substance of the tooth, are never present in such number as to give a red colour to the dental tissues. We shall find the more correct explanation by considering the state of the blood in asphyxia. The colouring matter of normal blood resides entirely in the globules. The liquor sanguinis is perfectly colourless. But under certain circumstances the coloured globules decompose, or are dissolved in the liquor sanguinis, which then becomes a deep red. The tubuli of the teeth, though too small to admit the red globules of the blood, freely admit the liquor sanguinis; and, if this be coloured red, the tooth itself will necessarily take the same hue.

In persons suffering from jaundice, the teeth become tinged. In some few instances they take a deep yellow, almost equalling in intensity the colour of the skin, but, in the majority of cases, they assume only a faint tinge of yellow.

In taking a retrospective view of the anatomy and physiology of the teeth, we are forcibly struck with the adaptation of these organs to their peculiar functions. Early in life, when the jaws are small and comparatively powerless, the small and more delicate milk teeth are provided by nature, to perform the necessary office of mastication. When the body has increased in size, and the jaws have become larger and more powerful, the smaller teeth are, by a natural process, removed, and a stronger and more numerous set is developed, with which we are enabled to masticate the more solid food required for the sustenance of the adult.

Like the bones generally, the teeth are required to support mechanical resistance, and in them, too, we find the structure admirably adapted to this end, but in the teeth the mechanical force is direct in its application; and in them we find a peculiar arrangement of osseous structure, enabling them to withstand without injury the force so applied. And, as a further adaptation, the teeth are endowed with a lower degree of organization than the bones, and are thence less susceptible of injury; while the latter, clothed with soft tissues, and capped with cartilage, are thus defended from the more immediate effects of mechanical force.

The teeth are said to possess in themselves no power of reproduction by which an injury can be repaired. This is not strictly true. The injury to which, in a state of nature and health, they are most liable, is wearing away of the masticating surface from use. The worn surface certainly is not renewed, but the teeth increase in density, and the pulp-cavity diminishes in size by the formation of dentine, so that the actual amount of dentine is not diminished, while the density is increased. In each of these actions we may recognise a form of renewal which in some degree compensates for the loss by abrasion. If the whole act of mastication is from any cause thrown upon two or three teeth, then these naturally, by the excessive use, wear away, till at last the whole crown is exhausted. Then, again, they make an effort to resist the inroad of caries, as I shall show you when we come to treat of that destructive disease.

The teeth are important as organs of articulation; so much so, that, when lost, we can scarcely make ourselves intelligible. The physiology of the teeth, when limited to this use, is well worth investigating, had we time at our disposal; but, before leaving this part of our subject, I may draw your attention to a few curious facts, in connection with the form of the mouth, in those possessed of a good voice, and with power to use it in song.

Wherever you have a fine, clear, sonorous voice, you will find well-formed and well-arranged teeth; each tooth will occupy its proper place. But, what is perhaps still more important, the hard palate will be well formed; that is, it will present a section of a large arch, perfectly free from contraction either, from side to side, or from before backwards. There will not be a deep vaulted form, neither will there be a sudden elevation immediately behind the front teeth, so common in those who speak with indistinctness—on the contrary, the palate will rise gradually.

The mouth, and its dental appendages, are not of the first importance in relation to the voice, yet they are highly important as auxiliaries, and, as such, their condition should not be lost sight of.

The vocal organ may be good, even first-rate, but the mouth and teeth must be well formed, or the voice will be injured in its passage through the mouth.

Those who are by nature endowed with the first qualities of voice, and have passed through an efficient course of vocal cultivation, sing with a fine, pure, clear, full tone, and articulate in their song with distinctness. They pass from one note to another rapidly, with full and even tone, and articulate words as distinctly as in ordinary speaking, and yet, in doing this, lose nothing in quality of tone.

On the contrary, those who by nature are less favoured (whatever may be their degree of cultivation) have supplementary sounds, in, or between, their notes. The tones do not flow freely. A slight hissing, or a cavernous, or a nasal sound, may be distinguished either in the tones themselves, or as the artiste passes from one tone to another. Great effort is made, and yet but little effect produced. The hearer feels as though there was some impediment to the free delivery of the voice. When the words are distinctly articulated, the voice loses in tone. This induces the vocalist, who feels that both good tone and the clear enunciation of words cannot be gained, to sacrifice the words to the tone, so that the bystander hears the air only—the words are lost.

It has been usual to impute these defects altogether to want of cultivation, or to inferiority of voice, the one or the other, as the defects are more or less apparent.

I think, however, it may be shown that they are frequently the necessary consequence of the form of the mouth and palate. And further, that, by inspecting the mouth, the degree of excellence to which the artiste can arrive may be foretold.

In other words, that a good orifice of exit is necessary as an adjunct to a good vocal organ, before excellence in the vocal art can be attained.

These observations have been made when inspecting the mouths of professional and other vocalists. At present I offer them without going into details, but, after further confirmation, I hope to place them on a more extended scale, and in a more useful form.

It is to be lamented that so much time and labour are spent, in early life, when time is most valuable, in learning singing; and yet so little progress made, that the pupil is, after all the expenditure, unable to sing moderately well. Surely it is desirable that the time should be otherwise employed, if the failure could be foretold in the formation of the mouth. And, on the contrary, that even more should be spent, when the capability for success is indicated.

LECTURE VII.

ABNORMAL CONDITIONS OF THE FIRST DENTITION.—DISEASES OF THE GUMS BEFORE AND DURING THE ERUPTION OF THE MILK TEETH (INFLAMMATION AND INDURATION).—DISEASES OF THE TISSUES OF THE MILK TEETH (CARIES AND NECROSIS).—DISEASES OF THE GUMS AFTER THE ERUPTION OF THE MILK TEETH.—DISEASE OF THE ALVEOLAR PERIOSTEUM OF THE MILK TEETH.

EIGHT years since, when resident within the walls of this hospital, filling the office of house surgeon, I determined to direct my attention to diseases of the teeth, and to practise exclusively this branch of the reparative art. From that time to the present, it has been my habit to take tolerably full notes of the more instructive cases of dental disease that have come under my notice, and to these have been added others related by the various writers on Dental Surgery, whose works I have read.

The main point I have had in view has been to collect useful illustrations of the various forms of dental disease, and of the consequences they may induce.

In order to accomplish this purpose, and at the same time to have the cases in a useable form, it has been necessary to arrange the subject in divisions and subdivisions. Thus, diseases of the temporary teeth and their appendages are included in one division, and the maladies affecting the permanent teeth in another. Then, again, the disease of the dental tissues—of the gums, of the alveoli, and the alveolar periostea—form subdivisions. These, again, are subject to a second subdivision in special diseases of these several parts.

This arrangement, made to facilitate note-taking, and intended only for private use, has grown into a rude classification of the disease of the dental organs, and, in the absence of a better, may be followed in the succeeding lectures. I have, therefore, put it into the form of a table, a perusal of which will give you the order in which each malady will be discussed.

ABNORMAL STATES OF THE TEETH AND GUMS.

Abnormal conditions during the presence of the milk teeth.	Diseases of the gums before the eruption of the teeth.	Inflammation. Induration.
	Diseases of the dental tissues	Caries. Necrosis.
	Diseases of the gums after the eruption of the teeth.	Inflammation. Ulceration.
	Diseases of the alveolar periosteum . .	Inflammation.
Abnormal conditions during the presence of the permanent teeth.	Irregularity in the time of eruption of the permanent teeth.	
	Irregularity in the position of the permanent teeth.	
	Mechanical injuries of the teeth . .	Fracture. Dilaceration. Dislocation.
	Mechanical injuries of the alveoli . .	Fracture.
	Diseases of the dental tissues	Caries. Necrosis. Exostosis. Abscess. Loss from the surface. Absorption. Pain.
	Diseases of the pulp	Irritation. Inflammation. Ulceration. Granulation, or polypus.
	Diseases of the alveolar periosteum . .	Inflammation, *acute*, *chronic*, and *rheumatic*. Hemorrhage.
	Diseases of the alveoli	Inflammation. Necrosis. Exostosis. Absorption.
	Diseases of the gums	Inflammation, *acute* and *chronic*. Ulceration. Recedence. Tumors. Epulis. Polypus. Vascular tumors. Blue gum.
	Tartar.	

In accordance with this plan, we shall first direct our attention to the abnormal conditions of the teeth and gums during the first dentition. I have already described to you the symptoms which bring in and accompany the eruption of the milk teeth in the healthy subject: it now remains for me to direct your attention to the process when attended with unfavourable symptoms—to interrupted dentition.

The progress of dental development may be for awhile suspended, in consequence of some temporary state of the system, and the coming through of the teeth thereby delayed. But this would be called suspended, rather than interrupted dentition. The latter term I shall restrict to that condition in which the development does, or would go on, and the teeth be erupted but for some mechanical obstacle, and this we find in the superimposed gum.

The attendant symptoms are both local and general; but as the latter generally arise out of, and are consequent upon, the local symptoms, we shall take the local condition of the gums as the base of this division of the subject.

Interrupted dentition is accompanied by either inflammation or induration of the gums, or by a combination of these conditions.

Inflammation of the gums.—The local symptoms are: swelling, heat, redness, and pain, accompanied by excessive tenderness, so that the slightest pressure on the affected part becomes intolerable. These symptoms will vary in degree in different cases, and they will vary relatively also. In one case the swelling will be great, while the heat and redness will be moderate, and vice versâ.

Aphthous ulceration of the mucous membrane of the mouth may supervene, and is not unfrequently accompanied with swelling and tenderness of the salivary glands. There is, too, a profuse flow of viscid saliva.

With these local symptoms we have general disturbance of the system, evinced by a dry, hot skin, rapid pulse, hurried respiration, thirst, broken sleep, vitiated and scanty secretions. But, in addition to these local and general symptoms of abnormal dentition, it not unfrequently happens that sympathetic affections arise, and these of no trivial nature. In the excited state of the system during painful dentition, inflammation, either acute or chronic, may attack any organ of the body. The organs of respiration, and the brain and nervous system, seem to be the most susceptible. Bowel complaints, terminating in mesenteric disease, sometimes supervene.

Many of the symptoms arising from interrupted dentition are of a purely nervous character. These vary, from slight spasmodic twitching of the muscles, to violent convulsions, ending in death.

Sudden development of the teeth; the appearance of several teeth at the same time; the evolution of the teeth at an early age; unequal rate of development in the teeth and jaw, so that there is want of sufficient space for the teeth; delicate health of the patient; are enumerated as the causes of abnormal dentition, and the attendant diseases. But pressure produced by the growing tooth upon the inflamed gum, and indirectly upon the formative pulp, are justly considered as the more immediate causes of the active symptoms.

The inflammation of the gums, together with the sympathetic affections, not unfrequently precede some time the appearance of the tooth. The teeth are then said to be breeding. Towards the later stage of the process, the gums, instead of presenting uniform redness, are red only at the base, while that portion which lies over the coming tooth is tense, pale, and bloodless—a condition produced by the pressure of the tooth from within. In this, and in the previous stages of the inflammation, the epithelium readily peels off the surface of the affected gum, which then bleeds from the slightest touch. If nature be allowed to take her course, the tooth after awhile appears through the gum, and the little patient, if no serious coincident disease has established itself, returns to good health.

But instead of dentition proceeding, and nature working her own cure, serious maladies of fatal character may seize and carry off the patient in a few hours. Inflammation may attack a vital organ, and yield to no treatment. Cerebral symptoms may arise, and terminate in coma, or in fatal convulsions.

The primary or predisposing cause of the alarming sympathetic diseases I have enumerated as connected with dentition, is often overlooked, from the very intensity of the diseases themselves, and attention is alone directed to their relief, without a thought being given to the predisposing cause. Not that any local treatment, addressed to the gums, would remove inflammation affecting a distant organ arising as a consequence of irritation existing in the gums; yet, if that irritation be removed, the chances of recovery will be greatly enhanced.

It will be your duty then, whenever called upon to treat a child suffering from disease, whatever be the nature of the disease (unless of specific character, such as small-pox), to inquire into the state of the dentition, and if you find the gums inflamed, and a tooth presenting, to freely lance the superimposed gum. It is useless to lance the gum superficially; it should be divided down to the surface of the pressing tooth, even if this be at some little depth in the gum. Having relieved the state of the gum, attention must then be directed to the coincident malady.

It has been supposed by many practitioners that lancing the gums before a tooth is ready to come through, retards rather than facilitates the future passage of the tooth. They consider that the cicatrix, formed after the lancing, is less readily absorbed than the gum would have been had there been no cicatrix, and, therefore, that an obstacle is created by the operation; unless, indeed, the tooth is so near the surface that it passes through the wound before the gum can heal. The assumption is not borne out by observation; cicatrices are more readily absorbed than natural tissues. You have many opportunities of observing how prone a cicatrix is to absorb, in the frequent recurrence of ulcers on cicatrices of the leg, and other parts of the body.

Induration of the gums.—Instead of the gums being removed to make way for the teeth, we sometimes find they become indurated and thickened, and offer a serious obstacle to their evolution.

In this condition there is no considerable tenderness, and scarcely any increase in the quantity of saliva. The gum, on inspection, is elevated, but not more florid than the neighbouring parts. Indeed, the local symptoms are slight, and often overlooked.

In connection with interrupted dentition, accompanied with these local conditions, the general symptoms are not less severe than where there is inflammation of the gums. The skin is hot and dry, the appetite fails: the child will often refuse the breast for an unusually long period. This state of health is often attributed to the presence of worms, and medicines are given to effect their expulsion.

The following case occurred in an inmate of my house. The child, a boy, seven months old, usually very healthy, became extremely irritable, the cheeks were flushed, and he cried frequently, without apparent cause; he slept badly, and refused his food, or took it at irregular intervals. On examination, the lower central incisors could be indistinctly felt in outline, on the anterior surface, but could not be at all distinguished on the ridge of the gums, which part was not more elevated than the adjoining gum: nor was it more florid. The gums were incised on the ridge, over the central teeth, and the lancet sunk three-sixteenths of an inch into the gum before it came in contact with the teeth. On the following day, at the same hour, each tooth could be seen above the level of the gums, so that the teeth must have risen, in twenty-four hours, more than the eighth of an inch. The child, too, had perfectly regained his comfort.

In induration, as in inflammation of the gums, either inflammatory or spasmodic diseases may arise, and require active treatment, the remedies being such as the character of the disorder may indicate; but in no instance must we neglect to make free incisions in the gums over the teeth that are bound down by the hardened tissues.

Where the symptomatic disease is of a purely spasmodic character, this simple operation will sometimes produce instant remission of the symptoms, but when the disorder has advanced to alteration of structure, the most we can expect will be a remission in the intensity of the symptoms, and a state of system more favourable for the action of remedies useful in the treatment of the disease.

Dr. Ashburner has written a very valuable work on Dentition, and its coincident disorders, in which a great number of cases are given, where lancing the gums produced instant relief to serious and distressing spasmodic diseases. The two following cases are taken from his work.

"I attended a fine boy, from the cutting of his first incisor tooth to the completion of his dentition of twenty teeth. He was the last child of a family in which all the children had afforded examples of abnormal dentition. This boy was of a nervous temperament, with black hair and eyes: every tooth had come forward with a want of biliary secretion. Nothing could exceed the care observed by the mother as to the diet of this infant; yet, whenever an effort at developing a tooth took place, she was always aware, from the deficiency of bile in the evacuations, that he was to have a slight fever, sometimes with a catarrh and cough, always with twitchings of the face and fingers, and starting and moaning during sleep, and a catch in fetching a deep sigh. With the appearance of the four first molars, the spasms were more severe. The thumb of the right hand was thrust into the palm, and the fingers clinched upon it; the toes were drawn down, the face was distorted. These spasms relaxed and reappeared. I found on these occasions that the tooth was always abnormal in its progress; seldom observing its turn, and never its time. The gum lancet, freely used, always cured these spasms. On the last occasion I was sent for in great haste, for the spasms had continued into an epileptic fit, from which I speedily and effectually relieved my little patient, by cutting through the capsule of the coming tooth."

"I was called one evening to the child of a lady in Regent Street. It was a fine girl, of fourteen months old. The head was large; dark hair, dark eyes. It was in a tub of warm water, quite insensible, passing from a state of epilepsy into tetanus. Its eyes were not influenced by light; the pupils remained dilated. The anterior molaris of the left side, in the upper jaw, was ready to come through. I cut freely through its capsules with my gum lancet; in two minutes the child was on its knees in the water, playing with the handle of the tub, in excellent spirits. This child had been twitching the angle of its mouth, and had had its right arm spasmodically affected during the day."

Mr. Bell, in speaking of the diseases consequent upon the irritation produced by abnormal first dentition, and in reference to the frequent occurrence of diseases of the brain from this cause, makes the following remarks:—

"The brain, too, is frequently affected; the pupils of the eyes are permanently expanded, the head is continually moved to and fro, with an uneasy restless motion, accompanied with an incessant moaning. Spasm of the voluntary muscles frequently succeeds, and convulsions at length recur at intervals, with increasing violence; which, unless immediate relief be obtained, too often terminate at once the little patient's sufferings and existence. The symptoms which I have here described as connected with a morbid state of the brain, often arising either from the overcharged condition of the vessels, or from actual effusion, do not always terminate fatally; but even where they are for the time relieved, and their acute form subdued, the occurrence of confirmed hydrocephalus is amongst the most common results of such affections. It appears, indeed, that the irritation has not been sufficiently attended to as the origin of this disease. Were this view of its cause more generally taken, it is, I think, probable that it may, in many cases, be arrested in its earlier stages, and its dreadful consequences—death, or a state of idiocy far worse than death—be frequently prevented."

Caries and necrosis of the temporary teeth.—The temporary teeth are subject to death and decomposition of a portion, constituting what is generally called caries, and to death of the whole tooth, constituting necrosis of the tooth. The former of these affections is equally common to the temporary and permanent teeth, and will be considered when we come to the diseases of the permanent teeth. But necrosis is more frequently found in the milk teeth, and, moreover, presents some peculiarities.

Dental necrosis in the young subject is usually consequent upon the destruction of the whole or part of the crown by caries. The pulp, from the exposure, is destroyed; after which, all vitality is lost in the fangs. Supposing absorption of the roots to have commenced, the process is arrested, the remaining portions of the fangs become discoloured, and the inclosing alveoli become absorbed. The gum then inflames and ulcerates, and the fangs of the tooth are exposed on the surface, from which, in a little time, they become detached. In the process, the tooth itself is not unfrequently borne up towards the surface, and is found lying across the gum, with the fangs directed towards the cheek, which is not uncommonly ulcerated from the rough points irritating the surface of the mucous membrane.

It does not always happen that the inflammation produced by a necrosid tooth is slight in degree, or limited in its effects; on the contrary, the neighbouring teeth and alveoli may partake of the diseased action, and suffer necrosis; and, further, you may find in the separated sequestrum the rudiments of permanent teeth.

Treatment.—The dead tooth or teeth should be removed, and the inflammation combated by general treatment. If the ulcer in the cheeks presents an unhealthy appearance, the surface should be touched once or twice with sulphate of copper. If the alveoli are necrosid, time must be given for the dead bone to be separated from the living; but, so soon as this is effected, the sequestrum should be removed. During the time the dead bone remains in the mouth, a wash, composed of chloride of lime and water should be used, as a means of rendering the sequestrum less offensive, and of keeping the parts clean.

Diseases of the gums during the presence of the temporary teeth.—At this period of life the gums are liable to be attacked with inflammation and other diseases, which are equally common to childhood and after life. These require no special notice in this division of our subject, but will come under our notice when treating of the diseases of the gums generally.

The gums are, however, during childhood, subject to a peculiar form of ulceration closely allied to that form of disease which, occurring in the adult in any other situation than the mouth, is called *phagedena*, and which, when seated in the mouth, is by most writers called *cancrum oris*. The disease commences on the free edge of the gums, with inflammation, which is marked by swelling, vascularity, and lividity of surface. Ulceration then commences on the edge of the gums, and quickly extends towards the alveoli, destroying in its course the textures involved. The disease, in addition to extending towards the alveoli, proceeds to the gums of the neighbouring teeth, but in these, as in those first attacked, the free edges are the parts first destroyed. The most common seat of the disease at its commencement is the edge of the gums about the canine and first molar, and the gums of the lower jaw seem more liable to this malady than those of the upper maxillæ.

In the cases which have come under my observation, the ulceration has commenced on the edge of the outer gums, and, excepting in one case, has never passed to the gums between the teeth, and from thence to the inner gums. This may, however, have arisen from the cases being treated early, or being in themselves less severe than those occurring to other practitioners.

The surface of the cheek lying in contact with the ulcerated surface of the gums, becomes involved in a similar disease, so that the surfaces of the two ulcers lie in contact. The parts immediately surrounding the ulceration are thickened, indurated, and of a deep red colour.

The diseased action, in addition to extending over the surface of the gums, also affects, in an almost equal degree, the periosteal connection between the roots of the teeth and the alveoli. The teeth become loose, and seem in their loose state to cause by irritation the continuance of the disease. The teeth, instead of becoming merely loose, in severe cases are necrosid, blacken, and produce, by their presence as foreign bodies, an increase of the inflammatory action. The surface of the ulcer is so peculiar in character as to be immediately recognised; it is of a pale yellow, or straw colour, with here and there a red point, slightly raised above the general surface, which bleeds on the slightest touch. The disease in its progress quickly destroys the gums, and leaves exposed the alveoli, which then become necrosid. The ulceration, if unchecked by treatment, extends, in unfavourable cases, destroying in its course the textures of the mouth, till some large vessel is laid open, or the patient sinks from general exhaustion.

The causes of this destructive form of ulceration are for the most part constitutional. It is only seen in children of strumous habit of body, who, from some cause, are in a low and debilitated condition; and is most commonly found in those who have resided in damp and badly ventilated situations, and have been badly fed. When I held the office of dentist to King's College Hospital, a number of cases of this disease presented themselves, almost all of which came from the immediate neighbourhood of Clare Market. At this hospital I have seen but few cases, and these were slight, and readily yielded to treatment.

The peculiar form of ulceration which I have described has occurred, to a fearful extent, in the children of the Asylum of Philadelphia. A memoir was published, by Dr. Coates, in "The North American Medical and Surgical," for July, 1826, in which is an excellent account of a number of cases terminating fatally.

But in these cases two forms of disease are described under one name, *cancrum oris*. The one, similar to that I have described to you as commencing in ulceration about the edges of the gums; another, in which some part of the cheeks or fauces was attacked with sphacelus, succeeded by ulceration. The latter disease does not affect the gums, though it seems from Dr. Coates's paper to supervene in some cases upon ulceration of the gums. This disease, affecting other parts of the mouth than the gums, does not properly belong to our subject, and though in its nature allied to the corroding ulceration attacking the gums, will, I think, be found to possess points of dissimilarity sufficient to establish it as a distinct disease. For this reason I have not adopted the name of cancrum oris to the phagadenic ulceration of the gums.

Treatment.—To successfully combat the ulceration, both local and constitutional treatment must be adopted. The state of the bowels must be first attended to; a mild aperient should be given in the form of gray powder—this medicine answering the double purpose of stimulating the liver, which is generally defective in its secretions, and expelling any accumulation of acrid matter from the bowels. Tonics and liberal diet should then be administered. The local treatment must be similar to that adopted in ulceration of specific character,—ulceration which increases by the acridity of its own secretion; that is, the surface should be perfectly destroyed by some agent, which, by its chemical action, will decompose both the secretion and the surface of the sore. Nitrate of silver, or potassa fusa, or either of the mineral acids, will effect the purpose, but nitrate of silver is, perhaps, the preferable agent. In applying the remedy, the surface should be first wiped dry, and then with a stick of caustic the ulcerated part rubbed over, taking care that no point remains untouched. The immediate effect of the nitrate of silver will be marked by a change of colour of the surface to which it has been applied.

In no case under my own observation has this treatment failed. The superficial slough, caused by the nitrate of silver, has in the course of two or three days separated, leaving a healthy ulcer, which has readily healed.

Supposing any teeth have been rendered loose by the disease, they must be removed, otherwise they will keep up the action. The American author, in the cases to which I have alluded, used with success sulphate of copper as a local application.

The copper in my hands has not been equally successful.

After using it, I have been obliged to have recourse to the nitrate of silver. In a few obstinate cases, where the patients have been in wretched general health from want of proper or sufficient food, I have found it necessary to repeat the application of caustic, twice, or even three times, at intervals of six or eight days, before the ulcers assumed a healthy surface.

My friend, Dr. West, tells me that he has succeeded in curing the disease by the administration of chlorate of potassa, in small doses, repeated every four hours, and without having recourse to any local remedies.

This mode of treatment was, I believe, first made known to the profession by Dr. Henry Hunt, in a paper on "Cancrum Oris," published in vol. xxvi. of the Medico-Chirurgical Transactions.

Dr. Hunt gives the following as the result of his experience:—

"The quantity of salt (chlorate of potash) I have been in the habit of prescribing, varies from twenty to sixty grains, according to the age of the child, in divided doses, in twenty-four hours, dissolved in water; the beneficial effect is often observed on the following day, almost always on the second; the disagreeable fœtor soon lessens, the sores put on a healthy reparative action, the dribbling of saliva diminishes, and if there is mere ulceration, it speedily heals; if there is an eschar, it soon separates, and the sore granulates kindly. It is sometimes advisable, indeed necessary, that an aperient should be occasionally repeated."

Latterly I have used this preparation as directed by Dr. Hunt, and with great advantage. The cases that have come under my notice since leaving King's College Hospital are, however, but few, and these mild ones.

Disease of the alveolar periosteum of the temporary teeth.—The alveolar periosteum, which connects the fang of the tooth to the inclosing alveolus, is subject to diseased action. It may become generally inflamed, or a certain portion only may be affected. The cause which most frequently produces disease in this situation, is caries, or necrosis of the tooth; in which case the inflammation will at first be confined to the part surrounding the apex of the root, from which the membrane becomes separated. Pus is poured out from that surface, which is no longer adherent to the fang, so that the apex of the latter is placed in an abscess. Inflammation of the alveolar periosteum is recognised by pain in the tooth, extending to the jaw; slight elongation of the tooth, which gives pain when pressed upon; swelling, with heat and redness in the gum, over the alveolus containing the tooth. If allowed to take its course, the external swelling will increase, and the cheek will become more or less swollen. The skin hot and dry. A portion of the alveolus, covered by the external gum, will become absorbed, and allow the pus to advance towards the surface. In the course of a few days the swelling in the gum will become soft; the surface at some point will give way, and pus will escape. The symptoms will then subside, leaving a small fistulous opening, surrounded with two or three granulations, communicating with the interior of the abscess; and the tooth will give no further trouble, until, from some accidental cause, the orifice through which the discharge has taken place has closed, when we shall again have all the symptoms of alveolar inflammation, terminating in abscess.

When, however, the disease attacks children out of health, or of a strumous habit, the spontaneous course and termination is less favourable. Necrosis of the alveoli, to a greater or less extent, supervenes, the bone exfoliates, and often carries with it the sacs and the inclosing cells of one or more of the permanent teeth.

Treatment.—The tooth which has induced the malady should be immediately extracted, and the disease will be cut short. If pus has formed, the gum should be freely lanced, in order to facilitate the escape, though, if the tooth be extracted, this will be unnecessary, unless we find it between the gum and the outer surface of the alveolus.

Relative liability of the various teeth to caries, and to other abnormal conditions that render their removal necessary.

I shall take this opportunity, which the natural break in our subject affords, to bring to your notice some statistical matters which will bear on most of the subjects that remain for our discussion, but do not belong to either subject exclusively. This position offers a considerable advantage in forewarning you of the relative importance of the dental maladies, and will thus afford some guide as to the degrees of attention that they will severally require at your hands, as they come one by one before us.

For several years past I have kept a register at the hospital of every case that has come under my treatment. The case-book has a tabular arrangement, and in an entry the name, and age, and the tooth or teeth affected are noted, each in their proper columns. In those cases requiring the removal of teeth (and forty-nine out of fifty are of this character), the situation in which disease has commenced is also noted, together with the position of the tooth, whether on the right or left side of the mouth, and whether in the upper or lower jaw. The cases in which permanent teeth were extracted have, with the assistance of my friend and pupil, Mr. Sass, been summed up, and reduced to a tabular form. These tables would occupy too much space in the body of the lectures. Abstracts of them will, therefore, be given; and the tables themselves will form an appendix. The cases have been necessarily taken from those belonging to the lower classes of society—from artizans, and labourers, of all the many kinds that reside in this great city. These people can neither find time nor money to submit to lengthened treatment. Thus, many teeth have been extracted, that might, under other circumstances, have been saved. Teeth ranging out of the proper dental line have been extracted that might, by the aid of mechanism, have been brought into proper position—but for the reasons I have stated.

The cases amount in all to 3000, and these have been arranged, to show, by numbers, the relative liability of each tooth, to conditions rendering its removal necessary, and the relative liability of the same tooth at different ages; also the relative liability of the teeth in the upper and lower jaw, and of the teeth of males and females to similar conditions.

In this return are included those cases reported in the Medical Gazette, but somewhat differently arranged. It will be seen that the calculations relate only to the relative, not to the absolute, liability to those abnormal conditions of the teeth which necessitate their removal. We can tell, if teeth are to be lost, what will be the proportions of the different kinds of teeth, and the ages at which they will go, and also the causes which will lead to their destruction; but we cannot tell with equal certainty what are the chances as to whether they will go at all. To ascertain this latter fact, a different set of investigations must be established. A given number of people must be watched from youth to old age, and amongst them must be included those who lose their teeth, and those who do not. We almost all, however, lose our teeth if we live to be old; hence, if these tables were still more extensive, we should arrive pretty closely to the absolute liability to loss of teeth at different ages; and the present numbers give, no doubt, a near approximation to the absolute liability, more especially those relating to the molar and bicuspid teeth, because these are represented by large numbers.

Table I.

Of 3000 permanent teeth, extracted from various causes,

72	were	central incisors.
117	,,	lateral incisors.
78	,,	canines.
273	,,	first bicuspides.
434	,,	second bicuspides.
1124	,,	first molars.
637	,,	second molars.
265	,,	third molars.
3000		

In this table is expressed, of the teeth lost, the relative amount of each kind of tooth; and from this, in conjunction with others, we may learn which tooth to sacrifice, if one of several sound ones must be removed to make room for the others. This point will be shown in a still stronger view in the succeeding tables.

Table II.

Showing the relative number of teeth lost at different ages, and the relative number of persons living at these ages, and the percentage of teeth over and under these numbers.

Column 1. Ages, in years.	2. Number of teeth removed.	3. Decrements of life, from Carlisle Tables.	4. Decrements of life, reduced to a total of 3000.	5. Percentage of teeth lost over and under the average decrements of life.
Under 15	548	6384	468	17 over.
Between 15 and 20	688	6197	455	51¼ ,,
,, 20 ,, 25	524	5984	439	19¼ ,,
,, 25 ,, 30	349	5770	423	17½ under.
,, 30 ,, 40	391	5362	393	½ ,,
,, 40 ,, 50	263	4727	347	23¾ ,,
,, 50 ,, 60	144	4073	299	51¾ ,,
Upwards of 60	93	2401	176	47¼ ,,
	3000	40,898	3000	

In the first column the ages are stated; in the second the number of teeth removed at the various ages. In the third column are stated the decrements of life, copied from the Carlisle Table. Thus, of 6384, who arrive at the age of fifteen, 2401 only of these will reach the age of sixty. From these and other similar tables, it may be gathered, that the proportions there expressed will correspond very closely to the relative number of persons living at those ages, in this country, or in any district of it. This subject forms a necessary element in calculating the relative liability at different ages to loss of teeth, because there are more persons to suffer the loss of the age of fifteen than of sixty. It therefore becomes necessary to ascertain how many more. In column 4, the numbers have been reduced from column 3 (the proportions between the numbers being preserved), so as to make the whole number add up to 3000, which is the number of teeth removed. Or it may be put in another manner. If 3000 persons be taken without selection, excluding only those that are under ten years of age, their ages would be represented by column 4. Now, if the teeth had been equally liable to cause for removal at all ages, the numbers in column 4 would be the amount lost at the several ages. This, however, is not the case. The amount of deviation is expressed in column 5.

Table III.

Showing of the 3000 teeth extracted the percentage of the different kinds of teeth taken out between given ages, thereby showing that of teeth destined to be lost, the relative liability of the several kinds at each given age.

Ages.	Teeth.							
	Central incisors.	Lateral incisors.	Canines.	First bicuspides.	Second bicuspides.	First molars.	Second molars.	Third molars.
	p. cent.	p. cent.	p. cent.	p. cent.	p. cent.	p. cent.	p. cent.	p. cent.
Under 15	2	3½	2½	7	8¾	68¼	8	0
Between 15 and 20	1	2½	1½	9¼	16	44½	22¾	21½
„ 20 „ 25	¾	2¼	¾	10¾	16½	34½	25	9½
„ 25 „ 30	1¾	2¼	1	8	15	27	27	18
„ 30 „ 40	2¼	3½	3	10½	16½	22½	24	17¾
„ 40 „ 50	7¼	8¾	7¾	9¼	13	18½	19½	16
, 50 „ 60	8¼	9	3½	5½	14½	14	34¾	10½
Upwards of 60	5½	13	8½	14	19¼	10¾	21½	7½

The table reads thus:—Of permanent teeth extracted under the age of 15, 2 per cent. were central incisors, 3½ per cent. lateral incisors, 2½ per cent. canines, 7 per cent. first bicuspides, and so on.

It will be seen that the percentage of incisors is small, as compared with that of the molars; hence, the relative percentage of incisors at different ages will have less statistical value than those deduced from large numbers.

TABLE IV.

Showing the relative percentage of any one kind of tooth extracted between the specified ages.

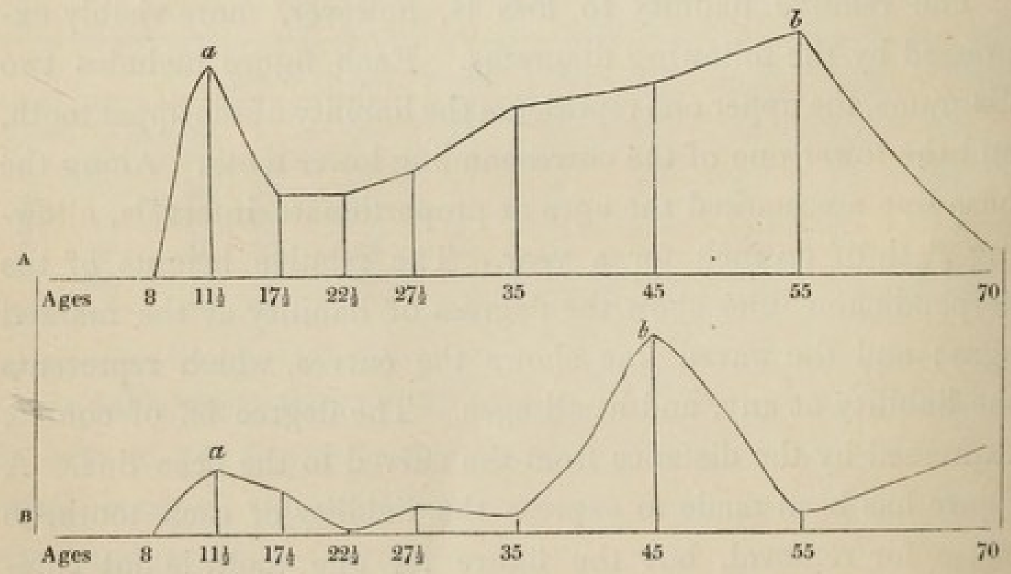
Kinds of teeth.	AGES.							
	Under 15.	Between 15 and 20.	Between 20 and 25.	Between 25 and 30.	Between 30 and 40.	Between 40 and 50.	Between 50 and 60.	Upwards of 60.
	p. cent.	p. cent.	p. cent.	p. cent.	p. cent.	p. ct.	p. ct.	p. ct.
Of the central incisors...	$15\frac{1}{4}$	$8\frac{1}{4}$	$5\frac{1}{2}$	$8\frac{1}{4}$	$12\frac{1}{2}$	$26\frac{1}{2}$	$16\frac{3}{4}$	7
„ lateral incisors ...	$16\frac{1}{4}$	$14\frac{1}{2}$	$9\frac{1}{2}$	$6\frac{3}{4}$	12	$19\frac{3}{4}$	11	$10\frac{1}{4}$
„ canines............	$16\frac{3}{4}$	$15\frac{1}{2}$	5	5	$15\frac{1}{2}$	$25\frac{1}{2}$	$6\frac{1}{2}$	$10\frac{1}{4}$
„ first bicuspides...	14	$23\frac{3}{4}$	$21\frac{1}{4}$	$10\frac{1}{4}$	15	$8\frac{3}{4}$	$2\frac{1}{2}$	$4\frac{1}{2}$
„ second bicuspides	$10\frac{3}{4}$	$25\frac{1}{4}$	20	12	15	8	5	4
„ first molar..........	$33\frac{1}{4}$	27	16	$8\frac{1}{2}$	$7\frac{3}{4}$	$4\frac{1}{2}$	2	1
„ second molar......	7	24	$20\frac{1}{2}$	$14\frac{3}{4}$	$14\frac{1}{2}$	$8\frac{1}{4}$	8	3
„ third molar	$\frac{1}{2}$	$6\frac{1}{2}$	$19\frac{1}{4}$	$23\frac{1}{2}$	26	$15\frac{3}{4}$	$5\frac{3}{4}$	$2\frac{3}{4}$

The table reads thus:—Of the central incisors extracted, $15\frac{1}{4}$ per cent. were from patients under the age of 15, $8\frac{1}{4}$ from those between the ages of 15 and 20, $5\frac{1}{2}$ per cent. between 20 and 25; and so on.

The relative liability to loss is, however, more visibly expressed by the following diagrams. Each figure includes two diagrams, the upper one represents the liability of the upper tooth, and the lower one of the corresponding lower tooth. Along the base line are marked the ages at proportionate intervals, allowing $\frac{1}{20}$th of an inch for a year. The relative heights of the perpendicular lines show the degrees of liability at the marked ages; and the waved line shows the curves, which represents the liability at any, and at all ages. The degree is, of course, expressed by the distance from the curved to the base line. A figure has been made to express the liability of each tooth, to cause for removal, but the figure for one tooth is not comparable to the figure for each of the others. Had the relative liability of the different teeth to each other been expressed in the figures, that for the central incisor would not have been intelligible,—the curved line would not have been distinguishable from the base line, so slight would have been the distance between them, while those expressing the molar teeth would have occupied several inches in height, and would therefore have been too large for insertion. To make them comparable, then, each figure must be increased or diminished in the proportions stated underneath. Thus, supposing the figure of the molar teeth to be life size, then, in comparing them with the figure for the central incisor, each vertical line in the latter must be reduced to one-tenth of its present length, and those of the figures of the lateral incisors and canines to the one-fifth of their present height. Or those of life size may be increased by ten times or five times their present length, as the case may be, and thus make the figures comparable the one to the other.

In each figure the curved rise out of the base lines, at the age at which the teeth are erupted. The ages marked on the base line are intermediate between those in the tables. Thus, in the tables are noted teeth removed between the ages of 20 and 25, while in the diagrams the perpendicular line is drawn at 17½, as being the mean point between the two.

Fig. 60.



Diagrams illustrating the relative Liability to loss of the Central Incisors at different ages. The vertical lines are magnified ten times.

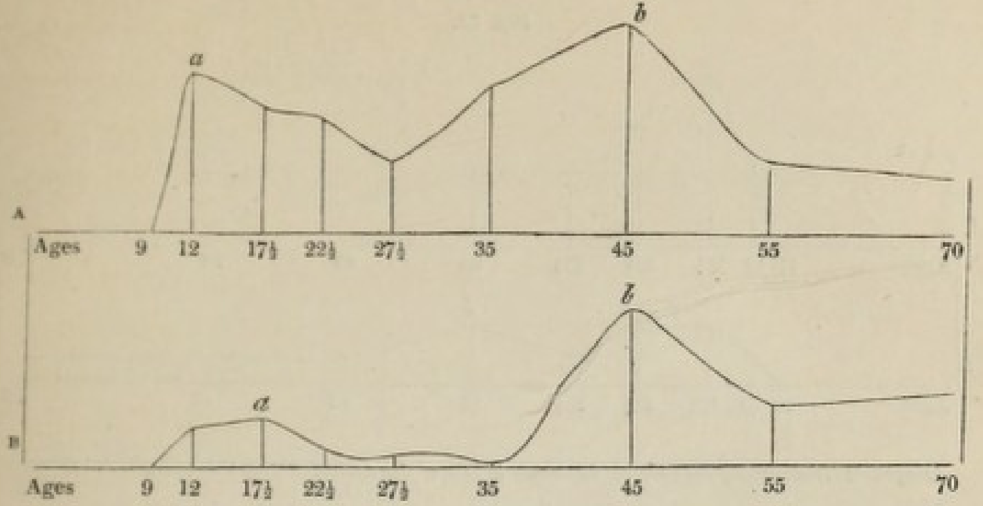
A. Diagram of the upper teeth. The elevation at *a* is occasioned by accidental loss from falls; at *b*, is occasioned by loss from absorption of the gums and alveoli, and consequent loosening of the teeth.

B. Diagram of the central teeth of the lower jaw.

a. Loss from accidental injury of the teeth.

b. This elevation is occasioned by loss from absorption of the alveoli, and from caries.

Fig. 61.



Diagrams illustrating the relative Liability to loss of the Lateral Incisors at different ages. The vertical lines magnified five times.

A. Diagram of the upper teeth.

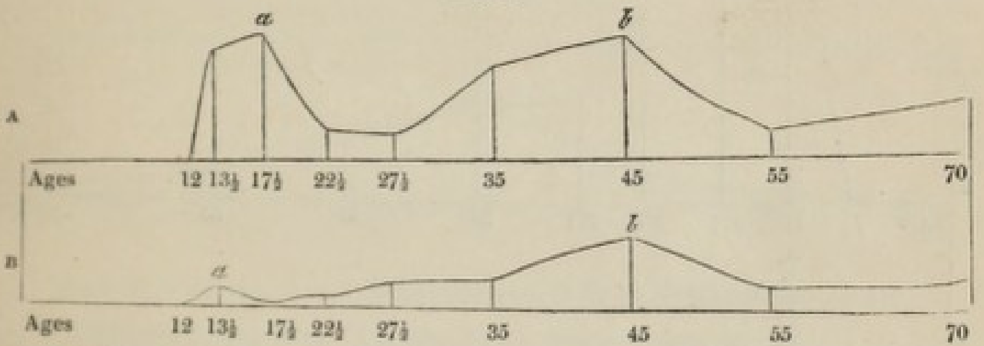
a. This elevation is occasioned by loss from extraction, consequent on the teeth being out of line.

At *b*, the elevation is mainly occasioned by loss from caries.

B. Diagram of the under teeth.

The elevation at A is mainly occasioned by the extraction of irregular teeth, and *b*, by caries and absorption of the sockets.

Fig. 62.

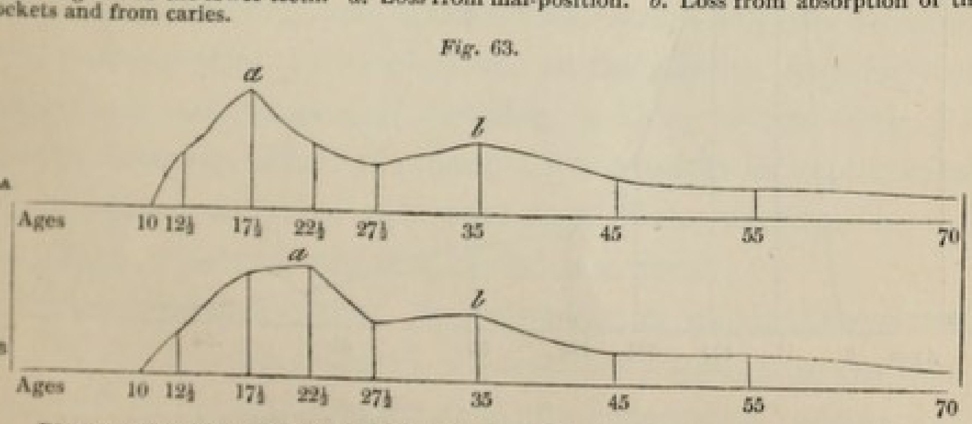


Diagrams illustrating the relative Liability to loss of the Canine at different ages. The vertical lines magnified five times.

A. Diagram of the upper teeth. The elevation at *a* is caused by teeth extracted from their mal-position. At *b*, by caries and absorption of the sockets.

B. Diagram of the lower teeth. *a*. Loss from mal-position. *b*. Loss from absorption of the sockets and from caries.

Fig. 63.

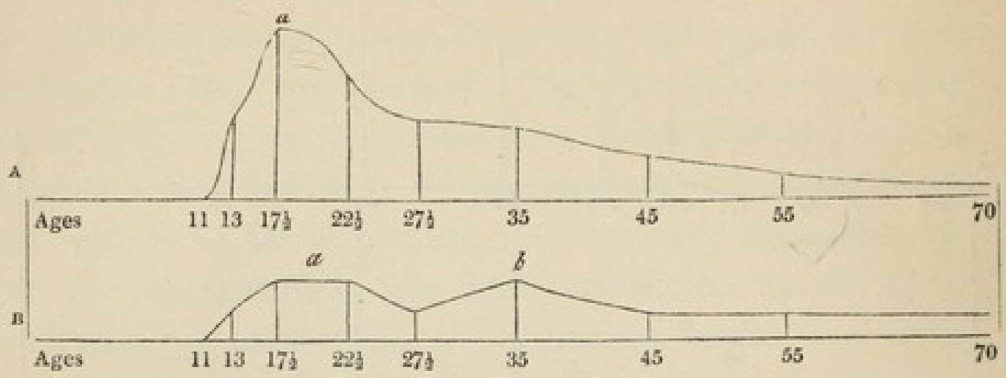


Diagrams illustrating the relative Liability to loss of the first Bicuspides at different ages.

A. Diagram of the upper teeth. The elevation at *a* is occasioned by caries, and at *b* by caries.

B. Diagram of the lower teeth. The elevation at *a* is caused by caries, and at *b* also, principally by caries.

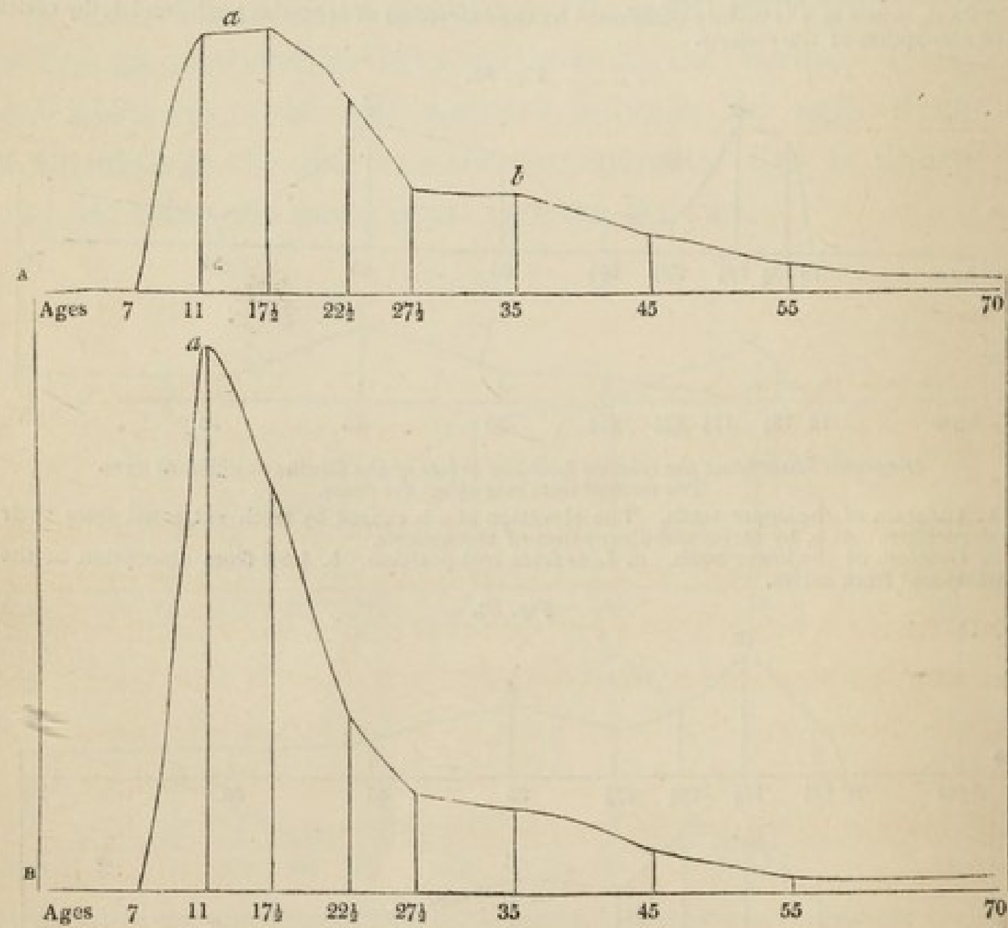
Fig. 64.



Diagrams illustrating the relative Liability to loss of the second Bicuspides at different ages.

A. Diagram of the upper teeth. The elevation, *a*, is occasioned by caries.
B. Diagram of the lower teeth. The elevation, *a*, is occasioned by caries, and *b*, by loss from absorption of the sockets.

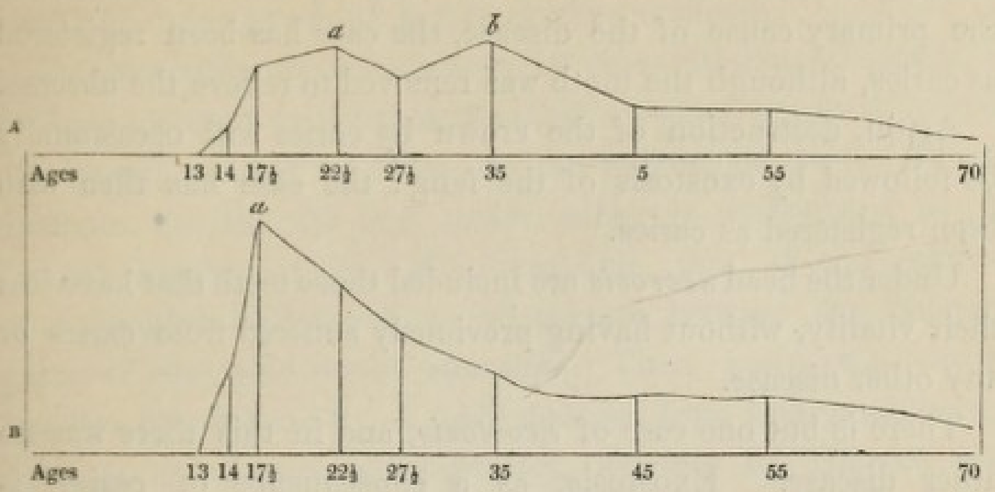
Fig. 65.



Diagrams illustrating the relative Liability to loss of the first Molars at different ages.

A. Diagram of the upper teeth. The elevation, *a*, is occasioned by caries, and *b*, also by caries.
B. Diagram of the lower teeth. The elevation, *a*, is occasioned by caries.

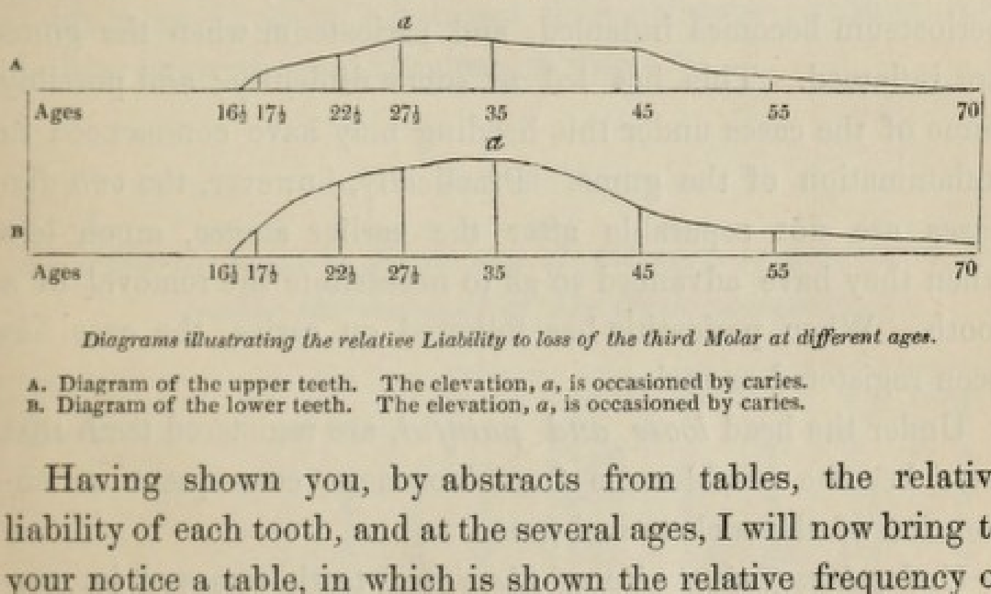
Fig 66.



Diagrams illustrative of the relative Liability to loss of the second Molar at different ages.

A. Diagram of the upper teeth. The elevations, *a* and *b*, are occasioned by caries.
B. Diagram of the lower teeth. The elevation is occasioned by caries.

Fig. 67.



Diagrams illustrating the relative Liability to loss of the third Molar at different ages.

A. Diagram of the upper teeth. The elevation, *a*, is occasioned by caries.
B. Diagram of the lower teeth. The elevation, *a*, is occasioned by caries.

Having shown you, by abstracts from tables, the relative liability of each tooth, and at the several ages, I will now bring to your notice a table, in which is shown the relative frequency of the various conditions that occasion the loss of the teeth. I should, however, offer beforehand a few remarks in explanation of the manner in which the cases have been classified in the case-book, otherwise you may be led into error.

First, as regards *caries*. In every case in which the removal of a tooth has been required, whatever may have been the condition of the tooth rendering immediate operation necessary, if caries was the cause of that condition, the entry was made under the head of caries. A carious tooth will often lead to alveolar abscess, but when this has been the case, as caries was the primary cause of the disease, the case has been registered as caries, although the tooth was removed to relieve the abscess.

Again, destruction of the crown by caries will occasionally be followed by exostosis of the fang: the case has then also been registered as caries.

Under the head *necrosis* are included those teeth that have lost their vitality, without having previously suffered from caries or any other disease.

There is but one case of *exostosis*, and in this there was no other disease. Exostosis, as a consequence of caries, is common.

Under the head *periostitis*, those cases alone are included in which the dental periosteum has been inflamed, the dental tissues being sound. The gums are necessarily involved when the periosteum becomes inflamed, and periosteum when the gums are inflamed. This has led to some difficulty; and possibly some of the cases under this heading may have commenced in inflammation of the gums. Practically, however, the two diseases are not separable after the earlier stages, much less when they have advanced so as to necessitate the removal of a tooth. When periostitis has followed on caries, the case has been registered as caries.

Under the head *loose and painful*, are registered teeth that have become troublesome from looseness, consequent on absorption of the sockets and gums.

Under *insufficient size of the jaws*, teeth removed in consequence of being out of line, or to gain space for other teeth, have been classed.

Under *mechanical injuries*, teeth removed in consequence of having been broken off, or otherwise injured by blows or falls on the mouth.

Under *neuralgia and tic doloroux* are registered those teeth removed for the relief of pains in the face, the teeth themselves being sound.

Under the heading *pain in the teeth*, teeth extracted in consequence of severe pain in them, but in which teeth no disease could be detected, either before or after removal.

In estimating the truthfulness of these statistical details, it will be apparent to all, that those tables which are formed from the largest number of cases are the nearest to truth. If, for instance, we take the first molar, which is represented by the largest number, 1124, it is probable that, if the number were doubled, still the same proportion between the different parts of the table would maintain. Then, again, the central incisors amount to 72. A table deduced from this number may be in parts incorrect, and must not, therefore, be regarded with the same confidence.

I am not aware that similar statistical facts have been before collected; thence, these may justly be assumed to be correct in all their results, since they are, even in their weakest parts, much more likely to be correct than opinions resulting from general impressions, dependent on memory.

TABLE V.

Showing the relative frequency of the several conditions that render the removal of the teeth necessary.

	Caries.	Necrosis.	Exostosis.	Periostitis.	Loose and painful, from absorption of the gums and alveoli.	Insufficient size in the jaw.	Mechanical injury.	Neuralgia and tic doloroux.	Pain in the teeth.
	p.ct.	p.ct.	p.ct.	p.ct.	per cent.	p. cent.	p.ct.	p. cent.	p. cent.
Central incisors. .	33½	4	0	1½	41½	2¾	16¾	0	0
Lateral incisors. .	48¾	3½	0	1¾	24	19½	1½	1	0
Canines	40½	0	0	2¾	33¾	23	0	0	0
First bicuspides. .	81¼	1	0	1	9½	6¾	0	0½	0
Second bicuspides	86¾	1	0¼	1	9½	0½	0¼	0½	0¼
First molars......	96	0¼	0	0½	2¾	0	0	0½	0
Second molars ...	88¾	0¾	0	1	9	0	0	0	0½
Third molars......	82¼	0	0	2½	13	1	0¾	0¼	0¼

The table reads thus:—Of central incisors extracted, 33½ per cent. were removed to relieve conditions resulting from caries, 4 per cent. from necrosis, $1\frac{1}{2}$ per cent. periostitis, $41\frac{1}{2}$ from absorption of the gums and alveoli, the teeth being sound, $2\frac{3}{4}$ from irregularity, arising from insufficient size in the jaw, $16\frac{3}{4}$ per cent were removed in consequence of having been broken or injured by falls.

TABLE VI.

If we take the teeth without separating the different kinds, and examine the causes of loss, they will be found to hold the following proportions:—

Thus, $88\frac{3}{4}$ per cent. were removed for conditions resulting from caries.

$\frac{3}{4}$ per cent., ditto, from necrosis.

1 per cent., ditto, from periostitis.

9 per cent., ditto, from absorption of the gums and alveoli.

$2\frac{1}{4}$ per cent., ditto, insufficient size of the jaw.

$\frac{3}{4}$ per cent., ditto, mechanical injuries.

$\frac{1}{4}$ per cent. from neuralgia.

$\frac{1}{4}$ per cent., (nearly,) from pain in the teeth, without apparent disease of the dental or of the adjoining tissues.

TABLE VII.

Showing the relative liability to loss of the teeth on the right and left sides of the upper and lower jaws.

	Upper Jaw.		Lower Jaw.	
	Right side.	Left side.	Right side.	Left side.
Central incisors	27	26	13	6
Lateral incisors	51	41	10	15
Canines	26	32	12	8
First bicuspides	109	98	29	37
Second bicuspides	144	135	73	82
First molars	237	243	342	302
Second molars	133	116	212	176
Third molars	44	53	88	80
	771	744	779	706

In this table we have distinct evidence that the teeth in the right side are (slightly) more liable to be lost than those on the left side of the mouth. Why this should be, it is difficult to tell. Perhaps people are right-mouthed, as well as right-handed, and that the teeth are more injuriously worn on that side than on the other.

TABLE VIII.

Showing the relative numbers of teeth removed from males and females.

	Male.		Female.	
Central incisors	35	= 122	37	= 145
Lateral incisors	55		62	
Canines	32		46	
First bicuspides	135	= 361	138	= 346
Second bicuspides	226		208	
First molars	586	= 1075	538	= 951
Second molars	350		287	
Third molars	139		126	
	Males...	1558	Females...	1442

From this table it would appear that females are more liable to lose the front teeth, while males suffer the greatest loss of the molar teeth; and that, on the whole, the male is more liable to the loss of teeth than the female.

LECTURE VIII.

ABNORMAL SECOND DENTITION.—IRREGULARITY IN THE TIME OF THE ERUPTION OF THE PERMANENT TEETH.—IRREGULARITY IN THE POSITION OF THE PERMANENT TEETH.—GENERAL REMARKS.—ANTERIOR POSITION OF THE UNDER TEETH, OR "UNDERHUNG."—ANTAGONISM OF THE CUTTING EDGES OF THE UPPER AND LOWER FRONT TEETH.—EXCESSIVE PROMINENCE OF THE UPPER FRONT TEETH.

Two separate actions are concerned in the renewal of the teeth; one action, the removal of the temporary teeth; the other, the evolution of the permanent.

For the regular appearance of the second teeth, it is necessary that each of these should proceed uninterruptedly, and that the jaws should have attained the requisite size. These conditions, from causes which it is not always easy to estimate, are not in all cases fulfilled.

The fangs of the temporary teeth in some individuals remain unabsorbed, and the teeth keep their position to the exclusion of those that should take their place. This cause of irregularity in time, more frequently occurs in the persistence of the milk molars than in either of the anterior teeth. During the last five years many cases have come under my notice, in which, between the ages of 15 and 27 years, one or more of the bicuspides were absent, and their predecessors, the milk molars, present. The patients have come to the hospital from suffering pain in the temporary teeth. On removing the temporary, the succeeding permanent teeth were seen coming forward.

The reason for assuming that in these cases the permanent were kept back by the temporary teeth, is, that the crown of the former is received between the fangs of the latter, and therefore cannot come through without the previous removal of the superimposed tooth. Again, irregularity in time seldom occurs to the same degree in any of the more anterior teeth, for these, when the temporary teeth remain after the usual time for their ejection, appear either anterior or posterior to them.

Another cause of irregularity in the time of eruption of the adult teeth, arises from defective growth, and consequent insufficient space in the jaw. The canines are retarded from this cause more frequently than any other teeth, arising from their being the last to be cut, and the space being occupied by the incisors and bicuspides which have been previously evolved. I have seen several specimens of this—one on the table—in which the canine tooth, from want of space, has been developed, but remained deep in the jaw, completely imbedded in bone, the crown resting between the fangs of the lateral incisor and the first bicuspis. Nature, in these cases, has fitted the teeth for their peculiar position by developing an extremely short fang. (Fig. 72.)

The second bicuspis is sometimes impacted between the first molar and first bicuspis, and is thus retarded, while the retarding teeth are hollowed on their sides to fit the crown of the interposed tooth.

The symptoms produced by interruption to the evolution of those permanent teeth, that are preceded by temporary teeth, are seldom severe; and, indeed, indications are not unfrequently wholly absent. When they are present, pain is felt about the obstructing temporary tooth, extending perhaps to the angle of the jaw. The pain is far from constant, coming on and going off at uncertain intervals. The gum round the tooth is generally slightly inflamed. The symptoms subside on the removal of the temporary tooth.

The wisdom teeth are liable to great irregularity in the time of their appearance, arising either from want of space in the jaw, or from irregularity in the position in which the development has taken place. Varied and distressing symptoms arise from obstruction to the development of these teeth; but as these obstructions are mostly consequent upon irregularity in the position of the teeth, we shall postpone entering into the subject until we come to the consideration of the irregularities in the position of the permanent teeth.

I shall now bring to your notice the various deviations from the normal arrangement of the teeth. You have been told that the front teeth (by which I mean the incisors and canines, with the bicuspides) occupy in the well-formed jaw a semicircle, and that the molars extend backwards from the two ends of the semicircle, in slightly diverging lines; thus forming, together, an elliptic curve. In this curve no tooth projects before, or recedes behind the neighbouring teeth. Such is the normal arrangement of perfectly developed teeth in well-formed jaws. Instead, however, of the teeth presenting this even and uninterrupted line, we occasionally find that one or more teeth are placed either external or internal to the line, the teeth themselves being at the same time individually well formed.

In the natural position, each tooth has its anterior and posterior, or, to speak more correctly, its labial and lingual surfaces, placed at right angles to the radius of the curve which it contributes to form; but a tooth may be twisted on its axis, and have these surfaces in a line with the radius, and present its sides instead of the broad surfaces, anteriorly and posteriorly, and thus constitute a form of abnormal position. Mr. Saunders, in his lectures before referred to, speaks of a case in which a front tooth was twisted half way round, so that the proper lingual surface was anterior.

In the normal arrangement the anterior teeth of the upper, close over and in front of the corresponding teeth of the under jaw. In some cases, however, from mal-position of the teeth, or from want of a proper ratio in the growth of the upper and lower jaw, the upper teeth close posterior to those of the lower jaw—a condition commonly denominated "underhung."

Instead of the under teeth closing anterior to the upper, we find in some instances that they close upon the cutting edges of the upper teeth; this constitutes another form of irregularity, though partaking of the same character as the preceding form.

A third form of abnormal position occurs where the front teeth do not come together at all, a space of variable width separating them when the mouth is closed.

From what has been stated, you will observe that the subject, so far as the front teeth are concerned, divides itself into two heads; first, abnormal position of the whole of the front teeth; and secondly, abnormal position of part of the front teeth, or perfect and partial irregularity of the front teeth.

The causes of abnormal position of the teeth are almost exclusively of a mechanical nature, and may be divided into four classes. First, want of sufficient room in the alveolar arch for regular arrangement; that is, the arch is too small, too narrow from side to side. The distance across the palate, from one molar to the corresponding tooth of the opposite side, may be only one inch and a quarter, when it should be an inch and a half. The teeth have grown too fast or too large for the jaws. There has been a want of concordance in the development of the two parts. Secondly, abnormal position during development, as regards the fangs of the preceding temporary teeth. Thus, supposing the cutting edge of an incisor at the time of formation be placed anterior to, instead of (as is normal) posterior to the fang of the milk tooth, the permanent tooth will come down and occupy a position anterior to the proper place. Thirdly, non-absorption of the fangs of the milk teeth, and consequent prolonged presence of them; thus obliging the permanent teeth to take an anterior or posterior position. Fourthly, a more rapid growth in the one jaw than in the other, producing undue prominences of the teeth, in other words, abnormal development of the jaws. In a preparation on the table the teeth are well formed, and arranged normally, yet when the jaws are closed, and the molars brought in contact, the front teeth do not meet by a quarter of an inch, in consequence of the peculiar form of the lower jaw.

In the foregoing classification I have enumerated to you the principal kinds of dental irregularity, with the causes producing them. In practice, however, you will not be able to classify from its cause each case of irregularity in the manner I have done in this description; on the contrary, you will meet with cases in which the producing cause partakes in some degree of the character of each division, and yet does not belong to either exclusively. However, by adopting this somewhat arbitrary arrangement of the subject, I think I shall be able to give you directions for recognising the cause of irregularity, and the treatment to be pursued; and in a more intelligible form than though we treated the matter with less system.

It is only necessary to recognise the cause of dental irregularity, to pronounce with certainty whether the evil admits of remedy.

If malformation of one or both jaws be the cause, there is but little hope of improvement. If the jaws are too small to admit of the natural arrangement of the teeth, but are otherwise well formed, then we may, by the judicious application of mechanical means (with which I shall presently make you acquainted), reduce the teeth to their normal position.

Treatment.—When we see how much can be done by orthopædic surgery in restoring crooked and deformed limbs to the natural form, whether the patient be middle-aged or young, we should at once conclude, even without the aid of experience, that much might be done to remedy irregularity in the arrangement of the teeth; and we should become more certain of our point when we observe that, if the molar teeth from age or accident be lost, the under incisors, closing against the posterior inclined surfaces of the upper incisors, slowly, but surely, force the latter outwards.

But experience proves that, when dental irregularity arises from any other cause than malformation of the jaws, the malplaced tooth or teeth may, by steady and continuous pressure, be reduced to the proper position: sufficient alveolar space, of course, having been by some means gained.

If the alveolar arch be contracted by insufficient breadth in the transverse diameter of the palate, then means must be adopted for its expansion. A gold band should be accurately fitted to the lingual surface of the necks of the teeth, and then rendered elastic by hammering, and so shaped, that, when fixed in the mouth, it shall press the molar and bicuspid teeth outwards, and so extend the width of the dental arch. The necessity of this treatment, and the manner of effecting it, has been described at some length, and instruments have been figured, together with the cases in which they were applied by M. Lefoulon [a]. Mr. Robinson is in error when he assumes that the subject has not received consideration till his time, and that he is the first to recommend the extension of the dental arch by mechanical means, and to devise and apply instruments to fulfil this purpose [b].

The treatment, then, mainly consists in applying steady uniform pressure upon the irregular tooth or teeth in the direction of the place you wish them to occupy.

What has been said of irregularity in the position of the front teeth, applies generally to irregularity in the bicuspides, as also to the molars, though the latter are less frequently subject to irregularity in position, and, when it does occur, the degree is very slight, amounting, except in rare cases, to nothing more than the one standing a little out, and the next a little in, thus forming a zigzag instead of an even line.

The wisdom tooth, from its peculiar situation in the jaw, is liable to several characteristic forms of irregularity, each of which is productive of great inconvenience;—we will, therefore, notice these after going through the forms of irregularity, with the treatment, in the more anterior teeth.

From this general outline we will proceed to consider our subject in detail.

Complete irregularity in the front teeth.—It can scarcely happen that we have irregularity in the teeth of one jaw, without a corresponding irregularity in the teeth of the other jaw; the one following as a consequence of the other.

The most common abnormal position occurs, in those cases where the upper teeth, on closing the mouth, pass behind those of the under jaw. This condition, when once established, is permanently maintained by the teeth of the under jaw, for

[a] *Nouveau Traité Théorique et Pratique de l'Art du Dentiste.* Paris, 1841.

[b] ROBINSON *on the Teeth.* London, 1846.

where there is any force, tending to press the upper teeth outwards into their proper position, the act of closing the mouth, and the consequent pressure of the under teeth upon the anterior surface of the upper teeth, would press them inwards, and thus overcome the force employed by nature to remedy the growing defect.

This form of malposition of the teeth may arise from several causes. Thus, the under jaw and teeth may be developed more rapidly than the upper. The incisors of the under jaw usually appear before those of the upper jaw, and take their position a little internal to the temporary teeth, which at the time are usually loose, and quickly fall out, and then the succeeding teeth come forward and occupy their places. But, while this is going on, the upper incisors usually appear through the gum, coming through behind the temporary teeth. Supposing, however, that the temporary are not loose, but retain their places, the permanent teeth are then forced still more backward, and, if the front teeth of the under jaw have progressed in their development, they will close between the temporary and the permanent teeth of the upper jaw. The teeth, having once assumed this position, necessarily retain it, unless mechanical means are resorted to for remedying the defect.

A third cause of the posterior position of the front teeth of the upper jaw may arise in the permanent teeth of the under jaw coming through in front of the temporary teeth, so that the upper teeth, closing behind them, tend to force them still further outwards.

Treatment.—The causes of the reversal of the relative positions of the front teeth of the two jaws, you have seen, are purely mechanical, and that the defect is maintained by a mechanical cause. Our treatment must, therefore, be mechanical also. The first thing we have to do is to prevent the front teeth from closing at all, and thus disable them from exercising any influence upon each other. This is effected by placing caps of metal or ivory upon the masticating surface of the molars of the upper jaw, and of such a thickness, that when the mouth is closed the front teeth no longer meet. Having attained this point, a steady uniform pressure must be directed against the posterior surface of the misplaced teeth, and continued till, on removing the caps upon the molars, the upper teeth are found to close in their natural position: the position, having been once gained, is retained by the action of the under upon the inclined posterior surface of the upper teeth.

There are three methods of applying the pressure to force the teeth outwards. In one a fixed point is gained by fitting a piece of ivory to the hard palate and the surfaces of the necks of the teeth, to which it is tied, so as to prevent the possibility of motion: pieces of caoutchouc, or dry compressed wood, are then interposed between the ivory and the necks of the teeth you wish to be moved outwards. The wood, on absorbing moisture, swells, and, as the fitted ivory cannot be moved backwards, the teeth are necessarily moved forwards. After the wood has remained about forty-eight hours, it should be removed, and a fresh piece of dry wood put in its place, which, on swelling, forces the teeth still further outwards. The renewal of the wood is repeated till the teeth have assumed the required position; the ivory is then removed from the palate, and the caps from the teeth, and the process is allowed to be completed by the action of the upper and under teeth upon each other; the under forcing the upper outwards, and the upper pressing the under inwards, till the molar teeth come in contact, when the front teeth assume their permanent place. (Fig. 71.)

In the second method the fixed point is made anterior to the teeth, and is accomplished in the following manner:—Caps, as in the former case, are fixed upon the molar teeth; from thence a strong piece of flattened gold or silver wire is made to pass in front of the teeth. Opposite each tooth the wire is perforated with one or two holes, through which a ligature of silk is passed round the neck of the tooth; the silk is then tied tightly to the wire. The teeth, by the action of the silk, are dragged outwards. The ligature requires to be tightened or removed from time to time, till the teeth have assumed the required position, when the apparatus is removed. Instead of silk, the vulcanised Indian-rubber is frequently used.

The third method of treatment consists in fitting metal to the surface of the front teeth of the lower jaw. The plate is continued upwards, above the edge of the teeth, but, instead of proceeding in the same line, is turned inwards, so that, on an attempt to close the mouth, the piece of metal passes behind the teeth of the upper jaw, and, presenting an inclined plane, forces them outwards. The success of this method of treatment will be greatly enhanced by capping the molar teeth.

Of the three forms of treatment I have described to you, I much prefer the first, as being more easy of application, more rapid in its effects, and less troublesome to the patient than the two succeeding methods.

A second form of complete irregularity of the front teeth is when the upper and lower close upon each other. In this case the cutting edges are quickly worn down, and the teeth look short and stunted, and, on losing the molars, the front teeth become worn down to the level of the gums, and the pulp-cavity, filled by secondary dentine, rendering a great part of the remaining portion of the tooth solid.

This condition differs only in degree from that which I have described, and, as far as personal appearance is concerned, it is less objectionable than that, yet in its effect it is more injurious. Where the upper teeth close behind the under, the teeth themselves are not injured, but where they close upon each other the thin edges are soon worn, and the teeth cease to be strictly incisors, and are capable of crushing only.

The treatment necessary for the reduction of this irregularity is precisely similar to that required in the treatment of the "under-hung."

However, in these cases, if attention be directed to the subject early, the simple pressure of the upper teeth outwards, by the thumbs, will, in many cases, with a little care and perseverance, place the teeth in their proper relative position; especially if frequent attempts be made to place the under teeth, by drawing back the teeth of the under jaw behind those of the upper jaw.

As a further means of restoration, the teeth may be closed upon some substance, such as a piece of wood, or the handle of a tea-spoon, and the spoon pressed downwards: by the motion thus induced, the upper teeth will be pressed outwards by that portion of the spoon within the mouth, while the under teeth, acting as a fulcrum, will be pressed inwards. This simple operation will, if frequently repeated, tend greatly to reduce the teeth to their proper situation.

A third malposition of the front teeth occurs in an excessive prominence of the upper row. The front teeth press outwards against the upper lip, are constantly exposed, and, when the mouth is closed, rest upon the under lip. This form of irregularity is more or less connected with a defective development of the upper jaw. The alveolar processes are developed at a considerable angle with the general surface of the face, and the edges embracing the necks of the teeth are therefore very prominent. This prominence might arise from several causes. Thus, the permanent teeth might come down in front instead of behind the temporary teeth and their alveoli, and, supposing the milk teeth to be present a little beyond the usual period, would at once tend to the deformity in question.

Again, if the incisors are long, and the molar teeth short, the under incisors, on the mouth being closed, will, instead of resting upon the basal ridge of the upper teeth, press down the inclination of the ridge, and finally get fairly behind the teeth, and rest with their edges against the surface of the gums. We often see this state produced, when, from age or some other cause, the molars and bicuspids are lost.

Treatment.—The first thing to be done towards remedying this evil is to remove one or two bicuspid teeth if they are marked by disease, otherwise the first molars should be taken out, seeing that, if both are sound, these are twice as liable to become diseased as the bicuspids. Thus, space may be gained for bringing the teeth inwards, and this may then be effected by pressure inwards, the fixed point being made either external to the teeth in the form of a band of metal, or internal to the teeth in the form of a piece of ivory fitted to the palate.

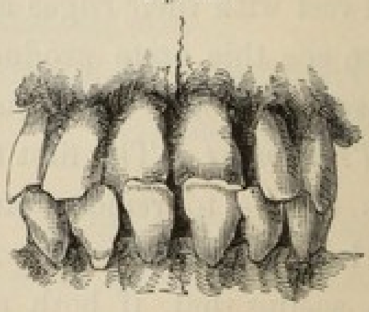
Before, however, we proceed to the remedy, we must look closely to the cause which has produced the evil, or which keeps it up.

There is a fourth form of complete irregularity of the front teeth: it is this. The alveolar lines of the jaws are developed at such an angle with each other, that on closing the mouth the molar teeth alone come in contact, and the front teeth lie separated by a considerable interval. The models on the table present a well-marked case of this peculiar conformation. If the defect be discovered early in life, some attempt at restoration should be made by making continued pressure under the chin; but, if the deformity is found in the adult, the less you interfere the better, as your patient will have overcome, by habit, the inconveniences arising from the malformation.

Partial irregularity of the front teeth.—At present we have treated of irregularity affecting the whole of the front teeth; we shall now consider malposition when occurring to a part only of the front teeth, and, in doing so, we will commence with the central incisors.

The central incisors, one or both, may project forward or retreat backward in an unnatural degree. Of these deformities, the latter is the more common, and the one which we are the most frequently called upon to remedy. (Fig. 68.) The cause which usually produces these misplacements is the prolonged presence of the temporary incisors, which oblige the new teeth to take either a posterior or anterior position, while the milk teeth are forced outwards or backwards, the proper place for the new teeth being between the two positions.

Fig. 68.

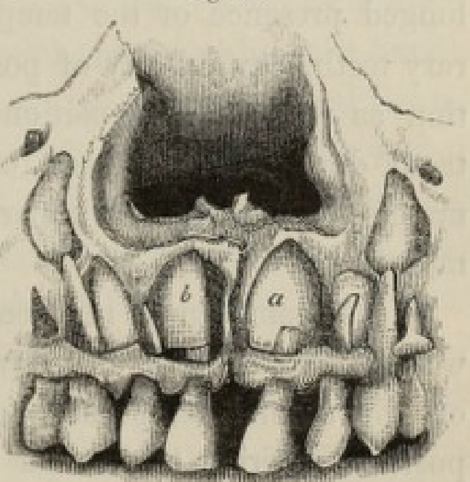


The Central Incisors of the Upper Jaw;
With the cutting edges directed inwards, and placed posterior to the under teeth when the mouth is closed.

The central incisors may, however, occupy the proper line, but yet be irregular. The teeth may be twisted on their axes, either towards or from the median line; that is, the median edge may be turned inwards, while the internal side projects forward in such a manner that the cutting edges of the two teeth form an angle with each other, the angle pointing towards the mouth; or the position may be reversed, and the angle point outwards.

This form of irregularity is, like the last, produced by the relative position of the temporary and permanent teeth during the development of the latter. Thus, the median angle of the cutting edge is placed anterior to the fang of the central, while the external angle is placed behind the fang of the lateral temporary tooth; or the position may be reversed, the external angle may be anterior to the fang of the temporary lateral. In either case, unless the temporary teeth are shed at an early period, the permanent tooth will, on coming through, be at an angle with the proper dental curve. (Fig. 69.)

Fig. 69.



The Temporary and Permanent Teeth,

Previous to the development of the roots of the latter.

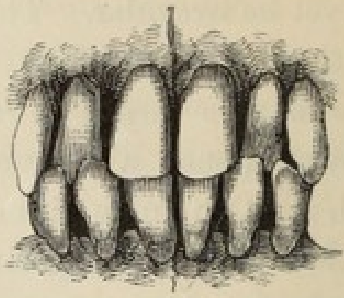
a. The left permanent central incisor in its normal position as regards the roots of the temporary, central, and lateral incisors; that is, placed posterior to them.

b. The right central incisor, with its median edge placed anterior to the root of the preceding temporary central, while the external angle and side is posterior to the root of the temporary lateral incisor. With this position, the permanent tooth must, unless the roots of the temporary teeth are quickly absorbed, descend with the median edge everted.

The presence of the temporary lateral, when the central is shed, may also lead to malposition of the permanent central, supposing the central be a large tooth, and the space destined for it be too small.

The lateral incisors are subject to the same forms of irregularity as those which occur to the central teeth, and therefore do not require a separate description. It may be observed that the more common malposition is the direction inwards, and consequent closure behind the teeth of the under jaw on shutting the mouth. (Fig. 70.)

Fig. 70.



The upper Lateral Incisors;

With the cutting edges directed inwards, and closing behind to the corresponding teeth of the lower jaw.

The causes producing irregularity of the lateral are similar to those effecting malposition in the central teeth, namely, want of space for them to take the proper position—the prolonged presence of the temporary teeth, irregularity of position as regards the position of the fangs of the temporary teeth during development, or irregularity in the teeth of the under jaw, forcing the upper teeth backwards on closing the mouth.

A case came under my treatment, in which the lateral incisor was forced outwards, and turned on its axis, by the persistence of the second temporary molar. The two bicuspids took a position anterior to it, and the canine, being the last to be evolved, came down and forced the lateral quite out of its place.

In another instance the stump of the temporary lateral remaining caused the permanent lateral to take a posterior position, and behind this, again, at some distance in the palate was a supernumerary lateral.

The canine teeth of the upper jaw may be turned sidewise, may stand anterior to the adjoining teeth (which is the most common form of irregularity), or may incline inwards, which is the least common of the irregularities of position occurring to these teeth.

The circumstance of the late protrusion of the canine tooth is, in a small jaw, a constant source of irregularity; the incisors anteriorly, and the bicuspides and the first molar teeth, posteriorly, having taken their places, insufficient space is left for the canines, and as they occupy, when developing, rather an outward position in the jaw, they are most commonly evolved on a plane slightly external to the neighbouring teeth.

Treatment.—Whichever of the anterior teeth be the subject of malposition, the same modes of treatment for the reduction of the irregularity are applicable. If, then, the front teeth are found, on examining the gums, to be out of position, the cause of the irregularity should be sought.

If there is a want of space, one or more of the temporary teeth should be removed, and the patient should be directed to press the new tooth frequently during the day towards the proper situation. The required position may, in some cases, where the irregularity is slight, be given to the new tooth by the frequent use of a piece of wood, shaped something like the handle of a spoon. The bent part should be passed behind the inward tooth, and the mouth partially closed, when the projecting portion of the instrument should be pressed downwards towards the chin. The under teeth will then form the fulcrum, and the upper tooth will be moved outwards. If the under teeth stand too much inwards, the action of the lever may be reversed, and the upper teeth made the fulcrum. The teeth forming the fulcrum of the lever may also be moved, though probably to a much less extent than those acted upon by the end of the lever, as in the one case the pressure bears upon the concavity of the dental arch, and in the other upon the convexity.

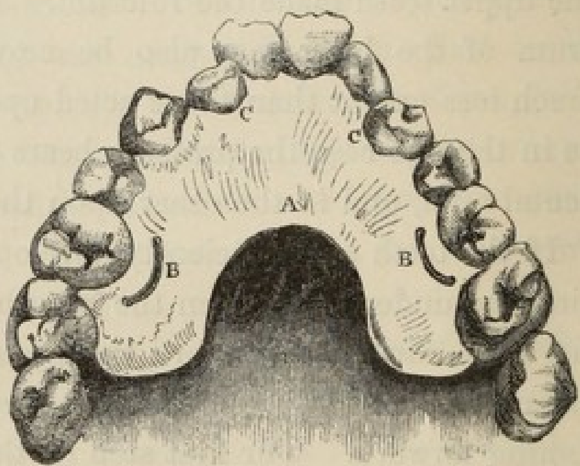
If the teeth are sufficiently developed in length to pass behind the under teeth when the mouth is shut, these means will not be sufficient to restore them to a proper position, because the under teeth, by their anterior position, prevent them from coming forward. Our first step in the treatment must, therefore, be to remove the influence of the opposing teeth, by placing caps upon the molars, which will so heighten them, that on closing the mouth the front teeth will not come in contact.

Having accomplished this point, and ascertained that there is sufficient space in the proper situation, steady pressure must be made upon the irregular teeth. If one tooth only be displaced, it may be sufficient to pass an elastic ligature behind or before (as the case may require) the irregular tooth, and then round the adjoining teeth, in such a manner that the ligature shall exercise a tractile force upon the tooth in the direction in which it should move. The best material for elastic ligatures is vulcanised caoutchouc.

If, however, the irregular teeth are full grown, the treatment by elastic ligature may occupy an inconvenient length of time, and it will be better at once to construct a plate fitting the palate, and thus gain a fixed point from which to exercise pressure. If the teeth are in-placed, we may force them outwards, by interposing pieces of compressed wood, or vulcanised caoutchouc, between the plate and the irregular tooth, or, if the irregular tooth stand external to the proper line, an elastic ligature, or short bit of gold spiral spring may be connected to the plate and to the tooth: the spring, by its action, will drag the tooth into its place. (Fig. 71.) In most cases, the tooth will move more quickly than the gum will absorb; it is necessary to bear this in mind, that sufficient space may be left for puckered gum.

The annexed figure will give some idea of the construction of a plate for the above purpose.

Fig. 71.



A Plate for a fixed point, from which to reduce to order Irregular Teeth, represented in situ.

A. Plate of ivory, fitted accurately to the surface of the palate, and to the necks of the teeth.

B, B. Ligatures passing through the plate and round the necks of the teeth, so as to prevent the slightest movement in the plate when subject to pressure.

C, C. The irregular teeth, which are to be forced into a more anterior position, by placing between the lingual surfaces and the plate compressed wood, or vulcanised caoutchouc.

A very simple and effective method of moving an upper tooth or teeth that are placed internal to the proper line consists in making an artificial elongation of the under teeth, the anterior surface of which inclining inward must pass, on closing the mouth, behind, and press outwards the in-placed teeth, while the base is fitted and firmly fixed to the under teeth. This instrument, which may be made of gold or of ivory, must be worn continuously by the patient until the irregular teeth have assumed the natural position.

If a tooth is twisted upon its axis, our treatment must be modified; pressure must then be made upon the side of the tooth which is most misplaced. But, before proceeding to use mechanical means, observe whether the evil is kept up by the opposing teeth; for, on examination, you will frequently find that the edge, when the mouth is closed, rests between the two opposing teeth, one angle of the twisted tooth lying in front, and the other behind its opponents. In this case the molar teeth must be capped so as to remove the reciprocal action of the antagonist teeth. To one of the caps a piece of elastic gold wire may be firmly united; the free end must then be brought in front of the twisted tooth, upon the receding side of which it must be made to act. The better method of connecting the spring to the tooth is to fit with great accuracy a band of metal round the crown, to which band a small loop may be soldered; the end of the spring may then be drawn down and secured, by ligature, to the loop. Or, instead of using the spring external to the teeth, we may attach a spiral gold spring to a fixed ivory or gold palate, and to the tooth, through the medium of a band and loop, as in the former case, and thus turn the tooth on its axis till it assumes the proper line. I believe, in a few instances, the central or lateral incisors have been, by the use of the forceps, at once twisted into their proper position, and then secured by ligature to the adjoining teeth. I cannot recommend the practice, as it will, in many cases, be attended with the loss of the tooth.

It has been shown that pressure regularly applied upon a tooth in any other direction than in a line with its axis will gradually move the tooth in the direction of the pressure, whatever be the age of the patient: it follows, therefore, that dental irregularity may be reduced at any period of life. Whether it is advisable at all ages to reduce by mechanical means outstanding teeth, is a question we must now consider.

If the patient be young, and the irregularity is not kept up by the closure of the teeth, it will be sufficient to remove the cause of the malposition by the extraction of the obstructing temporary teeth; or, if it be necessary, a permanent tooth. The teeth will then, during the general growth of the body, arrange themselves into the proper line. There is a strong tendency in the teeth to assume their proper relative position, and if the obstructive cause be removed sufficiently early, they will, though at first considerably out of place, gain of themselves the desired position.

If, however, the irregularity is kept up by the closure of the antagonist teeth, the sooner after the full evolution of the tooth mechanical means are resorted to the better.

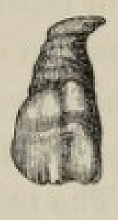
In the adult, if teeth are misplaced from want of room for a regular arrangement, the dental line must be expanded, or one of the permanent teeth must be sacrificed; and it may, if the maxilla is very small, be necessary to remove a tooth from each side of the jaw. The tooth selected should be either the second bicuspid, or the first molar; the reason for taking one or other of these teeth, in preference to a more anterior tooth, will be shown by a statistical table, illustrative of the relative value in durability of each tooth. After making space by the one method or the other, the anterior teeth must be forced backwards by pressing between them small pieces of compressed wood, or Indian-rubber: the former, by swelling, the latter, by its elasticity, will force the teeth towards the vacant place. Having thus gained sufficient space, the irregular tooth must be brought into its place by the means I have before described; for we must recollect that in the adult the disposition in the teeth to assume the proper line no longer exists.

It is necessary to bear in mind that, although a tooth may be moved either from side to side, or backwards and forwards, yet that we have no power of lengthening it. If, therefore, an irregular tooth be short, and its edge placed upon a different plane to the cutting edges of the adjoining teeth, and at the same time stands considerably out of line, it may be necessary to remove the tooth, even though it be a front one.

For if you bring a tooth into the line, and when there it is shorter than its neighbours, it will still be unsightly. The canine tooth of the upper jaw is especially liable to come through the gum at a much higher level than the adjoining teeth, and, if space be not afforded it to take its place, the development of the tooth will be completed in the irregular position. The crown will be of the usual size, but the fang will be very short. When these cases are met with, the tooth should be extracted, for it is not only irregular in position, but also in conformation, the fang being unnaturally short.

Before sacrificing the tooth, we should satisfy ourselves that its development is completed, for, if the fang is not fully formed, the tooth may be brought into its place, and the development of the fang will proceed. You will see how desirable it is to preserve the front teeth, and especially the canine, on inspecting the statistical tables of the relative durability of the teeth.

Fig. 72.



A Central Tooth,

That came through out of line, anterior to, and above the other teeth, with the fang completed, but short and ill-formed.

A tooth that has been moved by pressure feels to the patient, and indeed is, during the process, and for a short time afterwards, slightly loose, and exceedingly sore. In the young subject, and in the adult, the tooth, on being left at rest, soon loses this tenderness, and fastens; not so, however, in the decline of life. On the contrary, pressure upon a tooth induces irritation in the gum and alveolus; the latter becomes absorbed, and the tooth when left at rest seldom becomes as firmly placed as before the operation, neither is the absorbed alveolus reproduced.

In order to prevent any injurious motion in a tooth, after being by mechanical means brought into place, a silk ligature should be passed round the neck of this and the adjoining teeth, and securely tied. The ligature, if efficiently applied, will not only prevent motion, but will also counteract any tendency in the tooth to recede to its former position.

The bicuspid teeth are sometimes, from want of space, misplaced; the crown may project inwards, towards the tongue, or outwards, towards the cheek. If the degree of irregularity be slight, the teeth being but little seen, may be allowed to remain; if, however, any inconvenience be felt, the irregular tooth should be extracted. Where there is a choice, the second should be removed in preference to the first bicuspid, and the first molar to this.

The first and second molars are so seldom the subjects of irregularity in position that we may pass them over.

At present I have been speaking more especially of malposition of teeth of the upper jaw; what has been said of abnormal position occurring in the one may, however, be applied to the other jaw. I need not, therefore, occupy our time with a description of the dental irregularities occurring in the lower jaw. The treatment will be similar in principle to that adopted for the upper teeth, though the apparatus must, of course, be modified to suit the form of the jaw. Thus, when we require a fixed point from which to act upon a lower tooth, it must be external to the teeth. The under teeth, however, seldom require mechanical means to reduce them to regularity. In the first place, they are in the majority of individuals but little seen; slight irregularity is, therefore, but little regarded. Then, again, the malformation is generally the result of want of space, and passes away on the removal of the crowding tooth. The tooth selected for removal should, in the majority of cases, be the first molar, on account of its great liability to early decay.

There is, however, considerable disparity in the opinions of writers as to what course of treatment should be pursued in dental irregularity on its first appearance. That is, if a tooth presents out of line, whether treatment for its reduction into line should be immediately adopted, or whether it should for awhile be left alone, to give nature a chance of righting the defect: and this relates more especially to the canine teeth.

One party contends that little or nothing should be done in the way of mechanical interference before the age of fifteen, when all the permanent teeth are cut, that then space (if required) should be made by the extraction of a permanent tooth, and the irregular tooth reduced to its proper place. Bell and Delabarre are prominent advocates of this plan. Another party advocates the immediate interference with an irregular tooth soon after it appears through the gums, without reference to the eruption of the remaining permanent teeth. Fox advanced this system, and he has had many followers. A third party contends that none of the permanent teeth should be sacrificed, but that the dental line should be expanded by springs, &c. M. Lefoulon was, I believe, one of the first to explain at considerable length and to advocate this method of treatment, and Mr. Robinson has followed him as an advocate.

In the midst of such difference of opinion it seems hard to find a proper course. However, in this, as in most other matters, we shall not be far wrong if we follow that plan which is supported by the common-sense view of the case—avoiding the extremes, and adopting that plan which holds out a moderate chance of success.

If a permanent tooth is thrown out of line by the presence of a temporary tooth, the latter (whatever tooth it may be) should be removed, quite regardless of the age of the patient. It is unquestionably desirable to retain the temporary teeth till the permanent are ready to succeed them, but it *is not* desirable to keep them if they, by their presence, disarrange the permanent ones. It is better that one tooth should be considerably out of line, than that they should all be disarranged.

If, after the evolution of the permanent teeth, the canine, or any other anterior tooth, be out of line, our treatment must be guided by the amount of space that is required for it in the dental line. Thus, if the interval between the first molar and the second bicuspid be only one-fourth of that which is required, we shall have but little chance of gaining that space by expansion of the dental arch; therefore the first molar should be removed, supposing the bicuspides to be sound. On the contrary, if the interval be two-thirds of that required, then, by extension of the dental line, sufficient space may be gained, and no tooth need be sacrificed. The liability of the first molar to decay is, however, so great (seventy-six per cent. are lost under the age of twenty-five), that we need not grieve much at its early removal.

If the permanent teeth are to be extracted merely to make space for others, it becomes a question when this should be done. On reference to the tables showing the relative persistence of each kind of tooth, it will be seen that the canine is least of all liable to decay, and in another table it will be seen that it is more frequently out of line for want of space than any other tooth. Hence it is obviously more desirable to preserve this than any of the more posteriorly placed teeth.

Then, again, it is, I think, not less obvious that space should be made for the tooth to descend into its proper place, rather than allow it to take a malposition, and then make the required space and reduce the tooth into line by mechanical means. The prevention is surely better than the cure. The precise time for effecting this purpose must, therefore, in each individual case, be guided wholly by the time at which the canine teeth are ready to take their place in the dental line, and this will probably be somewhere between the eleventh and thirteenth year.

Dr. Mitchell has recently published a paper "On the Management of Irregular Dentition,"[a] in which he cites the opinions of various writers, and concludes by urging the expediency of the preventive treatment, and of extracting the first permanent molar when the bicuspides are sound, and there is occasion to extract a sound permanent tooth. This latter point will, however, be completely set at rest by the statistical tables of the relative value in durability of the several teeth.

In describing the various forms of dental irregularity, and the treatment to be adopted, I have endeavoured to lay before you general principles for your guidance, and especially as re-

[a] *Medical Gazette*, Feb. 18 and 25, 1848.

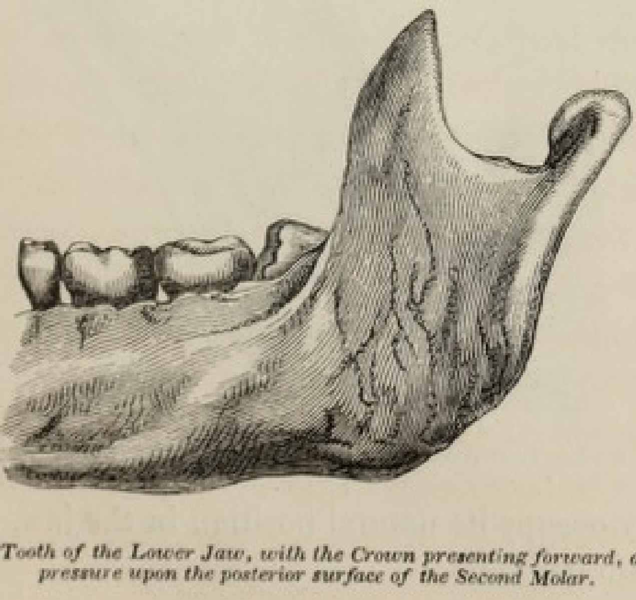
gards the treatment, in which matter I have described the plans usually adopted, in preference to giving an account of the construction of the instrument to be used in each case. I have done so, first, because we have not sufficient time allotted to us to go minutely into every part of the subject of dental surgery; and, secondly, because, if I did, such information would be but of little value to those destined to practise, irrespectively, medicine or surgery.

Irregularity in the position of the wisdom teeth demands our earnest attention, not so much on account of the disfigurement it may occasion, as on the serious and distressing disorders that are sometimes consequent upon misplacement of these teeth.

The wisdom teeth of the upper jaw, when taking a false direction, give rise to great inconvenience, but the more distressing symptoms are generally connected with the malposition of those in the inferior maxilla. I shall therefore direct your attention more especially to the latter, as in these cases we shall find the disorders similar, but more severe and better marked than when arising from ill-placed wisdom teeth of the upper jaw.

The third molar may be malplaced in five different directions.

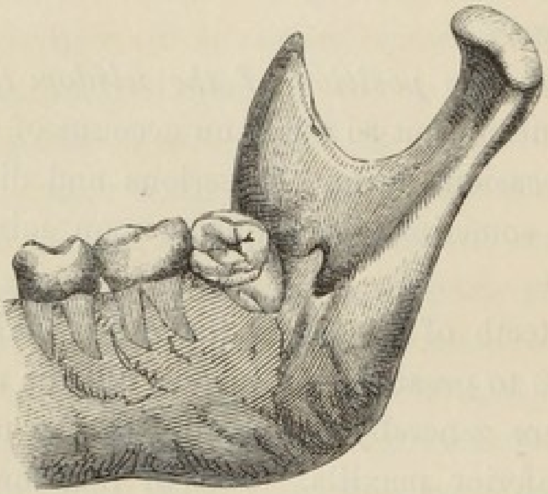
Fig. 73.



The Wisdom Tooth of the Lower Jaw, with the Crown presenting forward, and producing pressure upon the posterior surface of the Second Molar.

First, it may grow obliquely forward, with the masticating surface directed against the posterior surface of the second molar. (Fig. 73.) Second, the crown may be directed outwards towards the cheek, and may even be imbedded in the cheek. Third, it may take an inward direction towards the tongue. (Fig. 74.)

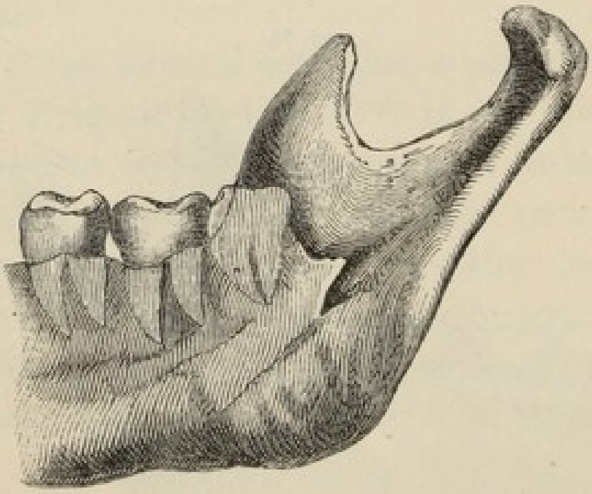
Fig. 74.



The Wisdom Tooth, with the masticating surface directed towards the Tongue.

Fourth, the tooth may be directed upwards in the coronoid process, either completely or partially within the bone. (Fig. 75.)

Fig. 75.



The Wisdom Tooth developed in the coronoid process of the Lower Jaw.

Fifth, it may occupy its natural position in the jaw, but be held down by indurated gum.

If we recall to our minds the progressive stages of the development of the three molars, we shall be able to assign the causes of these various forms of irregularity. You will remember that, immediately after the development of the sac for the wisdom tooth, it ascends into the coronoid process, that the ramus of the jaw increases in length, and that, when sufficient space is formed, the sac descends and forms a line with the more anterior teeth; but, if from any cause the jaw ceases to elongate when the sac occupies the coronoid process, the tooth will be developed in that situation. On the other hand, if the maxillary growth stops when the sac has descended to the angle only, the tooth will be directed forwards. Again, if growth should cease when the tooth has descended and fallen into the line, but before sufficient space has been formed for its evolution in the vertical direction, the tooth will be directed outwards or inwards, taking that direction in which the least resistance is offered. It may happen, however, that, although there is sufficient space in the alveolar line, yet the wisdom tooth does not appear through the gum, its delay arising, as far as we can tell, from the presence of a thickened and indurated gum, which offers effectual resistance to the eruption of the tooth.

Cases illustrative of the evils that occasionally arise from the various forms of malposition of the wise teeth not uncommonly present themselves to our notice. I shall, however, place before you several cases related by Velpeau; first, because they are well selected and particularly instructive in themselves, and secondly, because they come with the weight of his authority.

I should also, but for the want of time, cite some cases from Dr. Ashburner, to whom the profession is deeply indebted for bringing before their notice the various evils that may and sometimes do arise from malposition of the wisdom teeth.

Case I.—" A lady, at the age of 22, began to feel a dull pain at the angle of the lower jaw on the left side of the face, the pain soon extended to the adjoining teeth, but was distinct from toothache. As the pain continued to increase in intensity for several months, it was thought to be a case of rheumatism, and as such was treated, but without good effect; then blisters, and a seton at the back of the neck, kept open for a month, were tried, and opiates were given, but all to no purpose. She went and resided at a watering-place for some time, but came back to Paris nothing benefited. At this time the teeth were all good in appearance, the gums healthy, and nothing denoted the eruption of a wise tooth. However, upon making a section into the gum over the wise tooth, a probe passed down led to the discovery that the wise tooth was arrested in its progress by the direction it had taken—directly forwards, its crown coming in contact with the posterior surface of the second molar. The second molar was extracted, and the patient immediately released from her suffering."

CASE II.—" A lady, 29 years of age, sought advice on account of a painful tumour in the cheek; it had existed for several months. On examination it was found to arise from the wise tooth projecting horizontally outwards, and lodging in the parietes of the cheek. So soon as the mouth could be opened sufficiently wide the tooth was extracted, and the patient quickly recovered."

CASE III.—" A gentleman, of 45 years of age, had suffered from an ulcer on the side of the tongue, near its base. This ulcer he conceived to be syphilitic, and so was salivated as a means of cure. The salivation, however, made it much worse. After awhile, on application to Velpeau, it was found that the wise tooth on that side was directed inwards, and, projecting into the mouth, had occasioned the ulcer on the tongue; the tooth was extracted, and in a few days the ulcer healed."

CASE IV.—" Patient F. Boulanger applied to Velpeau in 1825. The right cheek greatly swollen, the tumefaction extending from the eyelids to the clavicle; several cicatrices, resulting from old abscesses, mark the skin in this neighbourhood. For the last twenty months the patient has not been able to open his mouth, and has therefore subsisted on broths. Three inches down the neck from the angle of the jaw there is a fistulous opening, through which much pus is discharged;

lower down the neck there is another fistulous opening. On passing a probe into the first of these openings, it penetrated obliquely backwards about three inches, and then was stopped by a hard body, which proved to be the dens sapientis. The patient's health had suffered much from frequent attacks of colic and diarrhœa, indigestion, &c. The mouth was gradually forced open by the introduction of bits of cork and wood between the teeth; the process was tedious, but successful. The tooth was extracted, and in five or six days a sequestrum was discharged, which seemed to belong to the coronoid process; it bore the mark of the crown of the tooth, and thus indicated the obstacle which had opposed the development of the tooth. The second molar was now extracted: eight days afterwards a second piece of bone was removed; and from this time the tumefaction of the neck and face disappeared so rapidly, that at the end of twenty days the face had resumed its natural appearance.

Case V.—A gentleman of 50 years of age had, during the last two years, suffered excessive torture. The right side of the face was greatly swollen and disfigured by sores from old abscesses; the neck, also, was swollen down to the clavicle, and marked in a similar manner; the mouth remained half open, and was distorted, from the lower teeth not corresponding in range with the upper. The general health of the patient had been considerably affected by his suffering. For the last four months he laboured under constant diarrhœa; fœtid saliva, mixed with pus, flowed constantly from his mouth. He was feeble, emaciated, and unable to walk without the support of two friends.

A mass of fungous flesh, which occupied the whole of the mouth on the diseased side, was freely divided, and, after a long examination, a wise tooth was found in the base of the coronoid process. The tooth and the whole of the process were removed, as were also several portions of the maxillary bone, with loose teeth. Within a fortnight all the bad symptoms had disappeared, and nothing remained but the deviation of the mouth, which was finally overcome by means of a bandage.

Case VI.—Dr. Fricard, when a student, was attacked, in the summer of 1821, with pain in the throat, and in the following November with severe inflammation of the right tonsil. This condition was partly subdued by antiphlogistic measures; but the pain soon returned, and continued, in spite of every means, up to the year 1823. The teeth and gums appeared to be perfectly healthy, and the surgeon was about to extirpate the tonsil, when it was accidentally discovered that the wise tooth on the affected side was not through. The gum was now freely divided, but the portions of the divided gum inflamed, and had to be removed with the knife and caustic. The tooth was thus completely freed, and the obstinate inflammation of the tonsil soon disappeared.

CASE VII.—M. Esquirol informed Velpeau that he had a case of mental derangement where the patient was restored to reason by a crucial division of the gum, which liberated the wise tooth.

These cases were related by M. Velpeau in a clinical lecture which was reported in the Medical and Surgical Journal in 1841.

We should at first sight scarcely expect that consequences so serious would arise from the development of the wisdom teeth, when occupying an abnormal position; neither do they necessarily occur when the teeth occupy either of the situations I have described. Before serious and painful results can arise, there must be a concurrence of many circumstances. The patient must be of strumous constitution, or predisposed to inflammatory action, or the nervous system must be peculiarly susceptible of excitement; in the latter case epileptic fits may supervene upon any interruption to the advance of the wisdom teeth. That epilepsy does arise in some cases from this cause is proved by its appearing when the teeth are passing towards the surface, and disappearing when passage is given to the teeth by removing the obstructing cause. I have within a few weeks of this time (1847) heard of three cases which occurred in the patients of medical friends, where fits commenced when wisdom teeth were presenting, and were completely removed by free incisions through the indurated gum over the teeth. As a precautionary measure, lint should be placed in the incisions, to prevent the union of the divided surfaces, otherwise the symptoms may recur.

I have during the last two years seen four cases in which the teeth presented with the crown forward, and produced great pain about the angle of the jaw, extending to the neck and shoulder, or to the side of the head. In each case the wisdom teeth were removed. The operations were attended with considerable pain, but it is better that temporary pain should be suffered than that the second molar should be lost in order to give space for a tooth which, when fully developed, will be useless in mastication.

The wisdom teeth, when malplaced, are wholly useless in mastication; we need not, therefore, hesitate to remove them whenever they give inconvenience. These teeth, although in their proper situation in the jaw, may yet, from their closeness to the ascending rami, give great inconvenience, not from want of space for the tooth itself, but from the mucous membrane of the ramus lying over the posterior surface of the teeth, and consequently being subject to injury from the upper teeth whenever the mouth is closed. Inflammation is thus produced, which in a susceptible subject will not only be kept up in the injured tissues, but will extend to the throat and tonsils, and there remain in a chronic state so long as the cause is allowed to exist.

In these cases the better remedy is to remove the tooth, seeing that, from its position, it is wholly useless; or, if this be objected to, the overlapping piece of membrane should be removed with a pair of curved scissors: a remedy may also be effected by the frequent application of caustic.

It is obvious that the evils produced by the development of irregularly placed wisdom teeth arise wholly from pressure produced by the gradual growth of the dental pulp, preparatory to its calcification; by which the superimposed tooth is forced against the tissues by which it is covered. In the natural course of things these tissues are absorbed, and make way for the rising tooth; but if they are not absorbed, and therefore resist the advance of the tooth, the pressure reacts through the tooth upon the developing pulp.

The pulp is very plentifully supplied with nerves, and moreover is placed immediately over the large dental nerve (at least in the under jaw). (Fig. 94.)

We all know that pressure upon a nerve or nerves, though slight in degree, will produce more or less pain, and that the pain will be felt in the part to which the fibres pressed upon are ultimately distributed. Instead, then, of being surprised that interruption to the growth of a tooth should produce pain extending through the whole jaw, or to the side of the head, or about the ear, we should be led to infer that such phenomena would exist.

It would be, perhaps, difficult to estimate the actual amount of mechanical force developed by a growing tooth, but we may form some estimate by observing the force generated by a growing vegetable. We have most of us seen a tolerably weighty piece of stone raised by the growth of a plant beneath it, any fibre of which might be readily crushed beneath the thumb and finger.

Pressure, moderate in degree and equally applied, will lead to the absorption of tegumentary tissues; but if the pressure be great, and unequally applied, instead of absorption we have induration and pain—a fact those who have worn tight boots are willing to admit. If a tooth be developed more rapidly than the superimposed gum is absorbed, gradually increasing pressure will be applied to the gum, which will then become indurated and painful, and the symptomatic disorders I have alluded to may supervene.

In all cases of inconvenience arising from malposition of the wisdom tooth, either the tooth itself or the parts obstructing its development must be removed.

The evil will, however, if not in itself considerable, and the patient has sufficient endurance, after a time terminate. The development of the tooth will cease in the formation of very short fangs, and the pressure, no longer generated, will cease, and the patient will be restored to comfort.

I have omitted to mention, that irregularity in position is sometimes caused by tumours growing from the gums or alveoli; but as we shall, in a future lecture, consider the history of diseases of that nature, I need not detain you now by describing their effects.

Inversion of the teeth.—Albinus relates a case in which the canine teeth of the upper jaw were found imbedded in the maxillary bone, under the orbit, with their crowns directed upwards. A similar case is recorded and figured by Hunter [a].

Mr. Arnott, in his surgical lectures, usually relates two cases of tumours of the upper jaw, in each of which teeth inverted in position were found. The crowns of the teeth were directed upwards, and, indeed, had grown into the antrum. The tumours and the inclosed teeth were removed, and the patients did well.

[a] *Natural History of the Teeth.*

LECTURE IX.

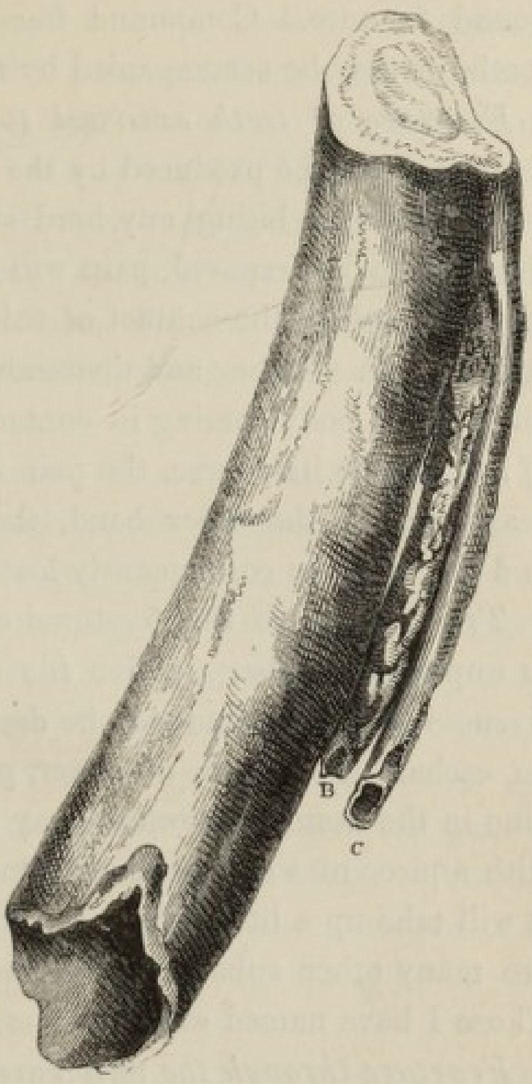
OSSEOUS UNION OF TEETH TO EACH OTHER.—UNION OF TEETH TO THE ALVEOLI.—MECHANICAL INJURIES.—FRACTURE OF TEETH.—FRACTURE EXTERNAL TO THE PULP-CAVITY—THROUGH THE PULP-CAVITY—THROUGH THE FANGS.—UNION OF FRACTURED TEETH.—DILACERATION OF TEETH.—INJURIES OF THE PULP.—DISLOCATION OF TEETH.—FRACTURE OF THE ALVEOLI.

Irregularity in the structural relations of the teeth to the adjoining tissues.—It is by no means uncommon to find the fangs of a molar tooth, which are usually separate, united; but further, there are many well-authenticated cases where the fangs of two adjoining teeth have been permanently connected. A case occurred in the practice of my friend Mr. Rogers, in which the second and third molars of the upper jaw were firmly united. If my memory does not fail me, the wisdom tooth was decayed and painful. On attempting to remove the offender, both teeth came out, and it was then found that they were united by their fangs. It is probable that junction was effected between the bone or cementum of the fangs. Although such cases are rare, yet there are a sufficient number recorded to establish the fact. Mr. Bell describes several cases from preparations in his own possession. In the American Journal of Dental Surgery, an instance is mentioned in which the lower bicuspids were joined.

Before we leave the subject of dental union, I shall take the opportunity of bringing before your notice a very interesting specimen which I had the good fortune to procure from an ivory dealer.

The tusk of the elephant grows during the whole life of the animal; the older the elephant, the larger the tusk. Usually there is a single tusk developed from each side of the upper jaw. In the specimen before you, three tusks have grown from one side—a large one above, and two smaller ones immediately below. But the great peculiarity exists in this, that the apices of the smaller ones are united to the under surface of the larger one. The union is effected not by the dentine of the three, but solely by the cementum. Each tooth has its separate alveolus and pulp-cavity. Portions of the alveoli are still adhering to the surface of the lesser tusks. (Fig. 76.)

Fig. 76.



An Elephant's Tusk,

With two lesser ones united by their apices, while each has its own proper alveolus and pulp-cavity.
A. The normal tusk.
B and C. The adventitious tusks.

Osseous union between the teeth and alveoli.—The fact as to whether the fangs of teeth are ever connected to the alveoli by osseous union, is not at present established. I have seen a specimen of a milk tooth which remained in the adult jaw, and seemed to be united to the bone; but, as a section of the parts had not been examined by the microscope, the fact could not be considered as established. There seems no reason why union should not, under some circumstances, take place; yet, if such does occur, the cases are very rare, and are, therefore, practically unimportant.

Mechanical injuries of the teeth: fracture.—The teeth, as well from their peculiar functions as their exposed situation, are very liable to be fractured. The fracture may be external to the pulp-cavity, in which case it may be termed simple, or it may extend through the pulp-cavity, and thus constitute compound fracture. Compound fracture may be confined to the tooth, or may be accompanied by fracture of the alveolus.

Fracture of teeth external to the pulp-cavity, or simple fracture, may be produced by the violent closure of the antagonist teeth, by biting any hard substance, or by a blow. If the dentine be exposed, pain will for a time be felt on subjecting the tooth to the contact of cold fluids, or even a current of cold air. A peculiar and distressing sensation is produced by any foreign body coming in contact with the exposed dentine. If left to take its course, the pain and sensitiveness may wholly cease, or, on the other hand, the pulp may become inflamed, and the tooth be consequently lost.

Treatment.—If the fractured edge of the enamel be rough, or unpleasantly sharp, a fine file should be used. The sensitiveness of the dentine may be destroyed by the application of an escharotic; nitrate of silver, potassæ fusas, or chloride of zinc in the state of powder, may be rubbed over the surface with a piece of wood, rendered rough at the extremity, so that it will take up a little of the remedial agent. No doubt there are many other substances which would answer the purpose. Those I have named will, however, prove efficient.

Fracture through the pulp-cavity is of very frequent occurrence, and is usually the result of a blow or a fall. It may possibly be produced by the violent action of antagonist teeth, when the muscles of the jaw are affected by spasm; though such a case has not come under my own immediate notice. The fracture may be situated in the crown, or in that part of the tooth which is inclosed within the alveolus, but, as the two cases may lead to somewhat different results, we will consider them apart.

When the injury has been confined to the crown, the fractured portion will, of course, be detached, and leave the pulp and surface of the dentine exposed to external influences. After an accident of this nature, you will find the pulp projecting from the fractured surface, and extremely sensitive to the slightest touch, even of the tongue. Inflammation will shortly commence in the exposed pulp, from which it will extend to that portion situated in the fang, and from thence proceed to the periosteum of the fang and alveolus. The inflammatory action may not stop here, but may extend further, and involve the periosteum of both the external and internal plates of the alveoli, and also the gum. In this case you will find considerable swelling of the face, diffused pain over the parts involved, accompanied with the constitutional signs of local inflammation.

If allowed to take its course, the inflammation will terminate in the death of the pulp, and in the formation of pus in the alveolus, which will find its way down the side of the tooth, and be discharged under the edge of the gum, or a canal will be formed by absorption through the alveolus and the gum, and the matter will issue through the opening, which is commonly situated opposite the apex of the fang. Free exit being given to the pus, the inflammation will now abate, and the pain and swelling will subside with the escape of the matter. The tooth will become gradually dark in colour. The secretion of pus will continue, though the quantity discharged may be so slight as to escape notice.

These are the consequences which, if no preventive means be used, usually follow upon a tooth being fractured through the pulp, and the pulp exposed, but not destroyed. But, if the accident occur in a strumous constitution, the results may be more serious; the neighbouring teeth may become involved in the inflammation, and the alveoli suffer necrosis; so that, instead of the injured tooth alone being lost, the adjoining teeth, with the inclosing alveoli, may be destroyed.

The pulp may, however, be destroyed by the force which occasioned the fracture of the tooth; thus, if the crown be broken off near the neck, the pulp will probably be torn out of the fang by the detachment of the crown. On the other hand, the tooth may have been so moved in its socket that the vessels and nerves are severed at their entrance into the fang. In either case there is much less risk of inflammation than where the pulp is exposed to the immediate action of air, and to the various substances taken into the mouth. The exposed surface of the dentine is in most cases for awhile very sensitive, but the sensitiveness gradually subsides; the tooth becomes discoloured, the discolouration commencing around the vacant pulp-cavity, and extending outwards.

In a susceptible subject, however, you may have considerable inflammatory action, following much the same course as occurs in those cases where the pulp is exposed, but not destroyed.

In the most favourable case there is an attempt at reparative action. If the pulp be torn across half way down the fang, the remaining portion of the pulp will, in the course of a little time, seal up the exposed aperture of the cavity of the fang with newly formed dentine, just as we see the cavity obliterated by new dentine in the fangs of teeth which have been much worn by mastication. In the one case the injured pulp withdraws itself from external influence, by forming a layer of dentine on its exposed surface, and in the other, by adding new dentine to the inner surface of the pulp-cavity as the external walls are thinned by wear.

Treatment.—If the fang of a front tooth be sound, and the adjacent parts free from inflammation, a new crown may be pivoted upon it in such a manner that the artifice cannot be detected unless very closely examined, and the crown will answer all the purposes of the original one. (The manner of performing the operation I shall describe to you in a future lecture.) Hence, in may cases it will be desirable to preserve the root of a tooth from which the crown has been broken. To effect this we must, if the pulp be exposed, immediately destroy it, by thrusting into the cavity a small steel instrument; and when it can pass no further, from the narrowing of the canal as it approaches the end of the fang, roll it between the finger and thumb: this will completely destroy the pulp soon after its entrance into the tooth; and the coagulum formed from the torn and bleeding vessels will protect that little which remains.

Having destroyed the pulp, we may proceed to fix on, by means of a pivot, the new crown.

Some dentists use platinum, or steel wire, heated red hot, for destroying the pulp, under a belief that, when the actual cautery is used, the patient is less liable to an attack of inflammation of the alveolar periosteum as a result of the operation.

Four years since a gentleman had the central incisors broken off by a blow from a ball. I saw him on the same day. The pulp in each tooth was destroyed for some distance down the fang. The stumps were pivoted. No inconvenience followed the operation, and at the expiration of three years the roots of the pivoted teeth seemed perfectly free from disease.

Such should be our treatment if the fang be firm in the alveolus, and the patient applies to you before inflammation has commenced; but if the root be loose, from the blow which fractured the crown, or if the indications of inflammation are present, you should at once extract it. If there is considerable inflammation about the alveolus, the patient should, after the removal of the tooth, be directed to foment the part freely, by taking into the mouth a strong decoction of poppy-heads, and at the same time an aperient should be given to reduce or to anticipate constitutional excitement.

If the accident has occurred at some distant period, and the now empty pulp-cavity has its walls discoloured, it will be inexpedient to pivot on a new crown, as in all probability the cavity gives passage to some slight discharge, which, on being blocked in by the pivot, will lead to abscess in the alveolus, for the relief of which the root must be extracted. You will, in some cases, find that pus, instead of passing out through the cavity, makes its escape through a small fistulous opening opposite the end of the root. In such a case pivoting may not make the matter worse; but, as disease about the fang of one tooth is apt to extend to the adjoining teeth, it is far better to remove the root, and replace the tooth by other means.

Fracture of the root.—The root of a tooth, you are aware, is invested with periosteum, and fracture may occur without that membrane being detached, except at the line where the fracture has taken place. The tooth may, therefore, be retained in its place. If, however, the force causing the injury has been great, the fractured part may have been knocked out. The alveolus, by the same blow, may have been fractured, in which case there may be great displacement of the tooth, and in some instances without detachment from its socket. The direction of the fracture may be either transverse or oblique, and may itself be either simple or comminuted.

The pulp, if the force causing fracture has not produced much displacement, may be but slightly injured, and vitality therefore preserved throughout its whole length; on the other hand, if the displacement has been considerable, it must be torn across, and that part external to the seat of fracture destroyed.

You will recognise fracture of the fang of a tooth by the crepitus that will be felt on moving the crown. The fractured tooth, if left to itself, will, in many cases, produce inflammation and pain in the alveolus, which may oblige the removal of at least the fractured portion. This will not, however, be the necessary result; the fracture may unite.

It has been believed that union of a fractured tooth could never occur, but the preparation which I am enabled to show you, through the kindness of my friend Mr. Saunders, whose property it is, shows that union not only can, but in this instance has, taken place. The tooth is a central incisor of the upper jaw; the fracture extended obliquely through the middle of the fang, and was obviously attended with slight displacement, in which position perfect union has taken place. Several small nodules of dentine mark the line of union, the oblique direction of which, together with the displacement, are so

Fig. 77.

A Central Incisor Tooth united after Fracture of the Fang.

A. The seat of fracture and subsequent union. Drawn from a preparation lent to me by Mr. Saunders.

well marked, that there can be no doubt of the producing cause of the present appearance of the tooth—namely, fracture and subsequent union.

A second case of union is recorded in the American Journal of Dental Science, vol. i., where you will see a woodcut representing an incisor fractured near the neck, with the crown bent at a right angle with the fang, and in that position united.

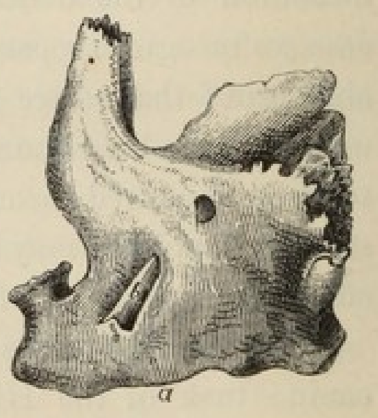
It will not be difficult to understand how a tooth fractured through the fang may be united, supposing the pulp be not destroyed by the injury of the dentine. You have seen that, when the surface of a tooth is worn, the pulp forms dentine in the cavity opposite to the worn external surface, and I shall show you that, when a tooth becomes decayed, the pulp will, in some cases, form dentine in the pulp-cavity, opposite to the seat of the disease situated on the external surface. The process of development in the two cases is similar to that engaged in the formation of the dentine of the body of the tooth. In each case we recognise reparative attempts, and also an unquestionable proof that where there is dental pulp there we may have, under favourable circumstances, dentine developed. If, then, a tooth be fractured through the fang, and the pulp be not destroyed, a process may be set up similar in every respect to that effecting the union of fractured bones.

Mr. Owen describes and figures a specimen—the inferior canine tusk of the Hippopotamus, in which a fracture completely through the tooth, near its base, is perfectly reunited, and the reunion effected by the development of secondary dentine, or osteo-dentine, as he calls it.

If we examine osseous union, we shall be able to trace the following steps up to the completion of the process. Thus, the immediate consequence of fracture of a bone is the effusion of blood from the lacerated vessels of the injured part; this is followed by effusion of liquor sanguinis, or lymph; the formation of cartilage between the fractured extremities then succeeds, and after awhile the cartilage is converted into bone, and the union is complete. Similar action would no doubt arise when dental union takes place, but instead of cartilage we should have dental pulp, which would be converted into dentine. Numerous specimens of hypertrophy of the cementum attest that, whenever there is dental periosteum, there may be formed dental bone or cementum. The bony layer of the fang may, therefore, under favourable circumstances, be united.

Treatment.—If the fracture be situated about the middle of the fang, or near the neck, and the body of the tooth be knocked out, the remainder of the root, if painful, should be extracted; but if a small portion of the fang only remain in the alveolus, it is not well, unless it be painful or loose, to attempt the removal, as the operation would be attended with considerable pain. A small piece of root very seldom gives any inconvenience, and is, after a time, by the deposition of bone in the alveolus, brought towards the surface and thrown off, or it may be impacted in bone, and there remain without giving any evidence of its existence. Such has evidently been the case in the specimen before you; the bone is here closely fitted to the surface, even to a somewhat irregularly fractured surface. Had there been any inflammation excited by the presence of the fang, we should see evidence of its existence in the adjacent bone. Instead of that, however, the texture of the bone immediately in contact with the root is free from the abnormal porosity common to inflamed bone, and is, in point of density, exactly similar to other parts of the maxilla. (Fig. 78.)

Fig. 78.



The left Upper Maxilla,

With the root of a tooth imbedded in its substance.

a. The alveolar line, the alveoli themselves having been absorbed from age.

b. The root of a tooth closely embraced by bone.

Again, a small portion of the fang of a fractured tooth may wholly or in part be absorbed. It must not be denied, however, that, in a few cases, the remaining part of the fang of a fractured tooth will produce inflammation, and subsequently a gum-boil, which, had the stump been removed, would probably have been avoided.

Tumours, too, of serious character have, in a few rare cases, sprung up around, and seemed to be caused by the presence of stumps.

If, then, after fracture the crown be not detached, but yet feels very loose in the gums, it should be removed; or, if the gum be inflamed, it should be removed, whether loose or not. Should, however, the fractured tooth be tolerably free from pain, and the gum from inflammation, and at the same time be held tolerably well in its place, we may attempt to get a union of the fractured surfaces. If we could insure perfect absence of motion in the tooth, it seems probable, judging from the specimen before us, that union might be effected. It will, however, be extremely difficult to ensure perfect rest in the parts, and we know that even a bone will not unite unless there is total absence of motion between the fractured extremities, and much less would a tooth, when the nature of the new tissue, namely, dental pulp, is much less firm, and therefore more readily injured than cartilage. From these circumstances our chances of success will, I fear, be small, though I think the chance worth the trial.

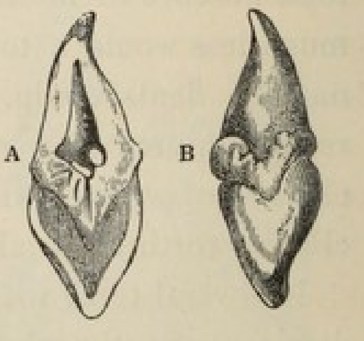
If several teeth with their alveoli are fractured, and there is displacement, the whole should be brought back to the proper position, and the patient should be enjoined to avoid all causes of motion in the injured part, which should be fomented, by taking into the mouth hot poppy-head fomentation, which should be renewed as soon as it cools. The general health should also be attended to, and aperients given if necessary.

Dilaceration of partially developed teeth from the formative pulp.—By this I mean the forcible separation of the cap of developed dentine from the pulp, in which the development of dentine is still progressing. I have but little experience in accidents of this nature. Dilaceration is, of course, the result of mechanical violence. Two cases have come under my notice, in which, after severe injury to the jaw—in one from the kick of a horse, in the other from a fall—partially formed teeth came away, with necrosid bone. I am, however, through the kindness of my friend Mr. Saunders, enabled to show you a specimen, in which there has been perfect reunion after dilaceration, and the development of the tooth has been perfected.

In this specimen the accident has evidently occurred subsequently to the development of the enamel, and there are also indications that there was slight displacement consequent upon the injury.

There is a distinct line of demarcation between the dentine formed before and subsequent to the accident; indeed, the great distinctness of the line throws some doubt as to whether there is perfect reunion in this tissue. The dentine developed immediately after, and by which the junction or reunion is effected, is perforated by numerous canals, which were probably occupied by vessels, but which, like the vascular canals in the antler of the stag, become partially obliterated on the organ reaching maturity. The thickening or ridge on the external surface of the tooth consists of cementum, in which the reunion is very perfect, and is, I believe, perforated by vascular canals. The pulp-cavity, you will perceive, is situated low down in the fang of the tooth, and at the upper part is studded with two small nodules of dentine. I have not seen a specimen which could be viewed microscopically by transmitted light, so that I cannot describe the structure more minutely. (Fig. 79.)

Fig. 79.



A Canine Tooth united, and the development perfected after dilaceration.

A. A section showing the pulp-cavity and the line of union, which latter is made much more distinct in the engraving than it exists in the specimen.
B. The external surface of the same tooth.
Drawn from a preparation lent to me by Mr. Saunders.

There are, however, on the table, several sections of teeth, in which, from the sudden and angular bend of the tubes in a contour line, extending through the crown of the tooth, it may be judged that the cap of dentine was, during development, slightly moved on the surface of the pulp, though not sufficiently to completely break the continuity of the tubes. In one specimen their continuity is kept by the presence of dilatations at the points where the previously formed are connected with the after formed portions of the dentinal tubes.

The subject of reunion after dilaceration, though interesting physiologically, is practically of little value. The accident rarely occurs, and when it does is either not recognised, or if recognised is involved with such extensive injury of the adjoining parts, that there are no hopes of the reparative action coming into operation.

Mechanical injuries of the formative pulp, with partial dilaceration, though almost unknown in the human teeth, are occasionally met with in the tusks of the elephant, or perhaps I should speak more correctly if I say the results of such injuries are occasionally recognised in the tusks. Most museums possess specimens of tusks, in which balls are impacted, and every where surrounded with dentine. On close examination, it will, as far as my experience goes, be found that the dentine near the surface of the ball is slightly peculiar; that it has a translucent horny look, and in some specimens has a laminated appearance.

Before the development of dentine became understood, it was extremely difficult to explain how a ball should get into the solid part of a tooth. We can now, however, see that if a solid substance be lodged in the pulp, and remain there without producing inflammation, it must, on the pulp being converted into dentine or cement, be inclosed in the solid substance of the tooth, just as it was before inclosed in the pulp. But, if the pulp near the foreign body be destroyed, then dentine is deposited at a short distance, in such a manner as to inclose the ball loosely in a case, and at the same time protect the remainder of the pulp. The specimen on the table illustrates this point. The missile has evidently entered through the base of the tusk, and passed into the inclosed pulp. The fracture in the tusk is unrepaired, but a loose case is formed round the ball, with an opening coming from without, which retains the marks of the fracture in outline, though the edges of the aperture are rounded.

Dislocation of teeth.—Dislocation may be partial or complete; that is, the tooth may be loosened considerably, and hang in its place, or it may be so completely detached from its articulation that it falls from the socket. Further, it may be complicated with fracture of the alveolus, or, on the other hand, the tooth may be driven up towards or into the nasal cavity. Mr. Bell cites a case of the latter kind, which came under his immediate notice. Dislocation is always produced by mechanical violence when occurring suddenly, or by the growth of a tumour, or by deposition of bone in the socket, when occurring gradually. A front tooth is occasionally seen lengthened beyond its fellows; this arises from the gradual filling up of the alveolus from the bottom by the deposition of bone; hence the tooth is forced out, and appears to have lengthened.

If the dislocation be incomplete, and there be little or no injury to the jaw, the tooth will, if kept quiet, in a patient having a good constitution, become firmly refixed; but, on the contrary, we may have inflammation set up, which will extend to the neighbouring parts, and produce great mischief.

If the dislocation be complete, with only trifling injury to the alveolus, and the tooth has fallen out, the jaw usually gives but little trouble. It is common for a patient after the skilful extraction of a tooth from an uninflamed jaw to feel no subsequent pain whatever. If the dislocated tooth be driven into the jaw, great pain and active inflammation of the injured part may occur in any case, and will almost surely supervene, if the tooth be not removed.

Treatment.—If a sound valuable tooth be completely dislocated, the alveolus should be immediately cleared of coagulum by the use of a strip of lint and a probe. The tooth should then be returned to its place, and fixed so as to prevent motion, by a silk ligature round the adjoining teeth. The patient should be cautioned against disturbing it by any attempt at mastication on that side of the mouth. By these means a dislocated tooth will often become firmly replaced in the jaw, though occasionally you will have inflammation arise as a consequence of the attempt. In all cases there will be some tenderness, and the tooth will for a short time be elongated and sore; a circumstance arising from swelling of the alveolar periosteum, and the consequent slight displacement of the tooth. If, however, the tenderness be great, and accompanied by constant pain, all attempts to induce reunion should be abandoned.

Supposing a tooth to have become quite firm after dislocation, it does not follow that it will continue serviceable for any great length of time. Such teeth being partially dead, from their connection with the vascular system existing only through the dental periosteum, and not through the pulp, usually become discoloured. The consequence is, that gum-boils not unfrequently appear, and these, if severe, may oblige the removal of the tooth. Still, I have seen several cases in which teeth removed by mistake and returned to their alveoli have united, and remained useful for years.

If the dislocation be partial only, the tooth should be pressed back into its proper position, and in most cases it will unite to the alveolar periosteum. There is frequently a little difficulty in returning the tooth when the alveolus has become occupied by a coagulum. Firm pressure should be used, and, when in its place, the tooth should be tied to the neighbouring teeth.

You will often fail, yet it is always worth while to attempt to save a sound tooth, even if the chances of success are small, supposing the risks of exciting inflammation are small too.

If the dislocated tooth be driven into the antrum, or into the jaw, it should be immediately removed, otherwise inflammation will arise, which may end in necrosis of the injured bone.

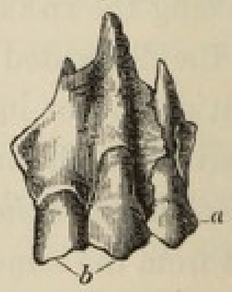
Mechanical injuries of the alveoli.—Fracture of the sockets arises from the same cause, and is usually connected with fracture or dislocation of teeth. In some cases it is the result of unnecessary force, or force injudiciously applied in the extraction of teeth. The extent of fracture will be in proportion to the degree of mechanical violence producing it, and may be confined to a simple fissure, or one or more pieces may be broken off. Fracture of the alveoli is necessarily concomitant with fracture of the jaw; but, as this forms a subject in the surgical lectures, we shall not touch upon it here.

It rarely happens that slight fracture of the alveoli, in a perfectly healthy person, is attended with any more serious inconvenience than some slight pain for a few days. If, however, your patient be in an unfavourable state of health, then necrosis of at least the injured portion, if not of more of the alveoli, may be feared.

Treatment.—No doubt slight fracture is a very common result of the extraction of the teeth, as well as of other injuries of the teeth; but when the fracture is slight, and is, in fact, nothing more than a fissure, with but little separation, we have no means of ascertaining its existence, neither would the knowledge, could we obtain it, be of any practical value. Should, however, you detect a piece of alveolus broken from its connection with the maxilla, and attached only to the gum, it had better be removed, otherwise it will occasion irritation until it is thrown off by natural efforts.

Two cases have come under my notice where large portions of the alveoli have been torn away with the teeth, and in each the exposed surface of bone exfoliated. In the first case the two bicuspides and canine were removed with the inclosing alveoli in an effort to remove the second bicuspid with the key. In the second case two molars, with their alveoli, were removed in the same manner, and the mucous membrane of the palate torn across as far as the soft palate. The patients applied to the hospital in consequence of the injuries received in the operations.

Fig. 80.



The Lateral Incisor and Canine b, and the first Bicuspid a, with their Alveoli, from the left side of the Upper Jaw,

Torn away in one mass in attempting to extract the bicuspid *a* with the *key*.

It is very common for a small bit of the edge of the alveolus to be found adhering to the neck of a tooth after removal. This amount of injury is very seldom of any account, neither need any treatment be adopted.

I need not detain you with any account of necrosis, as you will hear from Mr. Arnott or Mr. Shaw, your lecturers on surgery, a far better description of that disease, whether situated in the jaw or elsewhere, than I should be able to furnish.

LECTURE X.

DISEASES OF THE DENTAL TISSUES.—DENTAL CARIES.—THEORIES OF DENTAL CARIES.—PHYSICAL AND VITAL CHANGES OF THE ENAMEL AND DENTINE.—ANALOGY OF DENTAL TO OSSEOUS CARIES.—PREDISPOSING AND EXCITING CAUSES OF CARIES.—TREATMENT.

CARIES, dental gangrene, or decay, are the various names by which the disease I am about to describe is known. It is but of little consequence which of these we select for our present use. Caries is, perhaps, the oldest, and as expressive of the nature of the disease as either of the others, while it has the advantage of being short—we will, if you please, adopt that term.

Much has been written on this subject, and much more remains to be written before we arrive at a full understanding of it, in its various stages and modifications, unless the writers become a little more explicit than they have hitherto been, both as to their views, the statement of them, and the facts on which they are based.

Both the nature and causes of caries are, however, very differently estimated by different authors. The theories advanced, in explanation of the subject, may be arranged under one of the two following heads. The first will include those in which caries is in itself considered a vital action and the result of inflammation; and the second those in which caries is regarded wholly as the result of chemical action, caused by the presence of decomposing matter lodged in the interstices of the enamel.

I should, however, at starting, state that these doctrines were promulgated long before the structural anatomy of the teeth was understood.

Fox endeavours to show that dental is in nature similar to osseous caries; he assumes that separation of the periosteum is the cause of caries in the bones, and that separation of the pulp from the surface of the pulp-cavity is the cause of dental caries; and, further, that in each case the separation is the result of inflammation.

Mr. Bell advances the opinion, that caries is the result of inflammation in the dentine itself, and that, from the low degree of organization of that tissue, it is unable to recover from active inflammation. He says, "The true proximate cause of dental gangrene is inflammation, and the following appears to me to be the manner in which it takes place. When, from cold, or any other cause, a tooth becomes inflamed, the part which suffers most severely is unable, from its possessing comparatively but a small degree of vital power, to recover from the effects of inflammation, and mortification of that part is the consequence. Many subsequent writers have, with slight and unimportant variations, supported the views of these great authorities on dental surgery.

Mr. Robertson, of Birmingham, stands preeminent amongst those who assume that caries is nothing more than chemical decomposition of the tooth, and who assert that the tissues composing the teeth are devoid of life, and that, therefore, vital action cannot occur in them.

These two classes of opinions are sufficiently at variance with each other. I think, however, I shall be able to convince you that they are, in the main, when taken together, both right, but that neither, taken alone, will suffice to account for all the phenomena of caries.

If the views I am about to explain are sound, caries may be defined to be *death and subsequent progressive decomposition of a part or the whole of a tooth.*

I believe that the dentine from abnormal action loses its vitality, and with the loss of vitality the power of resisting chemical action, and that consequently the dead part is, under favouring circumstances, decomposed by the fluids of the mouth.—That there must be a concurrence of dead dental tissue, and of a condition of the oral fluids capable of decomposing the dead part before the phenomena of caries can be developed.

Further, I conceive that the causes producing the abnormal action may have been applied locally to the tooth itself, or may have had a constitutional origin, and therefore have acted through the nerves or the circulating fluids.

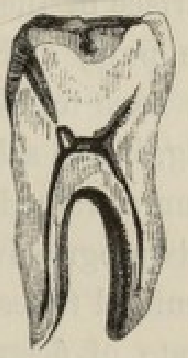
To support these views it will require that I should go to some length into the subject. Time, however, cannot be misspent when devoted to the consideration of a disease so universal in its presence, and at the same time so prejudicial to the health and comfort of those whose teeth are affected.

Death of the dental tissues precedes their decomposition; but, in practice, we know that the one has occurred by the development of the other. We recognise the presence of disease by the occurrence of physical changes in the diseased part. It will be needful, therefore, that our attention should first of all be directed to the progress and process of dental decomposition.

The physical changes, then, that tell us of the presence of caries, commence with discolouration of the dental tissues, this is succeeded by softening, and softening by disintegration. The enamel is the first to suffer, and then the dentine, but not till then. The enamel must have become unnaturally pervious before the destructive agents can gain admission to the dentine. As the decomposition proceeds from without inwards, the coronal ends of the enamel fibres suffer first, from whence the destructive action follows on towards the dentinal ends. The advance of decomposition in the length of the fibres is more rapid than its extension laterally. Hence a perforation through the enamel, down to the surface of the dentine, is produced before the lateral extent of the disease, or in other words the hole, is sufficient to attract attention. Indeed, the dentine may be exposed long before we even suspect the existence of caries, so small may be the opening through the enamel. The rapidity of the destructive process will, of course, depend upon the previous condition of the enamel, and upon the corrosive strength of the agent which works the evil.

The outer texture having been destroyed or injured, the dentine next suffers decomposition. From the greater porosity of this tissue at and near its coronal surface than the enamel, the destructive agents, so soon as they gain admittance, spread laterally, and from the surface extend inwards, towards the pulp-cavity, following the course of the tubes. From the convergent course of these, the diseased and disorganized mass of dentine takes, necessarily, a conical form. The same conditions as to form hold good as regards the enamel, so that the forms of the masses of the two disorganized structures would be represented by two inverted, truncated cones. The top of the one should be placed on the base of the other. The top cone should be the smaller of the two, then it will represent the diseased enamel, while the larger and under one will correspond to the affected dentine.

Fig. 81.



Longitudinal Section of a Molar Tooth;

Showing the course taken by caries, and the form of the diseased portion, in the earlier stages of the disease.

From the more rapid extension of decomposition in the subjacent tissue than in the enamel itself, this texture is speedily undermined, and when the dentine below is softened the decomposition then proceeds in the enamel from within outwards. Indeed, the outer surface of the enamel often remains good when undermined and suffering decomposition from within.

This undermining gives to a decayed tooth a deceptive appearance as regards the extent of loss sustained. The amount of destruction is much greater than a superficial examination would lead you to expect. The enamel, which is deprived of its natural support, is, however, very liable to break away in mastication; hence, when a hole is perceived in a tooth, it generally enlarges rapidly.

These observations as to the form of the carious mass are applicable to the disease in an early stage, and when situated in the crown of the tooth. If the dentine of the neck be attacked, then, as the tubes in this part converge in the horizontal plane only, the affected mass will probably be wedge-shaped. When so situated, the disease is very apt to burrow under the terminal edge of the enamel. Then, again, in one case it will burrow in the dentine, while in another it will have great superficial extent and but little depth, and will not burrow.

Caries may be said to proceed, invariably, from the surface towards the centre of a tooth. I have seen discolouration on the surface of the pulp-cavity, but this has been after the death of the pulp, and I doubt whether softening of the dentine would have followed had the tooth remained in the mouth ever so long, if the saliva remain excluded from the pulp-cavity.

If unrestrained by preventive measures, caries very generally extends progressively under the enamel, and in the course of the dentinal tubes, till the whole body of the tooth is destroyed. The rate of destruction is then lessened, the stump holds out against the ravages of disease, which, when it arrives at this part, is either greatly arrested or altogether suspended. The fang, with its clothing of highly organized cementum, has a higher degree of vitality than the crown, and is thereby better able to resist destruction. The consolidation of the dentine is more perfect in this than in any part of the tooth, and the decomposition is thence arrested. The surface of the stump becomes polished by friction, and this of itself gives a power to restrain destruction.

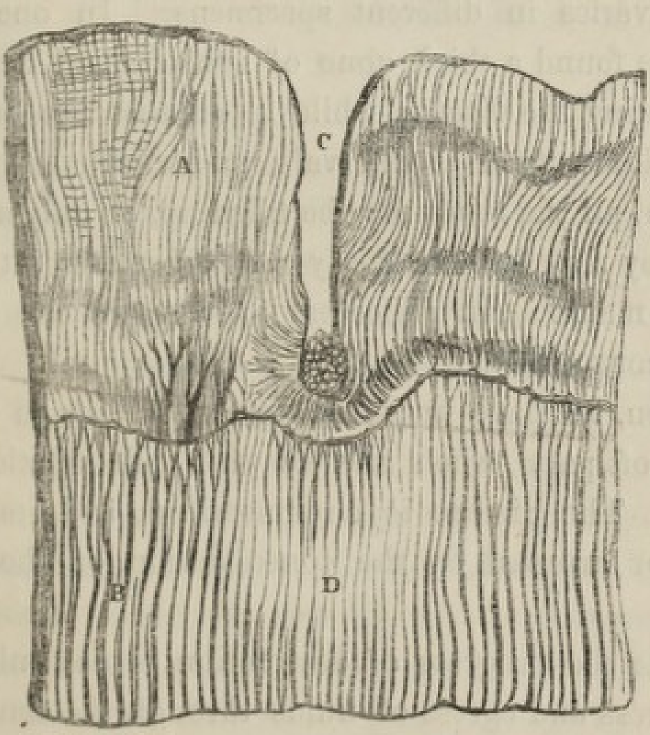
This desirable condition is now and then brought about in the crown of the tooth. The disease is arrested, the exposed surface becomes polished and hard, and the tooth remains useful for years. If, however, the disease advances in the fang, its course is altered—it proceeds from within outwards—from the pulp-cavity towards the surface in the course of the dentinal tubes.

So much, then, for the progress of decomposition in caries. I have now to bring to your notice another physical change in the dentine, consequent on the presence of this disease.

It has been assumed by most, if not by all writers on the subject in question, that the dentine affords no distinct physical evidence of vital action. That it is passive under disease many contend, while others say that caries is consequent on inflammation of this tissue. Mr. Bell speaks of one instance only where the dentine was red from inflammation.

I take some pride in being able to show you a point hitherto overlooked, namely, that caries is attended with a vital physical change in the dentine itself; one of an unquestionable character, corresponding to those common to other tissues similarly circumstanced. The dead is not separated from the living part of the tooth, but it is circumscribed by the consolidation of the living that is next to the dead. The tubes become filled up—they are rendered solid, and the circulation is cut off from the dead mass by the obliteration of the tubes.

Fig. 82.



A Section of Enamel and Dentine of a Molar Tooth;

Showing several predisposing causes of caries in the enamel, and consolidation of the dentine.

A. The enamel.
B. The dentine.
C. A deep fissure in the enamel.
D. Consolidation of the dentinal tubes around the part attacked by caries.

If a section of a carious tooth be examined with a low power, or even with an eye-glass, the carious portion will be seen to be circumscribed by a translucent line; this translucency is the result of the consolidation of the dentinal tubes.

If this condition existed only near the dentine that has suffered sufficient decomposition to render a change of character evident, it might then be supposed by some that the translucency was the result of chemical, and not vital changes.

We have, however, when the decomposition approaches the first line of consolidation, a second one formed, and, as this is advanced upon, a third.

It is a curious circumstance, that the consolidation does not go on gradually from without inwards, keeping in advance of the decay, but occurs at intervals. It would seem successive portions of dentine lose their vitality, and that the contiguous living tissue becomes consolidated.

The amount of consolidated tissue, and the degree of consolidation, varies in different specimens. In one specimen there will be found a thick zone of consolidated dentine completely isolating the disease, while in another the band is imperfect—is interrupted at intervals, and unequal in breadth.—Then, again, all the tubes may be filled up, or only a portion of them, or they may be imperfectly consolidated at intervals with transparent matter. In all cases, however, we can trace some attempt at consolidation.

Here, then, we have an analogous condition to that which obtains in soft parts, when affected with inflammation tending to abscess. The disease is circumscribed, and its extension prevented or arrested by the consolidation of the adjoining textures.

In dentine the progress of destruction is not only retarded, but the ingress and egress of fluids through the dentinal tubes is prevented. Nature erects a barrier, more or less perfect, to save the pulp from irritation.

In teeth that have lost the enamel from wear, and have consequently the dentine exposed, the exposed part is more or less consolidated. In teeth, too, in which decay has been arrested, and the exposed surface polished, the tubes near the surface are consolidated.

The surface of stumps is often quite smooth and translucent from a similar condition.

Although the act of consolidation is a vital one, yet it is more than probable that the dentine consolidated loses in vitality. This may be inferred from the place that it occupies, its external protective position, its decreased capabilities for capillary circulation, and its increased density.

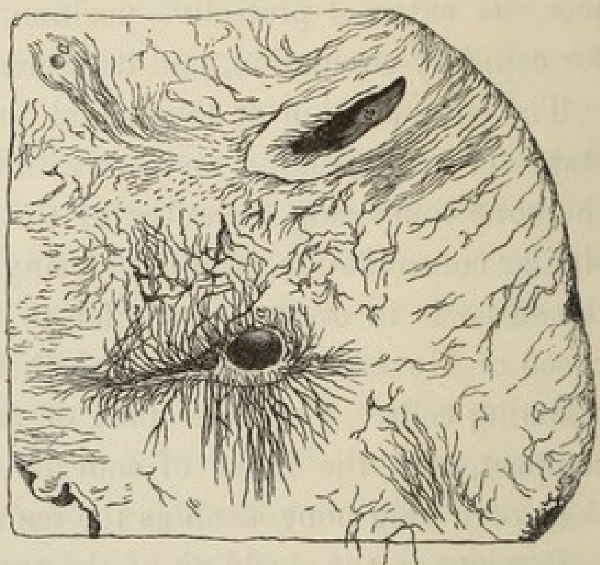
The consolidation of the dental tissues is not the only instance of consolidation we meet with in the hard textures. In the bone composing the antler of the stag we find a somewhat similar consolidation prior to its being cast off. The structure of the antler is in every way similar to that of bone; it is composed of Haversian systems, with their concentric laminæ and radiating cells. The outer part of the antler is composed of compact, and the inner of cancellated tissue, similar to the shaft of a long bone, such as the femur.

Previous to the shedding of the antler the Haversian canals become very small, and the cancelli are greatly diminished in size, and almost obliterated by the development of laminæ, of a transparent, and almost structureless tissue, so as to greatly limit, if not entirely cut off the circulation from the body of the antler, by the diminution of the channels for circulation.

The new laminæ are composed of a tissue so transparent, that in viewing the cancellous portion of the antler with the naked eye its presence is not recognised. In it there are but very few cells with radiating branches, and these, when present, are imperfectly developed, and do not form communications with those previously formed; hence the circulation by the cells and their branching canaliculi is cut off, much as the similar circulation is arrested by the consolidation of the dentinal tubes. When the antler has thus been deprived of circulation, and hence loses its vitality, a layer connecting it with the skull of the animal is absorbed, and it falls. I shall have occasion to revert to these interesting facts when we come to the subject of dental necrosis. I have mentioned it here to show you that consolidation of an osseous tissue, in some instances, precedes, and is the means of death in the consolidated part, and that it is probable that this holds good in the human tooth.

When the crown of a tooth has been attacked with caries, the pulp soon becomes excited by the proximity of disease, and renews its formative action. An attempt is made to keep out the disease, by placing a barrier of secondary dentine between the pulp and the spot towards which the disease is advancing. (Fig. 84.)

Fig. 83.



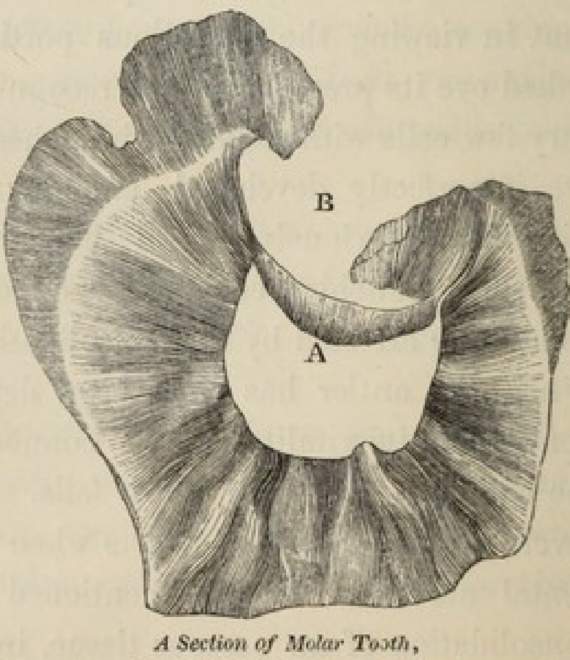
Section of newly formed or secondary Dentine, from the Pulp-Cavity of a Carious Tooth.

A, A, A. Vascular canals in the dentine.
The dentine from which this section was taken closed up an opening into the pulp-cavity, occasioned by caries.

The secondary is often adherent to the primary dentine, and the tubes are continuous, but their junction is marked by slight dilatations. The texture of the new is somewhat coarser than the old, and is commonly vascular. (Fig. 83.)

By this beautiful provision of nature, the pulp, by the conversion of its more external parts into dentine, protects from exposure the portion which remains unchanged. (Fig. 84.)

Fig. 84.



A Section of Molar Tooth,

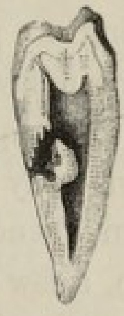
The crown of which has been partially destroyed by caries B, and the pulp protected by the development of barrier A of secondary dentine.

In nearly all instances of caries some portions of the pulp are calcified, but in the majority of cases the effort is not so directed as to afford efficient protection. (Fig. 85.) Little nodules of dentine are scattered through its substance, but no barrier is erected to keep off the disease, or the barrier is imperfect at points.

These little nodules of dentine, when situated near the surface of the pulp, form centres, around which calcification proceeds.

The structure of new dentine formed under these circumstances is rather peculiar. Each nodule has a large central granule, around which are concentric layers composed of granules; in the mass are a few tubes, and a few cells with radiating branches, but the principal constituent is intertubular tissue. From the absence of tubes and cells, secondary dentine of this kind is very transparent, and, to the naked eye, horn-like.

Fig. 85.



Longitudinal Section of a Bicuspid Tooth,
In which the disease has burrowed, and has been but partially kept out of the pulp-cavity by secondary dentine.

We have here two distinct evidences of vital action in the dentine when under disease. One consolidation, the other the transmission of irritation to the pulp, whereby it is induced to renew its formative functions, and thereby recede from the source of annoyance, behind a barrier formed at the expense of its own substance. We have, however, a third in the increased sensibility of the dentine; an evidence that none will dispute who have had tender teeth plugged.

I do not know any pain it is more difficult to bear than that occasioned by removing the disorganized dentine from a carious tooth, even before the disease has exposed the pulp, supposing the tooth to be tender.

The abnormal action productive of caries is not usually attended by severe pain, but I am disposed to think that even early in the disease there is, in most cases, a feeling of slight uneasiness in the affected tooth, though the degree may be so slight as to escape detection at the time, or lead only to the supposition that some foreign matter has lodged between the teeth. I am induced to adopt this opinion, though at variance with several authors of distinction, both from the description given by patients who have suffered from caries, and also from personal experience in this unpleasant malady. On several occasions my attention has been drawn to a tooth by a sensation not perhaps amounting to pain, but to slight discomfort only, which has lasted for a few minutes. After a recurrence from time to time of this unpleasant feeling, I have examined the tooth, and have invariably found that caries has commenced in the situation from whence the uneasiness seemed to proceed.

Again, a few cases are met with in which there is considerable pain attending the progress of caries, long before the pulp is at all affected by exposure, or by the contact of partially decomposed dentine. The tooth is, from the commencement, highly sensitive; the contact of hot or cold fluids induces severe pain, and any attempt to remove the carious dentine, though the disease has existed but for a short time, and is very slight in extent and depth, produces such unbearable pain, that the attempt is for the time obliged to be abandoned.

We will now inquire the manner in which the decomposition of the dental tissues is effected.

I have shown you that a dead tooth is pervious to fluids. A tooth that has been some little time removed from the mouth, and kept in a dry situation, becomes perfectly opaque, especially the enamel, and the more so if the tooth be taken from a young subject. But, if we immerse the dry and consequently opaque tooth in water, it will absorb gradually through the external surface a considerable quantity of the fluid, and thereby become slightly translucent. From these circumstances we learn that the fluids of the mouth may permeate the substance of a tooth if there be no vital action to oppose their doing so, and, supposing them to have permeated, they may, if they be of an active character, and there be present in the dentine no restraining power, decompose the substance of the tooth. As the solvent menstruum enters from without, the enamel and the more external part of the dentine are the first affected; again, the fluid, finding a ready passage through the tubes, travels inwards towards the pulp-cavity, contracting in its extent as the tubes converge. Further, we find decay travels under the enamel on the surface of the dentine: this circumstance is fully accounted for by the presence of the numerous cells and their frequent connections with each other in this part. It will be inquired why, as the decomposing agent enters through the enamel, is it that that tissue is not the greatest sufferer? It is the first, but as a much stronger solvent is required, or the longer application of the same solvent, to produce similar impressions on the enamel, the effect is more extensive on the dentine. If we place a tooth in a weak solution of muriatic acid, we shall find that the exposed dentine is affected before the enamel, and hence the exposed dentine before that covered by enamel. As a further testimony of the correctness of this view of the chemical solution of the earthy ingredients of dead dentine in caries, it may be urged that the action first shows itself in a situation where a fluid or semifluid might be kept for some time in undisturbed contact with the surface of the tooth: thus, in the fissures on the masticating surface of the molars, or on the laterally opposed surfaces of the teeth, in either of which situations the débris of food may remain unmolested for hours, and thus enable the fluid with which it is saturated to enter the enamel and the dentine.

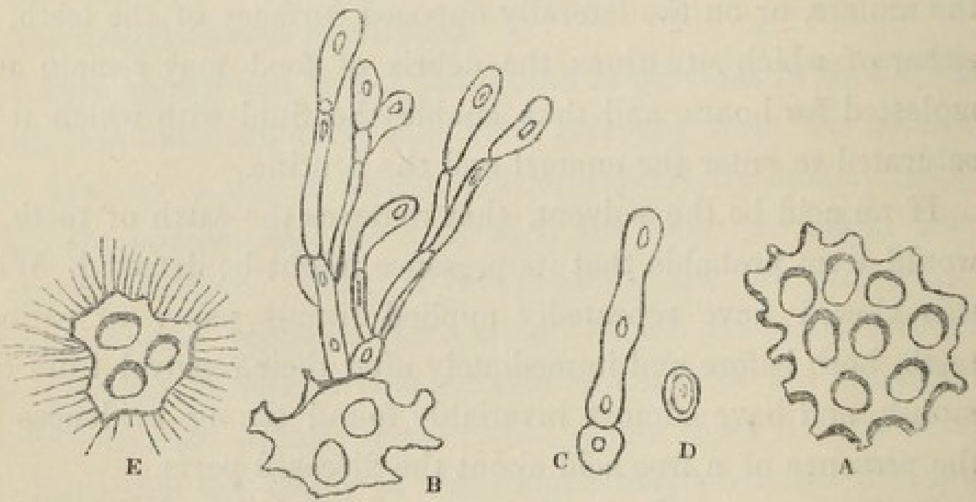
If an acid be the solvent, that removes the earth of teeth, it would seem probable that its presence might be detected. With this view I have repeatedly applied litmus paper to carious teeth, both before and immediately after their removal from the mouth, and have almost invariably found strong evidences of the presence of a free acid about the diseased parts.

So far we can understand the course which dental caries takes from our knowledge of dental structure, and can comprehend how the decomposition of the dentine is effected; but this point will become even more intelligible to you after an examination of the affected tissue with the microscope. A transverse section of carious dentine, rendered soft like cartilage from the loss of its lime, presents a cribriform appearance. The tubuli are much enlarged and irregular in outline, quite unlike the figure they present in dentine, previous to the commencement of decomposition. This condition pretty surely indicates that the solvent enters into, and acts upon the parietes of the tubes previous to affecting the intertubular tissue, and that the parietes of the tubes are the first exposed, therefore the first to disappear.

The consolidated parts suffer in the same manner. The new material, by which the tubes have been filled, is first softened or removed, and then the action proceeds as though it had not been there.

In examining with the microscope carious dental matter, I have very commonly found a species of conferva growing from the exposed surface, and in such quantities as to occasion some perplexity as to its nature, until, from finding it in several stages of growth, I became aware of its vegetable origin. In a favourable specimen, tufts composed of many branches, and single branches, and single cells of confervæ may be found. (Fig. 86, B, C, and D.)

Fig. 86.



Carious Dentine partially decomposed and Vegetable Growths.

A. Dentine softened by caries, and the parietes of the dentinal tubes lost.
B. A species of conferva found growing from the decomposing surface of carious dentine.
C. The same in an earlier stage of development.
D. A single cell of the conferva.
E. A vegetable growth found covering the decomposing dentine of a carious tooth.

There is another peculiar vegetable growth that infests carious teeth and tartar, and is also found entangled in the mucous membrane of the tongue and cheeks. This consists of minute straight stiff fibres or threads, so small that the structure cannot be seen. (Fig. 86, E.) They start out from the carious surface in myriads, and also from any animal or vegetable matters that happen to be lodged in the tooth. I have seen a striped muscular fibre completely covered with them. They look, with the lower powers of the microscope, much as ordinary mould does to the naked eye. I have never seen any of these fibres bent or branched. (Fig. 86, E.)

Mr. Hassall[a] has described and figured a spherical fungus developed on the surface of a section. With this I am not familiar.

As regards the source of the solvent agent, some little inquiry is needed. In many cases, where decay is rapidly progressing in several teeth at the same time, the saliva is strongly acid. The stomach frequently during the day secretes gastric juice, which, if eructated in a very small quantity, would be sufficient to keep up the dental decomposition already commenced. In seeking the source of the acid, you must not forget that the actual amount of phosphate of lime contained in a tooth is small; and, further, that the destructive action is often very slow, and spreads over many months. The presence of the least appreciable quantity of solvent would, therefore, be required, and even this, where the decay is slow, only at intervals[b].

You will find a statement in Simon's "Animal Chemistry" (translated for the Sydenham Society), to the effect that the saliva under certain circumstances is acid, and that this condition is not uncommon after salivation. But, quite apart from the saliva as a source of acid, I think we take a sufficient amount in our food to effect the slow decomposition of dead dentine.

[a] *The Microscopic Anatomy of the Human Body.* By ARTHUR HILL HASSALL. Part xi.

[b] Possibly the decomposition of the gelatine may furnish an acid of sufficient strength to rob the contiguous dentine of its lime.

It is not rare to meet with a case in which the saliva is strongly acid, either in itself or from the admixture of fluids from the stomach; and, should the gums have receded and left the necks of the teeth unprotected from the direct contact of the saliva, the exposed portion below the enamel will be deprived of its earthy matter, and the crown will be at last either cut off from the fang by the decomposition of the neck, or will be itself in a great part decomposed. We commonly see instances of this in patients, who, for the relief of indisposition, have taken one or other of the mineral acids.

"According to Donnè, the saliva has an acid reaction in all cases of irritation and inflammation of the stomach, in pleuritis, encephalitis, intermittent fevers, acute rheumatism, uterine affections, and amenorrhœa. Brugnatelli detected oxalic acid in the saliva of a phthisical patient. Normal saliva is either alkaline or neutral. Mucus, alkaline in health and in disease."[a]

Artificial teeth are frequently made of natural human teeth, fixed on a plate fitted to the gums. In these, decomposition goes on just as in the natural teeth; but there is this difference—you may always know where decomposition will take place, namely, wherever the dentine is unprotected from the contact of the oral fluids; and in most persons, though not in all, the artificial teeth will in course of time be wholly decomposed. Thus, in the bicuspid, the decay will commence on the masticating surface, if the pin fixing it to the plate be brought through and insufficiently riveted, and so allows saliva to get in by its side: and decay will also proceed on the surface fitted to the plate. In either of these situations the saliva may get in and remain in undisturbed contact with the surface of the dentine.

Thus, we have ample proof that dead dental tissue will, under favourable circumstances, be gradually decomposed by the fluids of the mouth; but there are conditions which, if present, entirely prevent or greatly retard its decomposition. The saliva may be so charged with phosphate of lime, that this salt

[a] SIMON'S *Animal Chemistry*, vol. ii.

is thrown down in considerable quantity wherever the salivary fluid remains at rest. It collects in large masses upon the posterior part of the necks of the lower incisors; and I have seen the cavities of decayed teeth completely filled with the deposit.

Enderlin considers that the alkaline reaction of the saliva is due to the presence of tribasic phosphate of soda.

A quantitative analysis of the ash from a large amount of saliva, obtained from different persons, yielded the following results:—

A. *Constituents Soluble in Water.*

Tribasic phosphate of soda	28.122	92.387
Chlorides of sodium and potassium	61.930	
Sulphate of soda	2.315	

B. *Constituents Insoluble in Water.*

Phosphate of lime	5.509[a]
,, magnesia	
,, peroxide of iron	

A lady, after wearing an under set of teeth for eighteen months, sent it for repair. Immediately behind the incisors the piece was quite good, and slightly coated with tartar, but the back parts were completely softened and discoloured.

Supposing, then, this condition to pervade the oral fluids, that is the saliva and mucous secretion, then being already saturated, they cannot dissolve more phosphate of lime; and dental decomposition therefore cannot commence, or, if commenced, cannot advance.

It must not, however, be supposed, from what I have said, that in all cases where phosphate of lime (or tartar, as it is more commonly called) is present on the teeth dental decay will be arrested: the state of the saliva may have changed since the deposit of the tartar, or, though the saliva may be alkaline, the secretion from the mucous membrane of the gums may be acid[b]; and, supposing such to be the case, we should

[a] Simon's *Animal Chemistry*, vol. ii. p. 8.

[b] *The Forceps.*

hardly expect that the secretion thrown out from the membrane between the teeth would be neutralized, as mucus does not readily mix unless agitated with another fluid; and such agitation would not take place in that lodged between the teeth, or in the fissures or cavities of teeth.

Dead dentine will also resist the action of the oral fluids, if the surface be highly polished. Thus, if the surfaces of artificial teeth constructed wholly of dentine be highly polished, and the polish be constantly kept up by the wearer, the teeth will not be acted upon, unless the decomposing agent be unusually strong. But, if they are polished in one part, and left rough from the file in another, decomposition will quickly commence on the rough, while it is resisted by the polished surface. You will scarcely find a set of artificial teeth that have been worn in which this point is not more or less illustrated. Those surfaces which are exposed to the action of the tongue, or of the springs, are kept highly polished, and in these situations decay is effectually resisted, while the parts lying in contact with the gums are gradually softened, and the teeth become unfit for use.

Again, if a tooth from any cause (as by filing) be deprived of enamel, the exposed dentine will in most cases soon be robbed of the lime, unless the surface be polished and kept in that condition. We have frequent opportunities of observing exposed and eburnated dentine in teeth that have been worn by the action of the antagonist teeth, and these, we see, have resisted decomposition.

From the foregoing facts we are led to conclude *that dead dental tissue, when retained in the mouth, will be decomposed or not, in accordance with the circumstances under which it is placed, and that the decomposition is effected by agents applied externally; and, moreover, that the phenomena observable without the aid of the microscope are wholly attributable to the decomposition of a necrosid portion of dental tissue.*

I have purposely avoided using the term necrosis as applied to death of the dentine in caries previous to its decomposition, (although it is obviously applicable,) because our notions are all connected with the succeeding decomposition, and because I wish to restrict that term to express the death of a part or the whole of a tooth when unattended with decomposition.

Before leaving this part of the subject, I will call your attention to a very curious fact in regard to bone, as it bears somewhat on the point in question. Mr. Gulliver, by a series of experiments instituted to ascertain whether dead bone was absorbed or not, found that a portion of human bone introduced into the medullary cavity of a rabbit's tibia not only remained there without exciting inflammation, but became united to the adjoining bone; and in other experiments, where union was not effected, living bone was deposited upon the dead bone.

The following is one of many experiments recorded by Mr. Gulliver in the "Medico-Chirurgical Transactions," vol. xxi. p. 16, expt. 16.—"A portion of the shaft of the human tibia was weighed and introduced into the tube of a rabbit's tibia; seven weeks after which the animal was killed.

"The limb was macerated for three months during the summer, when, a part of the circumference of the tibia being removed to expose the foreign bone, it was found firmly adherent to the inner surface of the rabbit's tibia, and the union was effected by true osseous substance, as proved by the analysis of Dr. Davy, E.P.B., 56, in the museum of the Army Medical Department."

Hence it is thus sufficiently apparent that dead bone may exist without our knowledge of its presence.

I find there is some difficulty in making an accurate comparison between the *caries of teeth and of bones.* Surgical writers are not very definite upon the point as to how the osseous tissue is affected; neither can I find any good account of the chemical nature of the discharge from a carious bone.

In South's translation of Chelius, I find, in a note from Miescher, under the article *Caries*, the following statement:—"We see it asserted in the works of not a few writers, that in a carious ulcer the pus may be perceived to be, as it were, sandy to the touch, and containing *bony particles*, oftentimes pretty apparent." Again, he says, "The whole surface, therefore, attacked with caries presented various stages of separation of the dead plates, by which the roughness felt with the probe was easily explained, as well as the corroded appearance of *the softened bone*, which, though less conspicuous, is discovered after the separation of the large piece of bone." Now the only means by which a piece of dead bone could be softened would be by chemical decomposition, the process being similar to that engaged in the destruction of dentine, thereby establishing a strong similarity between the caries of bone and of teeth. In caries, a portion of bone loses its vitality: the neighbouring bone becomes inflamed, as do the surrounding soft textures. This leads to the formation of an abscess, which opens on the surface of the body, and also to the separation of the dead bone from the living, by absorption of the thin layer of the living, which lay in immediate contact with, and connected the dead to the living bone; the former may or may not have been decomposed, the condition depending upon the nature of the fluids with which it has been bathed.

In dental caries, a portion of dentine loses its vitality, but does not, like dead bone, become separated from the living, which difference may be attributed to the very different circumstances under which it is placed, and also to its lower degree of vitality; but, on the other hand, the dead dentine will, like dead bone, be decomposed by solvent fluids, when such are present.

The crown of a tooth, the more external tissues of which are dead—the pulp and internal dentine being living—I conceive to be exactly similar in condition to an eburnated bone. The synovia of the joint in contact with the bone is not of a nature to decompose the bone, so no chemical change takes place in the osseous tissue, which, over the exposed surface of the bone, is by friction highly polished.

The saliva bathing the surface of a dead tooth may not contain active ingredients; and in that case the tooth will not be decomposed.

Again, bone may be dead, but there may be no inflammation of the neighbouring parts, and then the dead will not be separated from the living. This we may infer from Mr. Gulliver's experiments, in which dead was introduced into the medullary cavity of living bone, became perfectly united, and the limb in which the experiment was tried sound and healthy. That state, which is occasional only in bone, is constant in dentine; dead dentine is never separated from the living by the absorption of the connecting layer of the latter.

The analogy in the diseases of the two tissues is further established by the fact, that in many cases the presence of caries in the crown of a tooth leads to the development of dentine by the pulp opposite the point towards which the disease is advancing. The dental deposit may exist only in the form of a few granules of dentine, or may extend to the formation of a plate. (Figs. 84 and 85.)

From what has been said, you will have gathered that it is not at all times easy to know whether any, and, if any, how much dentine be dead in a tooth; and the same observation may be applied to bone, as, from the foregoing statements, it would appear that all indications of death may be absent.

Death of a part by no means implies immediate discoverable physical change. In a dense tissue of naturally low sensibility we have no means of recognising the loss of vitality, except by the occurrence of physical changes in the part. The colour must alter, decomposition must commence, or there must be alteration of figure, before we become aware of the event. Even in a soft tissue, we only recognise death by finding indications of decomposition in the suspected part.

In a tooth, then, you can only pronounce that the crown has wholly or in part died, by observing that discolouration or decomposition is present in that part.

Having investigated the conditions that are collectively expressed under the name dental caries, it remains for us to inquire into the predisposing and exciting causes, in order that the occurrence of a disease so mischievous in its effects may be, as far as possible, guarded against.

Predisposing causes of caries have, for the most part, a structural origin; they are faults in the development of the dental tissues, and especially of the enamel.

I have already pointed out to you some of these, but others have been reserved for discussion at this place. All, however, have an intimate connection with the subject of caries; and I must be excused if what has already been said on imperfect development of the enamel and dentine is again brought forward.

Structural defects are sometimes alluded to as causes or predisposing causes of caries; but in what those defects consist, and how they predispose, has not hitherto been told. I am, therefore, the more anxious to make myself intelligible on this head, and to give you a clear view of the whole subject of caries. It has been confessedly but imperfectly understood. I hope and think I have found points that must give a better understanding, that will connect and render consistent the hitherto discordant statements of writers, and that will place our practice on firmer ground, by showing how it may and should agree with our theories; and also how in the one case our treatment may be successful, and in the other unsuccessful, depending on the nature of the treatment, on the character of the disease, and greatly, too, on the degree of predisposition.

Some of these points I have already explained to you, the remaining ones I shall proceed to make you acquainted with.

The defects in the enamel are of several kinds, defects in quantity, defects in quality, and defects in both quantity and quality.

In many teeth the defect in quantity is sufficiently apparent —the enamel is irregular on the surface—full of small holes, giving to the teeth a "honey-combed" appearance. In the depressions there is scarcely any enamel, and on the prominences it rarely equals the normal thickness. (Fig. 87.)

It seldom happens that the whole crown of the tooth is so misformed; more commonly the irregularity occupies a horizontal line near the masticating surface, and the masticating surface itself.

Fig. 87.

A Molar Tooth from the Lower Jaw,

The surface of which is indicative of imperfect formation of the dental tissues, and especially of the dentine and enamel. This specimen was taken from a strumous girl, of 15 years of age, and exhibits in an unusual degree the external signs of imperfect development of the tissues.

It is rare to find one surface of a tooth alone affected, or one tooth only. Generally the defective enamel encircles the tooth in a horizontal line, and is equal in extent in those parts of the teeth that are formed at a corresponding time.

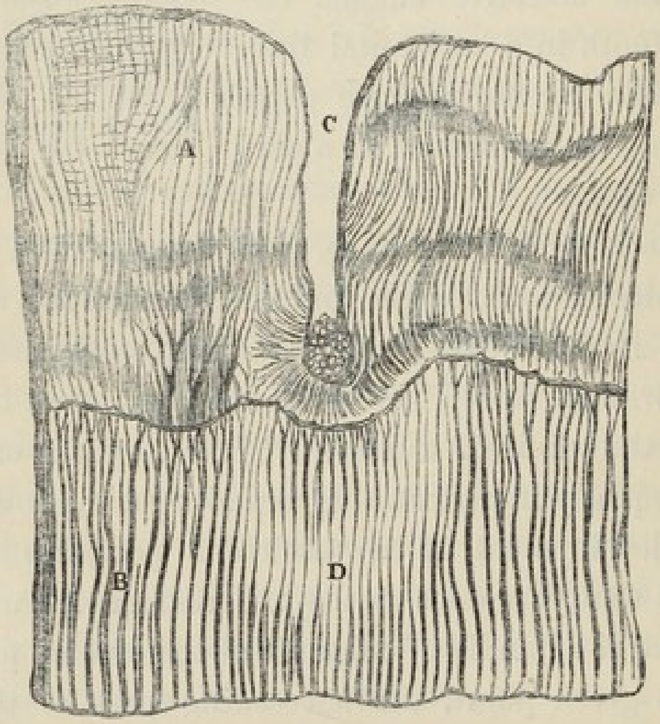
From this latter circumstance, it is pretty evident that the defect had a constitutional origin, and that it arose from a temporary condition. Had the cause been local, one tooth, instead of all that were forming, would have been affected; and, had it been permanent, the whole of the enamel investing the crown would have been equally imperfect. It would appear, however, when once the development in a particular part has been interrupted, that that part does not again resume its normal condition;—that if a bundle of columns of the enamel pulp are imperfect at a given point, the succeeding part of their length remains imperfect. Otherwise we should not find deep pits, with intervening parts of well-developed enamel.

But, again, this law is not quite constant, for I have several specimens in which cavities are formed in the substance of the enamel, with the fibres irregular and broken up about them, yet near the dentine, and also towards the outer surface, the enamel is perfect in formation. (Figs. 90 and 91.)

On inquiry it will be frequently found that your patient suffered from ill health about the time the development of enamel was going on.

In addition to these, which are very evident defects in quantity, there are others not less injurious to the health of the tooth that are difficult to discover until they have become dark-ened by disease. The fissures on the masticating surface of the molares in a perfectly developed tooth are superficial, and correspond to depressions on the coronal surface of the dentine. In many teeth destined to decay, the apparent fissures are in places continued down to within the hundredth of an inch of the dentine; but their width is so small that it would be impossible to detect their existence while the tooth is in the mouth.

Fig. 88.



A Section of Enamel and Dentine of a Molar Tooth ;

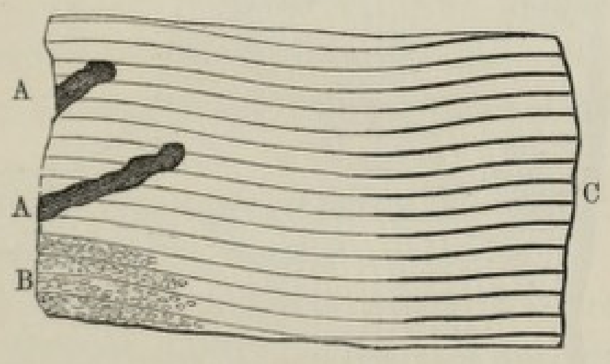
Showing several predisposing causes of caries in the enamel, and consolidation of the dentine.
A. The enamel.
B. The dentine.
C. A deep fissure in the enamel.
D. Consolidation of the dentinal tubes around the part attacked by caries.

In a vertical section these deep narrow fissures closely resemble a hair follicle, and the likeness is kept up by the dilatation at the bottom being occupied by a brown granular matter, not unlike the bulb of hair. The enamel that bounds the fissure is perfect in some parts, imperfect in others. (Fig. 88, C.) That which forms the bottom, and the sides near the bottom, is frequently composed of short fibres that tend towards the fissure as a centre. Occasionally calcified cells, equalling in diameter the fibres, occupy their place. (Fig. 91.)

Having disposed of the defects in quantity, I will next proceed to point out the imperfections in the quality of the enamel that predispose the tooth to caries. There are two kinds of imperfections in the enamel fibres themselves, and imperfections in their union to each other.

It will be remembered that the columns of the enamel pulp are made up of cells and of granules; that, as the columns become calcified, the cells and granules are lost—are fused into an homogeneous fibre; such is the process when the development is perfect. Occasionally the calcification is perfected before the blending of the elements is in all parts completed, and then the enamel fibre remains permanently granular. (Fig. 89, B.)

Fig. 89.



Section of imperfectly developed Enamel, viewed by Transmitted Light.

A. Large cell near the coronal surface of the enamel.
B. Granular fibres.
C. Imperfect union of the fibres.

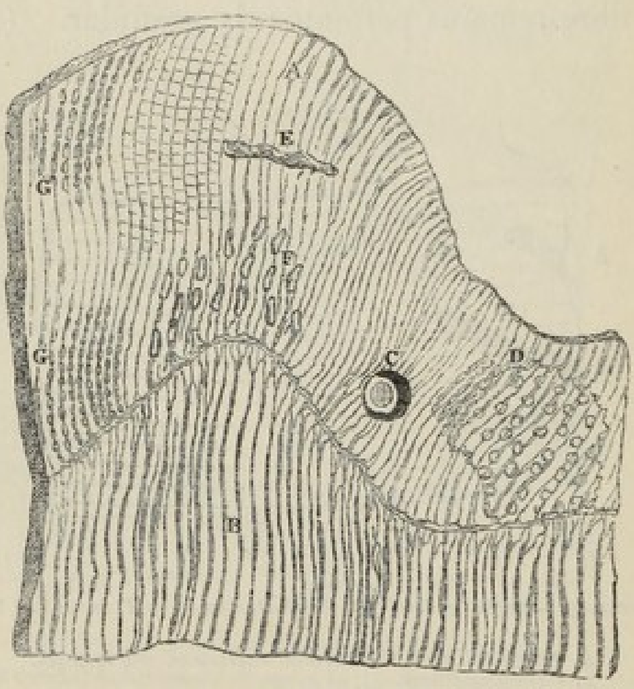
The second imperfection consists in the substitution of calcified cells for fibres. The cells are similar in size to those composing the columns, but want the columnar arrangement. This condition is most commonly found about the fissures, or about cavities. (Fig. 91, B.)

A third imperfection in structure is found in the presence of cavities in the substance of the enamel.

These cavities are of two kinds; one is large, and interferes with the course of the fibres, the other is small, elongated, and seems placed between them. This smaller kind are mostly found near the coronal prominences of the dentine. (Fig. 90, E, F.)

Several different appearances are presented where the fibres of the enamel are not perfectly united. In one case we have a broad coarse line, producing great opacity, in another the union is interrupted by elongated intervals. These look like a string of minute cells between the fibres. This condition occurs in patches, here and there, sometimes extending from the surface to the dentine, at others stopping short of that point. (Fig. 90, G.)

Fig. 90.



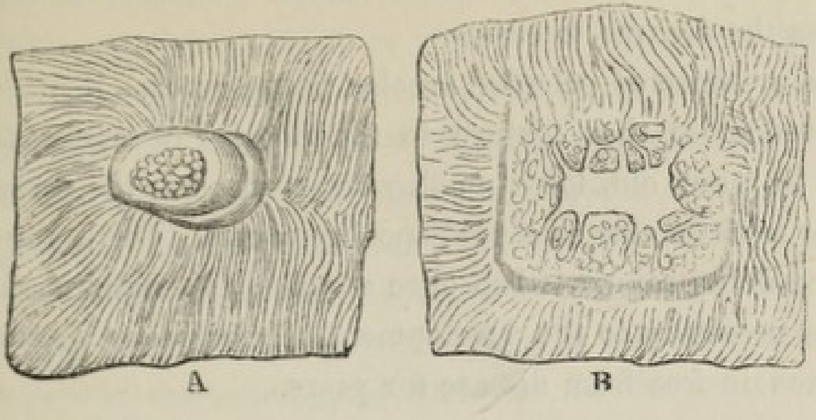
A Section from a Molar Tooth;

Showing several predisposing causes to caries existing in the enamel.
A. The enamel.
B. The dentine.
C. A perforation in the enamel.
D. A cribriform layer of tissue in the enamel.
E. A large cell lying transverse to the enamel fibres.
F. Cells in the enamel, about the apices of the coronal dentine.
G. Lines of minute cells between the enamel fibres.

Teeth which are subject to this imperfection have an opaque pearl-like appearance, and when examined in section with the microscope, by transmitted light, the enamel looks very opaque and brown.

I mentioned to you in an early lecture that cells are occasionally found in the enamel of faulty teeth. (Fig. 90, C, and Fig. 91.)

Fig. 91.



Section of imperfectly formed Enamel, viewed by Transmitted Light.

A. A cell containing granules, with the enamel fibres radiating from it.
B. A radiating cell, surrounded by granulated enamel, with a radiate arrangement of the surrounding enamel fibres.

In one section I found a very curious structure. A piece of cribriform membrane in the midst of the fibres, and in two or three parts of the same tooth. It looks something like the basement membrane of the enamel pulp, and very possibly it is a portion of that tissue entangled amongst, and calcified with, the enamel fibres. (Fig. 90, D.)

I mention it here because I found it in a carious tooth, and because I have not known where else to notice it.

These, then, are the structural defects that predispose the enamel to caries, and you will see that they are sufficient.

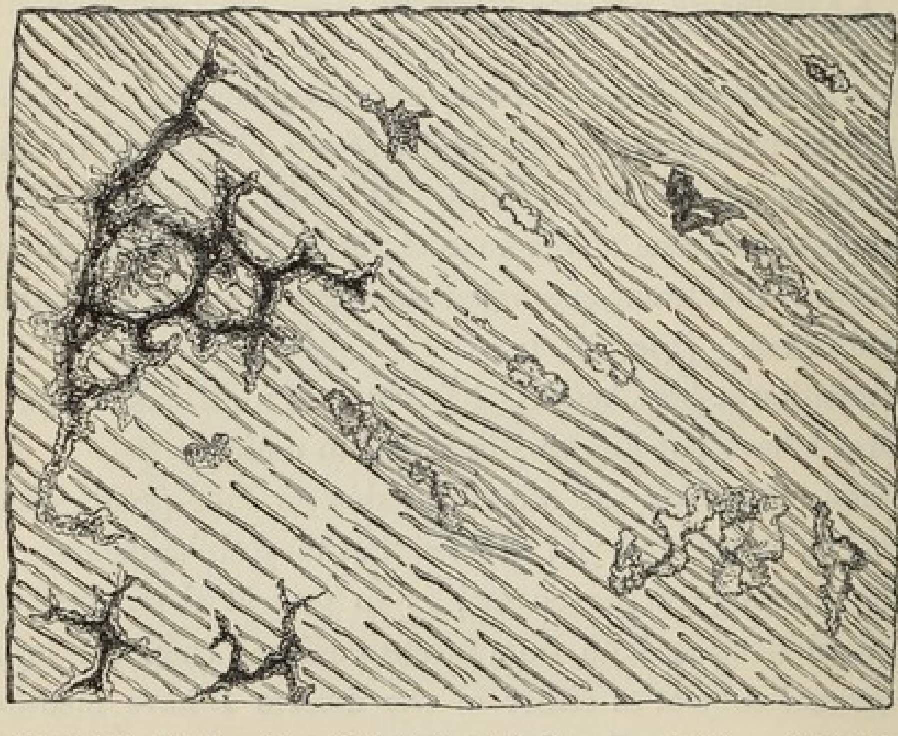
The purpose of the enamel is to protect the more highly organised dentine both from mechanical and chemical injury; but enamel subject to either of the defects I have mentioned can perform this office but indifferently. It is unnaturally porous, and by absorbing acids will become itself destroyed, and allow the destroying agent to come at the dentine. This is especially the case in the deep fissures; if an acid get into them, it may remain undisturbed till the textures are destroyed.

There are but few who have not at some time experienced most unpleasant sensations, oftentimes amounting to pain, in teeth apparently quite sound, when acids or sweets are taken into the mouth. In these cases, the irritating fluid must have passed through the enamel, and come in contact with the dentine, which we know is sensible, while the enamel is not.

It now remains for us to consider the conditions that predispose the dentine to caries.

The presence of calcified areolar tissue in the dentine does not predispose that texture to the ravages of caries, for it is found in many old, long, much worn teeth; but the presence of areolar cavities acts as a predisposing cause. Teeth thus constituted decay rapidly when once attacked; though, if the conditions necessary to the development of caries are absent, they may remain free from disease for years.

Fig. 92.



A Longitudinal Section of Imperfectly Developed Dentine, as seen by Transmitted Light.

In this specimen the tissue is occupied here and there by large irregular cells. The surface of the tooth from which this was taken resembled that expressed in Fig. 87.

It is very seldom, however, we find areolar dentine and perfect enamel. If the one texture is defective, the other is generally faulty too; hence the tooth is rendered liable to be destroyed by the occurrence of conditions, which, had it been of more perfect organization, would have produced little or no effect.

Recently I have met with a specimen in which the dentine, both of the crown and fangs of a molar tooth of the lower jaw, is traversed by numerous canals, which form loops directed either towards the coronal surface, or that of the fangs. These are evidently, both from their size and arrangement, the vessel of the pulp calcified. They are obliterated at parts, and do not look as though blood had recently circulated through them. Their presence could not have been detrimental, for the tooth had lasted for many years, and had suffered only from wear. The enamel was worn away, and the dentine exposed over the greater part of the masticating surface. In the same tooth a considerable amount of calcified areolar tissue was observable.

In addition to these, which may be denominated the visible physical defects in the dental tissues, others that we cannot recognise may and no doubt do exist—the relations between the component elements may be defective in strength or in proportions.

Supposing the teeth to be in every way perfect in organization, a constitutional condition may supervene that will predispose them to caries.

Thus, patients are occasionally met with who state that they were attacked with pain in several sound teeth; that the pain left, but, after the lapse of a short time, the teeth decayed, and the stumps only remain.

Then, again, after fever, and especially scarlet fever, teeth, before quite sound, oftentimes rapidly decay. The same occasionally occurs after salivation.

Children of a scrofulous diathesis are liable to lose their teeth by caries at an early period; also persons who suffer from indigestion, especially if there be excess of gastric acid. A residence in a low, damp situation is said to be a predisposing cause—that people so situated lose their teeth early.

Many of the circumstances which favour the chemical decomposition of the dental tissues may lead also to the loss of vitality, which renders them susceptible of decomposition. Thus caries may, no doubt, be excited by the local application of numerous substances, such as the mineral acids, either when incautiously taken in medicine, or in sweetmeats, and also by the presence of the gastric acids eructated during a fit of indigestion.

Many writers assume that, where teeth are crowded, great pressure is exerted upon the lateral surfaces in contact, that this causes a disarrangement of the fibres of the enamel, and thus leads to disease. I am disposed to doubt whether this is by any means a frequent cause; you will very commonly see a most crowded set of teeth, and yet no caries. Again, if lateral pressure were a frequent cause, you would naturally expect to find those teeth the most subject to lateral pressure during their eruption, the first to decay, and, further, the parts of the tooth subject to the pressure would be those first affected. Yet neither the one nor the other point is borne out by experience; on the contrary, the first permanent molar is the most liable to become diseased, and the masticating surface, the point most commonly attacked, and yet this tooth is less liable during its development and eruption to lateral pressure than any other in the mouth.

The canine teeth are more subject to lateral pressure during their evolution than any other, yet these are less liable to caries than any other teeth, excepting only the central incisors. (See Table 5.)

I have already shown, in a tabular form, the results of my experience as regards the liability of teeth to caries, and a more detailed account will be given in the tables in the appendix. I need only remind you that, of those teeth that are lost, $88\frac{3}{4}$ per cent. are destroyed by caries, and that at different ages they are liable to be attacked at different parts. Thus, in youth, caries generally appear on the masticating surface, or on the sides, while in aged persons the necks of the teeth are more commonly attacked.

The consequences of caries are various. The disease may commence and progressively destroy the crown of the tooth, and very little pain may be felt during the process—or it may be arrested after the destruction of the crown, and the roots of the tooth may remain in the gums, and give little or no inconvenience. But, on the other hand, pain may commence with the disease—the pulp, as the disease advances, may become inflamed, and, if the tooth is not removed, the inflammation extend to the dental periosteum, and be followed by alveolar abscess—the pain all the while increasing.

Not only alveolar abscess may arise as a consequence of caries, but periostitis, and subsequent necrosis of, a large portion of the jaw. There have been recently several out-patients attending the hospital who have suffered from necrosis of the lower jaw, occasioned by inflammation set up by carious teeth.

Tumours of the gums may arise as a consequence of caries, as also may fungous growth of the pulp. But, as these diseases will come under our notice at a future lecture, I need do no more than refer to them now.

Treatment of dental caries.—Lost vitality in a tissue we cannot restore, neither should we gain much if we could, when the loss is confined to that portion of a crown of a tooth protected by enamel, seeing that the dead part is as useful as before, supposing that it be enabled to resist decomposition. In our treatment, then, what we have to do is to enable the affected tooth to resist future chemical change, or, if partially decomposed, to replace the lost part by some substance that will itself resist the action of the saliva, and prevent it from coming in contact with and injuring the dentine; or, if the disease has destroyed the crown of a front tooth, to replace it, if required, and the root be healthy, by an operation called pivoting.

But, as the treatment will, to a considerable extent, be modified by the extent and situation of the disease, it will be expedient to describe the treatment adapted to each of these several conditions.

Treatment of superficial caries.—If, then, the disease is of very small extent, and indicated by slight discolouration of the enamel, and if on examination by a pointed steel probe it is found to be superficial, it will be sufficient, whatever the situation, to remove the affected part by a sculper, or file, and afterwards to well polish the exposed dentine, at the same time directing your patient to keep the surface polished; otherwise the exposed tissue will soon be decomposed by the saliva, should it chance to be acid.

It is no uncommon thing to find that many teeth are attacked at the same time; on inquiry, you will generally hear that your patient has acid saliva from indigestion, or has been taking medicine containing a mineral acid. In either case it will be well for the patient to use an alkaline dentifrice, and in the latter to rinse the mouth with a weak solution of carbonate of soda after each dose of acid medicine.

On attempting to remove the carious portion, however superficial and small in extent it may be, the tooth will sometimes be so tender that the operation cannot be borne—the slightest touch of the instrument is attended with intolerable pain. Whenever this is the case, the operation should be postponed till the sensitiveness of the affected part is reduced. The most ready means of effecting this is to rub powdered nitrate of silver, or any other escharotic, on the sensitive part with the end of a piece of whalebone, or cane. Chloride of zinc is perhaps the best application, as the effect is speedy, and the tooth will not be discoloured. The operation may then be proceeded with, and, should the surface again become tender before its completion, the escharotic must be reapplied. The prolonged application of camphorated spirits of wine will, gradually, under ordinary circumstances, subdue the sensitiveness; but when the disease has attacked the exposed neck of the tooth, and commenced its ravages on the surface of the cementum—a situation in which we find extreme tenderness more frequently than any other—the camphorated spirits is difficult of continued application, and commonly proves ineffective.

If, however, instead of finding the disease superficial on examination, the probe sinks to some little depth into the tooth, indicating thereby that to that depth the dentine is deprived of its earthy ingredients, then we must have recourse to the operation of plugging. The softened dentine must be removed by conveniently shaped steel instruments. The whole of the softened tissue having been removed, the cavity must be wiped dry, and then carefully filled with some substance which will resist the action of the constituents of the saliva, and will at the same time be sufficiently hard to resist injury from mastication.

Metals are the only substances found to combine these qualities. Gold, platina, tin, or lead, reduced to thin foil, and packed tightly in the cavity, form efficient plugs. Of these gold is the most valuable, and the others, as regards excellence, follow in the order in which they are placed. An amalgam of palladium or silver may be used with advantage in cases where the cavity is so situated that it becomes inconvenient to pack densely gold or other foil.

A plug is effective only so long as it perfectly excludes all extraneous matter from the cavity; thence it follows that, in order to fill a cavity with metal foil, considerable compressive force must be used in the operation. You will, therefore, at once perceive that should the disease have extended so far as to reach the pulp-cavity—though by careful management the softened dentine might be removed—yet the patient would be quite unable to bear the pressure requisite to pack metal foil, even in the most favourable cases, unless considerable precaution be used; and, when the surface of pulp exposed is considerable, the operation could not be borne, and, if borne, would produce inflammation of the pulp.

In many cases, however, your patient will not apply for relief until the disease has not only progressed to the pulp-cavity, but the softened dentine removed so as to make a communication between the pulp-cavity and the mouth, thus exposing the sensitive pulp to the action of the many fluids and the various matters taken into the mouth. In this case the pulp itself will be more or less diseased. The exposed surface may be inflamed, and throw off a discharge, or it may have receded partially or wholly from the pulp-cavity, leaving the vacated space to be occupied by extraneous matter.

So that it is of considerable practical importance to learn whether the pulp has been exposed by the removal of softened dentine during the operation, or whether it has been previously exposed. In the one case, plugging, if so managed as not to produce pressure on the nerve, may be successful; in the other, it will, if performed, be followed by ill consequences, as the discharge from the pulp will be confined, and the usual distressing symptoms, indicating pus confined in an unyielding cavity, will result. It is a very good practical rule, if, in removing the softened dentine, or in pressing a probe in the cavity, pain is felt, but only so long as the instrument remains in contact with the tooth, to proceed to plug the cavity, for then the pain will be in the dentine only, and will not be followed by mischief; but, if the pain continues after withdrawing the instrument, to postpone plugging, and resort to some means to restore the pulp to a healthy condition, or to produce its destruction; for the continuance of the pain is a tolerably sure sign that the pulp is more or less involved in disease, and has been pressed on by the instrument, and that, if the tooth be immediately plugged, inflammation will supervene.

The diseases of the pulp, and their treatment, as also the operation of plugging, will occupy our attention on a future occasion.

LECTURE XI.

NECROSIS.—EXOSTOSIS.—ABSCESS IN THE SUBSTANCE OF THE DENTINE.—LOSS OF ENAMEL AND DENTINE FROM THE ANTERIOR SURFACE OF THE TEETH.—ABSORPTION OF THE FANGS OF THE PERMANENT TEETH.—CRACKS IN THE ENAMEL.—PAIN IN SOUND TEETH.

Dental necrosis.—This term is used to denote the death of the whole or a considerable part of a tooth, including more or less of the fang or fangs; but, unlike caries, is not usually attended by decomposition of the dead tissue. When the whole of a tooth loses its vitality, we have complete necrosis; when only a part dies, we have partial necrosis. In complete necrosis the fangs are entirely denuded of living periosteum, and the pulp dies; in partial necrosis the dead portion of the fang only is deprived of its periosteum, and the pulp of the fang in the majority, though not in all cases, dies.

The physical changes in the dental tissues indicative of complete necrosis commence with the death of the tooth, but from their slow progress some time elapses before they become discernible. The tooth gradually assumes a darker hue than natural, which increases in intensity till it is almost black. The dental periosteum gradually detaches itself from the fang, the tooth becomes loose, and, unless held in by the crooked form of the roots, drops out. The surface of the fangs is generally rough, and, near the neck, dotted over with nodules of hard green-coloured tartar, while the ends of the roots often look worm-eaten, as though absorption had commenced.

In some cases, where the teeth are dark and look wholly dead, and produce irritation in the alveolus, we find, on some parts of the fang, patches of newly formed cementum, to which the periosteum is strongly attached, and the tooth is thus firmly held in its place. In these instances the death of the tooth must have proceeded gradually, and the periosteum subjected to that species of irritation which leads to the formation of cementum.

The tubuli of the necrosid fangs are generally consolidated throughout the greater part of their extent. Here and there near the pulp-cavity you may find bundles of them porous, but even in these the peripheral ends are consolidated. The consolidation appears to proceed from the surface towards the centre of the fang, and probably has to do with its death, by depriving it of circulation, much in the same manner that the antler of the deer is first consolidated, and then cast off. The surface of the necrosid fang is always more or less deprived of its cementum by absorption, which leaves a pitted rough surface, similar to the surface of bone that has been subject to absorption, and also to the base of an antler that has fallen.

Dental necrosis may result from mechanical violence, or from inflammation of the alveoli; severe salivation and fever are sometimes productive of this disease; absorption of the alveoli, with advancing age, may also lead to necrosis; but, usually, the tooth in old age is connected with the dental periosteum, and the pulp lives till the tooth, having lost all natural support, is forced out.

The effects of death of a tooth upon the neighbouring parts vary with the nature of the producing cause. If a severe blow be the cause, the inflammation consequent upon the injury done to the tooth and alveoli will be acute, and if not wholly caused in the first instance by the death of the tooth, but arises partly from the injury the several parts have conjointly received, yet it will be kept up and even extended by the presence of the dead tooth. But if, on the other hand, the dental necrosis be the consequence of a slight blow, or results from any deranged state of the system, the gums and alveoli may then become but slightly inflamed and thickened; pus will be discharged from the alveolus, and cease only with the removal of the tooth; whether this be effected by extraction or by absorption of the alveoli and consequent extrusion of the dead tooth.

Mr. Fox in his practice attempted to save teeth where the pulp was exposed and painful, by carefully dislodging the affected teeth from the alveoli, and thus destroying the pulp by breaking off its connections with the nervous and vascular systems, and then returning them to their sockets. In some cases the experiments were successful, the teeth reunited to the periosteum of the alveoli; but in the great majority they did not reunite, and the teeth then, of course, became dead. In narrating these cases he gives an excellent description of the effects of sudden and complete necrosis of a tooth upon the alveolar periosteum. He says, "The method I adopted was to raise the tooth, by the common operation of extraction, so high in the socket as carefully to break the nerves and vessels which enter the extremity of the fangs: then, in withdrawing the force, to put the tooth back again into its former situation. I not only recommended this operation, but performed it upon a great number of persons, and, for a short time, flattered myself with very sanguine expectations: these, however, were gradually destroyed, for some of my patients, in about three or four weeks, came complaining of pain, and were anxious to have the tooth completely removed. They did not suffer the toothache so acutely as before, but the tooth had become loose and was protruded from the socket, so that, whenever the mouth was closed, the pressure of the teeth of the other gum against the tender one occasioned great pain. On extracting these teeth I found the fangs covered with a considerable quantity of coagulated lymph." I have seen many cases, where teeth, dislocated from a fall, have been returned to the alveoli, but could not be retained, and when speedily removed were found enveloped in a coating of what Mr. Fox calls coagulated lymph, but when allowed to remain a little longer, and then removed, the lymph is replaced by, or infiltrated with, pus.

The consequences upon the neighbouring parts, when necrosis occurs without previous absorption of the alveoli, and the tooth is allowed to remain, are often more serious than those I have at present noticed. The periosteum of the alveoli becomes inflamed, together with the neighbouring parts: and, if the case be still neglected, the adjoining teeth are not unfrequently lost, and necrosis of a considerable part of the jaw may also result. Cases of this serious description sometimes come from a blow, but occasionally result from alveolar inflammation.

Should, however, the inflammatory action be less severe, the gum and alveolus of the dead tooth may alone be affected; the tooth will then become gradually loose, the gum will be inflamed and thickened, and pus will be discharged from between the tooth and alveolus whenever the gum is pressed: this state continuing, the tooth becomes more loose, and at last falls out, and the gum resumes a state of health.

In teeth where necrosis has been gradually produced, the tooth is generally wholly deprived of periosteum: but when the death has been the result of violence, or of active alveolar inflammation, you will, on removing the tooth, find shreds of dead periosteum, infiltrated with pus, adherent to the surface of the fang. In partial necrosis of teeth the extent of the disease may be very limited, or the greater portion of the tooth may be involved; but, whether the extent be great or small, the necrosid portion is deprived of periosteum, and presents, on examination, a more or less rough surface, from superficial absorption.

Whether or no the dentine be discoloured will depend upon the situation of the necrosid portion. Thus, instances are not uncommon when the pulp of the tooth has died while the external surface of the fang has preserved its vitality. In these cases the dentine becomes discoloured, and gives a general dark appearance to the tooth. On the other hand, nothing is more common than necrosis of the extremity of the fang, while the remaining portion of the tooth retains its vitality, but here we find no discolouration, though the extent of the necrosis is clearly marked by the adhesion of the periosteum to the living portion, and its separation from the dead portion of the fang. In all cases of partial necrosis with which I have become acquainted, where the neck of the tooth retains its periosteal covering, the separated periosteum forms a sac round the dead dentine, the inner surface of which sac secretes pus, and, in fact, forms the coat of an abscess. (Fig. 102.)

Partial necrosis seems generally the result of inflammation of the dental periosteum, or of the pulp, and may be situated in any part of the tooth, but it is far more common to find it about the apex of the fang, resulting from inflammation of the periosteum, communicated by inflammation of the pulp. But instances are not very rare in which the necrosid portion occupies a circumscribed spot on the fang, or between the fangs of a molar tooth.

The following is generally typical of such cases. A male patient, of twenty-eight, applied to have a tooth removed, in consequence of severe pain. On examination, the tooth, a first molar of the upper jaw, appeared perfectly sound and healthy, but the gum was inflamed opposite the root of the tooth. The gum was lanced, a little pus escaped, and the pain ceased. In a short time the patient again applied, for relief from severe pain in the same situation, and insisted on the tooth being removed. He said that excessively severe pain had at short intervals attacked this tooth, and, though generally reduced by lancing the gums, yet the inconvenience was too great to be endured for the sake of the tooth. On removal, a circumscribed spot of necrosid dentine was found between the fangs, from which the periosteum had separated and dilated, thus producing absorption of the alveolus between the fangs. The so-formed sac was full of pus: the tooth was otherwise healthy, and of good colour. Whether inflammation of the periosteum, and consequent separation, was the primary condition, or whether necrosis was the first abnormal state, would be difficult to determine, but that the necrosid condition of the dentine was the cause which kept up the diseased state of the periosteum admits to my mind of no doubt.

In another case which occurred in a lad of fifteen, the first bicuspid of the upper jaw was painful, and a little loose. The pain seldom lasted for more than half an hour at a time, and was commonly excited by cold water. The gum over the tooth was thickened and rather blue. On removal, the periosteum was found to be detached from one side of the fang, nearly to its apex, and the surface of the fang was rough and discoloured.

Towards the middle or later period of life, the molar teeth are occasionally rendered painful and useless from necrosis of one of the fangs. I will recite a case that recently occurred to me. A male patient, aged 48, applied to be relieved of a troublesome tooth, of which he gave the following history. Twelve months since the tooth became slightly uneasy on contact with hot or cold fluids; after a while, he discovered that it was perceptibly loose; still mastication produced little or no pain. The inconvenience gradually increased, till at last severe pain was felt whenever a fluid differing in temperature from the mouth came in contact with the tooth. Pain, too, was occasionally produced by mastication. On examining the tooth—a second molar of the upper jaw—about the crown no morbid appearance presented itself, but the inner fang seemed more exposed at its base than usual. The gum about it was a little thickened, but not inflamed; a probe, however, could readily be passed down into the socket, without meeting any obstruction: this at once proved the fang to be necrosid. The tooth was removed, and the inner fang was found to be perfectly unattached, was rough and discoloured. The two external fangs were healthy, and the tooth in no part carious. Had this tooth been allowed to remain, the process of absorption of the alveolus and gum of the affected fang, which had already commenced, would have gradually advanced, and the fang in the process of time would have been left exposed in the mouth. (Fig. 93.)

The case I have detailed to you is not in any way peculiar; it is, in fact, an average specimen of a very common complaint, the only remedy for which is extraction of the tooth.

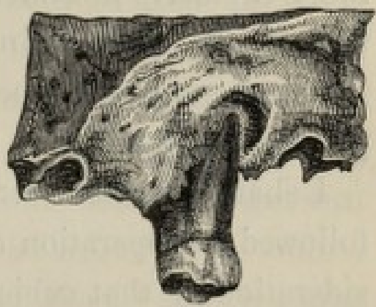
In these cases the pain felt on the application of hot or cold fluids may, I believe, be seated in the alveolus occupied by the dead fang, which, being unattached, not only prevents the alveolus from filling up, but allows foreign matter to get into it, and keep up irritation, as well as producing irritation itself.

But in many cases the pain is obviously in the tooth itself, for immediately after its removal pain is no longer induced by the application of warm fluids to the alveolus.

I have recently had opportunities of examining several teeth, in which one fang has been necrosid, and the teeth painful when surrounded with hot or cold fluids; and in each the pulp of the crown and the remaining living fang has been living, and rather unusually vascular. In these the pulp has probably become unusually sensitive, and thus has arisen the pain.

Distinguished from total necrosis of a fang is death and discolouration of one side only: we have occasional opportunities of seeing, in the molars of the upper jaw, the lingual side, or the buccal side of the gum and alveolus, absorbed, leaving the fangs completely exposed in their whole length, while those surfaces of the fangs which are opposed to each other are strongly attached to the periosteum and to the alveolus, which lies between the fangs. In these cases but little uneasiness is felt—the teeth remain useful to the last.

Fig. 93.



A Molar of the Upper Jaw,

With the inner fang necrosid, and the gum, the alveolus, and dental periosteum of that fang consequently absorbed.

There is yet another form of partial dental necrosis—the pulp sometimes dies, and with it the surface of the pulp-cavity, while the outer surface of the fang retains its vitality. The tooth, in this case, gradually darkens in colour, but, the periosteum remaining healthy, the tooth is retained, and may be useful for years. On the other hand, the periosteum may be slightly affected, and yet practically give no inconvenience to the patient. Such teeth are usually retained, and continue useful for an indefinite period. But unfortunately the periosteum of the alveolus, and of the tooth, continuing in this state, is rendered very liable to inflammation, which, on its occurrence, renders the removal of the tooth imperative.

In the operation of pivoting, or grafting, as it is sometimes called, the crown is removed, while the fang is permitted to remain in the gum. The pulp of the fang is destroyed by a fine steel probe, and the cavity enlarged to hold a piece of gold wire, to which is attached the crown of a foreign tooth. Here we produce death of the pulp, and hence necrosis of the inner portion of the fang. The external surface of the fang may, and does, in the majority of cases, remain healthy, though in a few individuals, unfortunately, the opposite result occurs. The fang becomes necrosid, the periosteum inflames, and the fang would be eventually dislodged, but that the degree of risk of more extensive mischief and of suffering, from the inflammation of the surrounding textures, renders the removal of the fang necessary long before nature could have completed her process of expulsion.

I shall describe several cases in which serious consequences followed the operation of pivoting, when we come to the consideration of that subject.

Dental exostosis, or hypertrophy of the cementum of the fang.—It will not be forgotten that the surfaces of the fangs of teeth are coated with a thin layer of cementum. Under certain circumstances this layer becomes increased in thickness by additions on the external surface. The newly added cementum is in every way similar in structure to that previously forming part of the tooth.

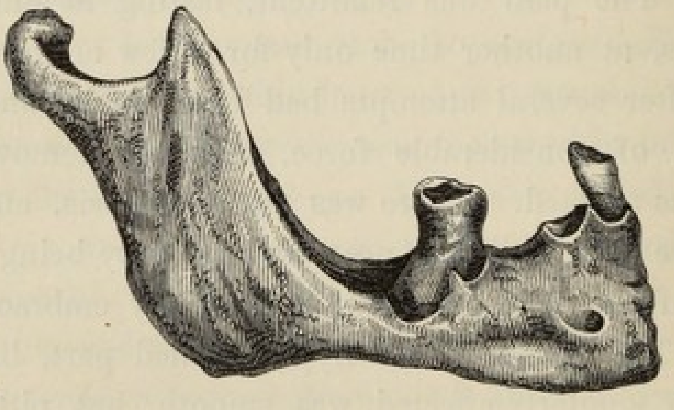
You have learned from your pathological lecturer that a natural tissue increased beyond the natural amount constitutes a disease, by changing the size and figure of the affected organ, and hence encroaching upon neighbouring parts. When the cementum of a tooth becomes developed in an unnatural degree, the form of the tooth becomes changed, and we have exostosis. With the increase of size in the fang of the tooth, there must be a corresponding increase of capacity in the containing alveolus.

In dental exostosis the amount of new cementum may be very slight, or it may be considerable in quantity. The affected fang may be but little enlarged, or it may be increased to twice its natural size. Near or about the end of the fang is the most common situation to find the greatest amount of cementum: but you seldom find an increase on one side of the fang only, unless the opposite side has been exposed by the absorption of the gum, or deprived of its periosteal covering. In some cases nodules of cementum are found in various parts of the fang, even near the neck of the tooth. Then, again, it is not rare to find the thickening commence abruptly above the necrosid extremity of the fang usually present in chronic gum-boil. You will also meet with cases in which the dentine of a fang has been necrosid, and the fang itself been thrown up and lying in its length on the surface of the gum, held in that situation by a patch of new cementum, which has been deposited on and is adherent to the stump. The periosteum of the new cementum then connects the stump with the gum. A short time since, a patient applied to have the fang of a second bicuspis removed. She stated that she had suffered a great deal of pain, which, commencing in the tooth, extended to the side of the face and the head. The pain was remittent, lasting at one time for many hours, at another time only for a few minutes. It was not until after several attempts had been made, and with the application of considerable force, that the removal of the offender was effected. There was great exostosis, and the difficulty arose from the fang near its extremity being twice the diameter of the neck, where it was closely embraced by the alveolus. The surface of the hypertrophied part, like that of other teeth similarly affected, was smooth, but pitted, unlike the smooth and even surface of the fang of a healthy tooth. The orifice admitting the vessels and nerves into the pulp-cavity, small in the healthy tooth, is comparatively large in the new cementum of exostosis, and its edges are rounded.

Several writers on dental structure have described the surface of the pulp-cavity of the fangs of teeth as being coated with a layer of cementum. This is certainly incorrect when applied to healthy teeth, but is occasionally true when applied to teeth that have suffered from exostosis. I have from thirty to forty sections of teeth affected with this malady, and out of these but one in which the pulp-cavity is lined with cementum, and, singularly enough, this came out of my own head. The outer surface of the fang (the palatine one of a first molar) is coated with a thick layer of laminated cementum, which is vascular, and vessels pass from this through the dentine to a layer of cementum in the pulp-cavity. In the new or secondary cementum, the laminæ are much more strongly marked than in the old or primary cementum of the fang, and the junction of the two is generally pretty distinct.

Dental exostosis is caused by that condition of the periosteum which is called irritation—a state usually induced by pre-existing disease in other dental tissues, and, in a great majority of cases, by caries—not always, however. In the specimen before you, from which the figure has been taken, the tooth appears in all respects healthy, excepting the exostosis of the posterior fang. (Fig. 94.) In bones we find exostosis situated in the

Fig. 94.



A Second Molar of the Lower Jaw,

With exostosis of the posterior fang, accompanied with absorption of the alveolus. The crown perfectly sound.

immediate neighbourhood of inflamed parts. It is also exceedingly common about the sheaths of the tendons of the fore-legs of horses subject to be ridden at a fast pace on hard roads, whereby the feet and legs become injured, and often slighly inflamed. It is, when so situated, called a *splent*.

The fangs of teeth that have been pivoted are very liable to exostosis, and with it thickening and increased vascularity of the gum belonging to the tooth. In teeth connected with chronic gum-boil consequent on necrosis of the extreme end of the fang, exostosis of the upper part of the fang is very common.

In all these instances we find hypertrophy of the cementum brought about in or by the vicinity of diseased action.

The *symptoms* of dental exostosis are not in all cases sufficiently distinct from those indicating other diseases to enable the surgeon to recognise the exact nature of the malady. When fangs that have lost their crown by caries are subject to this disease, the gums usually become thickened, are of a deep dull red colour, and bleed readily. The surface of the gum is sometimes smooth and shining; at others is rough and granulated, and the edge, instead of becoming gradually thinner to its termination on the neck of the tooth, ends by a thick, broad, flat margin, in which change of form the edge of the alveolus also participates. The condition of the gums I have just described is very commonly seen when the incisors of the upper jaw are affected with exostosis, and I have observed it is frequently confined to the anterior or labial surfaces, while the surface of the gums within the mouth is comparatively free from disease. We may, however, have exostosis without any disease in the gums. Pain is not a constant attendant on exostosis, though in most cases it is occasionally present, and, when present, is generally of a gnawing character. In cases of sympathetic affections induced by dental exostosis, pain in the affected teeth, so far as my experience goes, is very commonly absent.

Of the various dental maladies, exostosis is the most frequent source of sympathetic disorders. The affections so induced are usually confined to functional derangement of the whole nervous system, or the nerves of some particular part.

I need do no more than remind you that, in whatever part of its course a nervous fibre be subject to irritation, the effect produced by that irritation, whether it be suspension or derangement of function, will be felt in the part to which the nerve is ultimately distributed, and that you may or may not have pain in the part where the irritation is applied. Again, if the whole or part of the nervous system be predisposed to any special disease, irritation applied to any set of nerves may induce that disease, the degree of irritation being wholly insufficient to excite the sympathetic malady had there been no predisposition. Thus, disease of the teeth will occasionally produce epilepsy where there is a predisposition to that complaint. Tic-douloureux is also sometimes brought on by the like cause. The following case will illustrate the point under consideration: —A lad, a farm labourer, from Windsor, was admitted into the hospital for epilepsy. The usual remedies were tried for six weeks without effect. His mouth was then examined, and the molar teeth of the lower jaw were found to be much decayed, and of some of these the fangs only remained. He did not complain of pain in the diseased teeth, or in the jaw. The decayed teeth were, however, removed, and the fangs of each were found to be enlarged and bulbous from exostosis. During the eighteen months that succeeded the removal of the diseased teeth, he had not a single fit, though for many weeks previous to the operation he had two or three per day. This is a case of singular interest, inasmuch as there was no complication of maladies, and hence there could be no doubt as to the cause of the disease, seeing that it immediately subsided when the teeth were removed; and it is further useful, in showing that a sufficient source of local irritation to induce functional derangement may exist without pain being felt in the part where the irritation is applied.

A similar but less marked case occurred shortly afterwards in the person of a policeman. He had fits, which were greatly relieved by the removal of an inferior wisdom tooth, the subject of caries and of exostosis.

Vague and shifting pains about the head and face, and sometimes even in the neck and shoulders, are not uncommon consequences of dental exostosis. Tic-douloureux is also sometimes induced by the like cause, though much less frequently. I have seen tooth after tooth removed for the relief of tic, where no benefit has followed; but, on the other hand, several cases have come to my knowledge where the pain gradually diminished from the time the teeth were extracted, and shortly wholly subsided. I should here remark that, when pain has become periodical, and has existed for some time, the attacks will not necessarily cease immediately the cause which originally produced them has been removed; on the contrary, they frequently appear for some little time afterwards, but in each successive attack the pain diminishes in intensity, and at last ceases.

I have observed that the removal of a tooth which has occasioned sympathetic pain almost always produces a severe paroxysm of the sympathetic pain, and that the paroxysm will bear some relation in duration and in intensity to the previous attacks. In accounting for the production of these sympathetic maladies, I must beg you for a moment to bear in mind, that a sympathetic affection in one part is a consequence of organic or functional derangement in some other part of the body, but for which the sympathy would not exist. The most familiar example illustrative of the point is, perhaps, the pain felt in the shoulder when the functions of the liver are deranged. It is not, in all cases, very easy to see why, when we have diseases in one part, we should also have pain in another, the parts being apparently disconnected, and at some distance from each other; and it is still more difficult to see why the sympathetic pain is not constant in all apparently similar cases of the primary affection. Anatomical examination will, however, enable us to understand how many sympathetic affections may arise from dental disease. The annexed diagram is a faithful representation of a second molar of the lower jaw, with the inferior dental nerve giving a branch to each fang of the tooth. Both the tooth and nerves are the life size, and the distance between the ends of the fangs and the dental nerve are accurately represented, the distance being not more than the eighth of an inch. (Fig. 95.)

Fig. 95.

Second Molar of the Lower Jaw,

With the inferior dental nerve giving fibrils to the tooth, each part being life size.

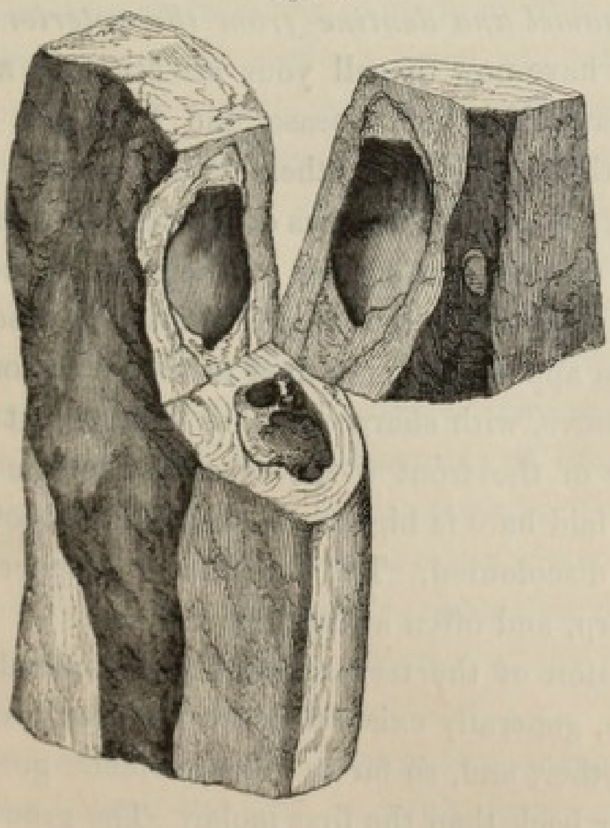
Now you are well aware that some tissues, and especially bone, are absorbed, and make way for a growing tumour, and that the process is pretty generally unattended with pain. Not so, however, with the larger trunks of nerves: they, instead of being absorbed, are pressed before a growing tumour, become strained, and hence there is pain or suspension of the nerve's function, either in the part itself, or in those parts to which the nerve is ultimately distributed. The trunks of the dental nerves contain many fibres that are to be distributed to other parts than the teeth.

Bearing, then, these facts in mind, we can at once understand that, if the extremities of the fangs of a tooth be but slightly increased in size, whether by hypertrophy of the cementum or by the growth of any other tumour, the dental nerve may be thereby disturbed, and hence sympathetic pains may be induced in any of those parts with which the nerve is connected. (Fig. 12. These interesting physiological points will, however, be brought more fully under your notice in other lectures than those on dental surgery.

Abscess in the dentine.—Abscess in the substance of the dentine, external to and unconnected with the pulp-cavity, is extremely rare. Mr. Bell, I believe, records the only case yet published as occurring in the human tooth. I give it in his own words. "Mr. S., a medical gentleman, had long been suffering extreme pain in the right side of the lower jaw, apparently produced by the second molar tooth, which, however, had no external marks of disease. After a time inflammation took place in the periosteum of the root, and the tooth was in a measure loosened. As it now became evident that the cause of the pain, which still continued to the most excruciating degree, was produced by the tooth, it was extracted; and as no diseased appearance was found on the surface, I sawed it asunder at the crown, and found a cavity in the solid bony structure, perfectly circumscribed; the surrounding bone being white, and of a healthy and sound texture. Not the slightest appearance of disease existed in any other part of the tooth, excepting that, from the inflammation which had so long existed, the membrane itself had begun to suppurate. In this case, then, it appears that inflammation had occurred from some local cause in the bone of the tooth; that the vessels of the bone had formed pus, and that absorption had taken place in consequence of its pressure, and formed a cavity for its reception."

This case occurred at least twelve years since, and probably longer, as the edition of Mr. Bell's work bears the date of 1835. At that period the microscope was not much in use, and hence no account of the microscopic appearance of the tooth, about the abscess, or of the pus in the cavity, was given; without which it is a little difficult to understand how the cavity was produced by the process described. A case similar to that cited from Mr. Bell I have not seen, but I have two specimens which present a similar state in the elephant's tusk. In each of these there is a cavity in the substance of the dentine external to the pulp-cavity, and, perfectly unconnected with it, cavities without

Fig. 96.



Portion of an Elephant's Tusk,

With cavity in the dentine, apparently an abscess, and without any outlet.

any outlet. (Fig. 96.) The one was, when opened, quite empty and dry, excepting only a small portion of dried membrane or fluid which seems to have settled in the most dependent part of the cavity, and there become inspissated. In the second specimen before you, the cavity is much larger, with no outlet, confined to the dentine, and lined by inspissated membrane, with here and there a spicula of dentine projecting from the walls of the cavity. The dentine around the cavity is marbled from the various directions taken by the tubuli, and is also permeated by numerous canals for vessels visible to the naked eye. The membrane which lines the cavity of the second specimen, when removed and softened with water, presents the appearance of a fibro-cellular tissue.

It may be difficult to suppose that these cavities in the dentine were formed in the same manner that an abscess is produced in the soft tissue; yet it may be so. That we cannot see how an abscess is produced in dentine, is no proof whatever that an abscess cannot occur in that tissue.

Loss of enamel and dentine from the anterior surfaces of the teeth.—I have now to call your attention to a very extraordinary disease (if it be a disease, and I assume it to be so rather upon the authority of others than my own conviction). It consists in the progressive loss of a portion of the enamel and dentine from the external surface of the teeth, without any appearance of disease in the dental tissues themselves. The more common appearance presented to the practitioner is a deep transverse groove, with sharp edges, as though cut with a file, in the necks of the front teeth, especially in the under jaw. The dentine laid bare is highly polished and smooth, and but very slightly discoloured. The enamel at the upper edge of the groove is sharp, and often a little undermined.

This condition of the teeth, though not confined to one side of the mouth, generally exists to a greater extent on one side than on the other, and, so far as my experience goes, does not extend farther back than the first molar. The groove is for the most part deepest in the more prominent teeth, and on the left side when the individual is right-handed. It is not rare to find teeth almost cut off at the neck by this deepening groove; on the other hand, the groove may widen laterally, and so leave but little of the anterior surface of the tooth entire.

In the cases that have come under my notice the abrasion has commenced on the neck of the tooth immediately below the enamel, the gum having slightly receded and left the cementum exposed. The direction taken by the groove is always horizontal, and, as regards each tooth, transverse to its length, and invariably commences at the neck of the tooth; never, so far as I know, midway in the crowns, or on the lingual surface of the teeth, unless the enamel has been defective in that part. Mr. Bell, however, mentions an exception, in which the edges of the incisors were gradually reduced: he says—" When I first saw the patient, the abrasion had extended so far, that, when the mouth was closed, the anterior edges of the incisors of the upper and lower jaws were nearly a quarter of an inch asunder. The surface was uniform, even, and highly polished and continuous, without the least break from one tooth to another. It extended to the bicuspides, and was perfectly equal on both sides, and, when the molars were closed, the opening occasioned by this loss of substance in front was observed to be widest in the centre, diminishing gradually and equally on both sides to the last bicuspides."

In Mr. Hunter's work on the teeth, you will find this condition described under the name of " Decay of the Teeth by Denudation," and ascribed to " an original disease in the tooth itself, and not to depend on accident, way of life, constitution, or any particular management of the teeth." Fox says, " As it appears to be connected with some cause which may produce a solution of the enamel, it is very possible that the saliva may have some influence, and that the friction of the lips may contribute to the removal of the enamel."

In addition to the authors I have quoted, many others might be added who believe the loss to result from other than mechanical causes. On the contrary, many writers of credit consider it to result solely from friction. I may mention Fuller, Duval, Fitch, Lefoulon, and Dr. Reid.

Supposing this gradual progressive loss, from without, of the dental tissues to be the result of disease in the tissues themselves, no satisfactory explanation of its cause has as yet been given. Were I to deduce a cause from the cases that have come under my own observation, I should at once ascribe it to friction, to the effect of the tooth-brush upon the softer parts of teeth, themselves unusually soft, and for the following reasons:—First, that the process of removal commences below the enamel, on the cementum, which is comparatively soft. Secondly, that the grooving is always in the commencement horizontal, in which direction the tooth-brush is principally used. Thirdly, that the exposed dentine is always highly polished, like a surface exposed to friction, and unlike one exposed to absorption. Fourthly, that the most prominent teeth are the first to suffer, and are the most deeply grooved, while the posterior teeth seem wholly to escape. Fifthly, the loss is confined to the anterior surface of the teeth: and lastly, I have never seen a case in the poorer of my hospital patients, who are not accustomed to use a tooth-brush, while many have presented themselves in private practice where our patients have that cleanly habit.

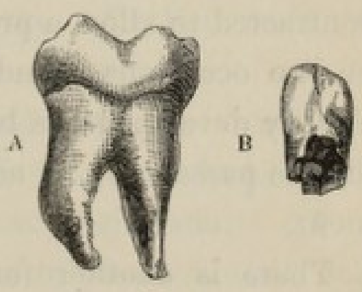
Dr. Reid states in a paper entitled, "On Erosion, or Notching of the Teeth," published in the monthly journal of Medical Science, for April, 1848, that on repeating Berdmore's experiment of brushing teeth with a gritty powder, he succeeded in deeply notching them, and that, too, in a quarter of an hour, instead of an hour, as Berdmore relates. Dr. Reid, in his experiment, used a common tooth-brush, moistened with water, and charged with finely powdered charcoal.

The consequences of the loss of dental substance are in many cases a sensation of pain in the injured teeth on the application of sweet or acid substances to the exposed dentine, or of hot or cold fluids; occasionally, too, the groove becomes the seat of caries.

Inasmuch as the cause is not known, the treatment can be but little understood. However, you will be right in recommending strict forbearance from the application of acids to the exposed dentine, and also the very careful use of a soft tooth-brush; indeed, in the process of cleansing it is wiser in these cases to rub the anterior surface teeth with a napkin, rather than with a brush. But, while unnecessary friction is avoided, care should be taken that a good surface be kept on the exposed dentine, otherwise it will be attacked with caries, and the tooth or teeth will certainly be lost.

Absorption of the cementum and dentine of the permanent teeth.—The fangs of the permanent teeth are liable to absorption, though the instances of any considerable amount of absorption which come under our notice are not very numerous. Mr. Bell mentions a case in which the fangs of a dens sapientia were wholly removed, the crown having been previously destroyed by caries. The accompanying figure of a second molar exhibits partial absorption of the fangs, while the crown is to all appearance perfectly sound. I am indebted to my friend, Mr. Brookhouse, of Manchester, for a fine specimen (Fig. 97, B.) of complete absorption of the fang of a permanent tooth. With the tooth Mr. Brookhouse sent the following account:—"Will you give me your opinion of the inclosed tooth, which I took from the mouth of a patient twenty years of age—the right lateral incisors evidently of the *second set*, yet lost by a process similar to that by which the temporary teeth are removed. The patient did not remember a blow, or any other cause, for such a loosening of his tooth. He appears of good constitution, and says he has never required the attendance of a medical man."

Fig. 97.



A. A molar of the lower jaw, with the fangs thinned by absorption.

B. A permanent lateral incisor, the fang of which has been absorbed.

In a subsequent letter I received from Mr. Brookhouse, in answer to inquiries concerning the case, he says: "The canine teeth were present in the mouth from whence I took the lateral

I sent you, and I could not detect any tooth coming down (to take the place vacated by the lateral), though I gave my patient some pain in probing, to ascertain that fact."

I have seen many instances where the fangs of the anterior teeth, and especially the bicuspides of the upper jaws, have been shortened by absorption; but I have never before seen a specimen in which the fang was wholly removed.

A slight but yet a noticeable amount of absorption about the ends of the fangs of teeth connected with periosteal diseases is very common. If the teeth removed for the cure of gum-boil be examined, a slight corroded state of the extremity of the fang will, in many cases, be found, and evidently the result of absorption. Fangs that remain in the gums after the destruction of the crowns by caries are often the subjects of absorption; and if these are removed from any cause, they, instead of being the usual size, as might have been expected, are found shortened.

On removing permanent teeth where the jaws have been too contracted to allow a proper position for the whole set, I have on two occasions found that the fang of a permanent tooth already developed has been more or less absorbed to make way for the passage of an adjoining tooth in the process of development.

There is another form of absorption of the fang, which is described under the name of *spina ventosa* by Fox and others. The aperture of the fang through which the nerves and vessels pass, naturally very small, becomes in some cases of disease of the pulp, or dental periosteum, much dilated. Absorption occurring in this situation is no doubt the result of disease in the soft textures; and, as these will come under our consideration at a future lecture, we will pass over this part of the subject for the present.

We have aready occupied considerable space in describing the manner in which absorption of the fangs of temporary teeth is brought about; I need not, therefore, describe to you how (what appears to be) a similar process is effected in permanent teeth. It should, however, be borne in mind, that in the one instance the space vacated by the diminution of the temporary fang is occupied by the permanent tooth, while in the other case the place vacated in the socket is occupied by bone, with a layer of vascular tissue in each case separating the increasing and diminishing textures. We have no means of recognizing the loss by absorption till the tooth loosens and is removed, or is removed from some other cause.

Cracks in the enamel.—The enamel, especially of the front teeth, is liable to be traversed by vertical cracks. The surfaces of the fissures do not, however, separate, so that the defect can only be seen in certain oblique lights; unless, indeed, they have existed for a long period, when there will be a slight brown discolouration in the line of the fissure. In some cases there will be two or three cracks in each incisor, in others only one; but in either case I am not aware that there is any evidence to show that the durability of the tooth is lessened.

The only precaution to be adopted is cleanliness; and if the patient dreads slight discolouration, the use of tobacco should be avoided.

Pain in teeth without any discoverable organic disease.—An apparently healthy tooth will, in a few rare cases, become the seat of pain, which resists every attempt at amelioration. Adopt what treatment you will, still the pain continues unabated, and the patient at last insists on the removal of the tooth.

Inspection after extraction brings no light on the subject: the tooth seems in every part healthy, and the pulp shows no indication of disease. The pain is, however, no longer felt, which circumstance is a tolerably sure indication that the cause existed in the tooth itself, and not in any distant part, as might be expected. Cases of this kind are rare, while sympathetic pain in sound teeth is very common; hence, the practice of indiscriminately extracting teeth whenever they become the seat of pain cannot be too strongly deprecated: for in nine-tenths of such cases the pain will be symptomatic of mischief elsewhere, and when the tooth is removed will either remain in the gum or attack another tooth.

When, therefore, a patient complains of pain in a sound tooth, the mouth should be carefully examined, and, if there are any stumps or unsound teeth, they should be removed, rather than the one complained of, as they may, and often are, the cause of the mischief. Should this fail, or should there be no unsound teeth, a leech may be applied on the gum, opposite the fang of the aching tooth, and a dose of aperient medicine administered. This failing, half-drachm doses of hydrochlorate of ammonia, taken at intervals of four hours for three successive doses may be tried [a]. If this treatment brings no relief, your patient will probably insist upon having the tooth removed.

[a] For an account of the use of hydrochlorate of ammonia in pains of the teeth and face, see DR. WATSON'S *Lectures on the Practice of Physic.*

LECTURE XII.

DISEASE OF THE DENTAL PULP.—IRRITATION OF THE DENTAL PULP.—CAUSES AND TREATMENT.—INFLAMMATION, GENERAL AND LOCAL, OF THE PULP.—CAUSES AND TREATMENT.

Diseases of the dental pulp.—The dental pulp, composed of vessels, nerves, and the remains of the formative tissues, is, like other vascular textures, liable to irritation, to inflammation, and their events. These, in their various forms and consequences, it will now be our business to trace.

Irritability of the pulp.—By irritability here is meant an increased susceptibility to pain and to morbid action, unattended with organic change. A cause productive of no inconvenience in a healthy tissue will in an irritable one induce pain and increased action, and, if long continued, inflammation, and its various results.

The most frequent cause of irritability is caries, immediately prior to its laying open the cavity. When a tooth is in this state, the pulp, having its natural defence much weakened, is consequently much exposed to sudden changes of temperature, and also to the contact of the fluids of the mouth, by their oozing through the diseased or disorganized dentine. Hence the pulp becomes irritable; so that when hot or cold, or sweet or acid matters are taken into the mouth, and come upon the tooth, a more or less severe twinge of pain is felt, which may last but for a moment, or may continue for some minutes, and then subside, the time varying in each case with the degree of irritability of the pulp.

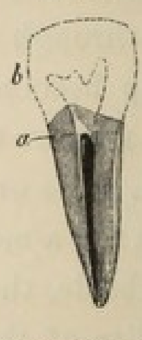
Again, if the pulp or periosteal membrane of a tooth be inflamed, the pulps of the neighbouring teeth may become highly sensitive, and even painful, and consequently unfitted for use. Sometimes pain in one tooth will be followed by pain in the corresponding tooth of the opposite side, and even of the opposite jaw; indeed, occasionally disease of a pulp itself, unattended with pain, will induce pain in the pulp of another perfectly sound tooth. In these cases we can explain the irritation produced in neighbouring teeth only on the supposition that the nervous fibrils destined to be distributed to the affected tooth are irritated in their passage past the pulp that is really diseased.

Irritation of the dental pulp terminates in one of three ways: —*First*, the cause being removed, the irritation subsides, and the pulp returns to health, as instanced where a tooth with an inflamed pulp has been extracted, other teeth that have been affected by it become again healthy. Again, a tooth irritable from incipient caries becomes healthy after the cavity has been plugged.

Secondly, the pulp may become converted into dentine opposite the point from whence the source of irritation acted, and thus form a barrier for itself against the ingress of the irritating agent. We see instances of this event of irritation in cases where the pulp is converted into dentine opposite a point from which a portion of the enamel and of the dentine composing the crown has been removed by wear, by fracture, by the use of the file, or even by caries. (Figs. 32, 84, and 98.)

Indeed, if the pulp of a tooth extracted for caries and subsequent odontalgia be carefully examined, there will, with few exceptions, be found more or less calcification near the point towards which the disease had advanced.

Fig. 98.



A Longitudinal Section of an Incisor, worn by mastication,

a. With the pulp-cavity filled up by calcified pulp.
b. The dotted lines show the shape of the tooth and cavity in its original state.

Thirdly, the irritation may terminate in inflammation and suppuration of the pulp. This result usually follows long-continued irritation, arising from a local cause, as caries, or simple fracture of a tooth.

Treatment.—Where one tooth is rendered painful in consequence of disease in another tooth—that is, is sympathetically affected—the treatment must be addressed to the primary offender, the cure or removal of which will be followed by the subsidence of the irritation in the one sympathizing. Should, however, the irritation have a local origin, and arise from loss of substance in the crown of the tooth by caries, the tooth should without delay be carefully plugged with gold or other stopping; the irritating agents will then be hindered from filtering through upon the pulp; and though the metal used for plugging transmits changes of temperature more readily than the sound portion of the tooth, yet the pulp soon becomes inured to this source of irritation, or shuts it out, by calcifying opposite to the plug—an event very desirable in all such cases. A sudden change of temperature, especially from hot to cold, will, in most teeth that have been recently plugged, supposing the plug to be of any size, produce sharp pain for the moment. The paroxysm of pain, however, quickly subsides, and, after awhile, cannot be reproduced by a similar cause.

If the loss of substance in the crown arises from fracture, time, with the application of astringents to the exposed and sensitive dentine, together with a careful avoidance of unnecessary sources of irritation, will effect the cure. If the crown has suffered from undue wear, similar treatment should be pursued, with a more careful use of the tooth. If the bicuspides or molars are reduced to this state, a cap of gold may be fitted to them, on which the patient may masticate for a time. Should this, which is often a most serviceable plan, be adopted, the cap must be removed several times in the course of the day, and the tooth or teeth carefully brushed: it must also be left off during the night, otherwise the teeth may become the subjects of caries.

Inflammation of the dental pulp.—The pulp, in common with all vascular tissues, is liable to inflammation, and, like those which are confined in an unyielding case, is the seat, when inflamed, of violent throbbing pain. We are most of us pretty well acquainted with the sensations which accompany inflammation of the dental pulp, seeing that that condition is, in nine cases out of ten, the cause of tooth-ache.

The structural and physical changes of texture that accompany or constitute inflammation are very much the same, whatever soft tissue may be the seat of the disease. I need not, therefore, occupy your time in a minute description of these, but shall content myself with noticing those appearances that generally accompany inflammation of the dental pulp. The possibility of swelling is precluded by the dense case in which the pulp is contained, unless indeed this is somewhere imperfect, and then the enlargement can only occur at that point. Redness is, however, always present, and is occasioned by an increased size of the capillaries; these vessels, invisible to the naked eye when healthy, become very apparent under inflammation. The healthy pulp is, in colour, a very light pinkish grey, but an inflamed pulp is bright scarlet.

The best method of getting at the pulp for examination is to screw the body of the tooth in a vice till it breaks. The broken pieces may then be carefully removed, and the pulp examined. This plan is preferable to sawing through the tooth, for then the saw-dust gets upon the diseased part, and obscures the view.

The whole of the pulp may be involved in disease, or only a portion, the amount chiefly depending upon the nature of the producing cause, or, in other words, there may be *local* or *general* inflammation of the pulp. Thus, if the pulp-cavity be entire, and the pulp be subjected to prolonged irritation, the whole substance of the organ will become inflamed; on the other hand, if an opening has, from any cause, been made into the pulp-cavity, the disease may be confined to that part situated near the opening. It is not difficult to conceive why this should be, when we consider that in the latter case the surface subjected to the direct action of the irritating agent will be confined to that exposed by the opening; and further, that any discharge poured out from the inflamed part will find a ready passage for escape, and hence produce no direct influence upon the unaffected part of the pulp, whereas, had the pulp-cavity been entire, any swelling of, or discharge from, one part of the pulp finding no escape, would press equally on all parts, and thus the whole organ would become involved in disease. Again, the inflammation may be general and acute, and speedily terminate in the destruction of the pulp, or, on the other hand, it may be chronic, and the pulp may, under disease, retain its vitality for a considerable time.

The degree of the inflammation will depend upon the character of the producing cause, upon the previous state of the pulp and of the walls of the pulp-cavity, and also upon the state of the system at the time of the attack. If the pulp has been rendered irritable by gradual thinning of the walls of the cavity, the inflammatory action will probably be general, and terminate in destruction of the part, as illustrated in the following case.

A short time since, a patient applied for treatment who stated that she had suffered severe throbbing pain in a first molar of the lower jaw for two days, that the pain, at first slight, had gradually increased in intensity, and that the adjoining teeth had now become tender, so that the mouth could not be closed without pain. The aching tooth had suffered from superficial caries of the masticating surface, which disease had thinned the walls, but had not made an opening into the pulp-cavity. After removal, the tooth was very carefully examined, and the cavity found to be perfectly entire. The pulp had been inflamed, was dead, offensive, and bathed in pus (as ascertained by the microscope), while in its substance a few small nodules of dentine could be distinguished. The periosteum of the tooth was becoming slightly affected about the extreme point of the fang. This case presents no peculiarities, but is, on the contrary, typical of general and acute inflammation, and subsequent suppuration and death of the dental pulp, arising from prolonged irritation, caused either by irritating fluid oozing through the thinned wall of the pulp-cavity, or by sudden alternations of temperature arising from the same condition. A similar state of disease not unfrequently comes on from exposure of the pulp by caries; in such cases the inflammation commences at the exposed point, and extends to the rest of the pulp. Another cause, not unfrequent among the more wealthy, is the closure by plugging of a carious opening, through which a small portion of discharge thrown off from the exposed portion of the pulp had habitually escaped.

Compression of the pulp by the bending or bulging inwards of the softened or thinned wall of the cavity, or mechanical injury from any cause, is also an occasional excitant of general inflammation. The pain attendant upon general inflammation of the pulp mostly commences with slight gnawing, which gradually increases and becomes throbbing, and lasts till the pulp is destroyed. The pain then ceases, or is altered in character to a dull heavy pain, and at this period the side of the face very commonly becomes more or less swollen and œdematous. This change of symptoms indicates that the pulp has been destroyed, and the occurrence of dull heavy pain that the periosteum has become the seat of inflammation. Supposing, however, the inflammation to have resulted from compression, then the pain will of course set in suddenly. If, again, the general, is the consequence of previous local, inflammation, as the one is a mere extension of the other, the exact period of change cannot be declared.

General inflammation, when there is no outlet from the cavity, excepting through the fangs, unless arrested at an early stage, terminates in suppuration and death of the pulp. If there be an opening into the cavity, the inflammation may perhaps partly subside, but the pulp seems never to return to a state of health. Again, if the inflammation result from exposure through fracture of the crown of the tooth, destruction of the pulp is the usual consequence.

The consequences that may be entailed on the neighbouring parts from general inflammation of the dental pulp are numerous and varied. The violent pain may cease and the face swell, the swelling may subside, and the tooth lose all tenderness: the patient soon forgets the attack, but if the tooth be examined it will be found to have assumed a greyish hue, thereby indicating that the dentine of the pulp-cavity is necrosid, and that the tooth holds its vitality from the periosteum alone. The tooth, however, may remain useful for years; hence, this is the most favourable result of general inflammation of the pulp; but unfortunately it is a rare one. It is far more common for the inflammatory action to extend to the periosteum of the fang, and thus induce death of the end of the fang and consequent gum-boil. Indeed, the disease may not stop here; the maxillary periosteum may become inflamed, and lead to necrosis of a large part of the jaw. Two cases in which this result has occurred are at this time (1847) in attendance at the hospital.

Treatment.—Inasmuch as the pulp very rarely becomes the subject of general inflammation unless the crown has been previously injured, either by caries, wear, or mechanical violence, it will be better to remove the tooth at once, rather than to endure the pain that would be consequent on its continuance, and run the risk of injury to the neighbouring parts; unless, indeed, it be a front tooth of the upper jaw, where, in some patients, it is desirable to preserve the fang for pivoting; in that case the crown only must be cut off, and the pulp destroyed. If the disease has resulted from plugging, the plug should be immediately removed; by which measure, if the pulp itself is not saved, yet the disease will possibly not extend to the periosteum of the tooth.

Several years since I had a tooth plugged; the cavity was occasioned by caries, and the pulp was exposed at one point, but whether before or during the operation I could not tell. I experienced considerable pain at the time, but within an hour the tooth became quite easy; for two months I had no pain or uneasiness, but at the end of this time a gnawing pain commenced, which gradually increased, and became throbbing. At the end of twelve hours from the commencement of the pain, I removed the plug; the pain ceased within a few minutes, and the mouth was filled with a most disagreeable fœtid taste. On subsequent examination it was found that the body of the pulp had perished, while that occupying the fangs had survived.

I have found in practice that it is far from uncommon for a tooth plugged after the pulp has been slightly exposed, but previous to pain being suffered, to answer for one, two, or even three months, and then to be attacked with inflammation of the pulp; thus obliging the removal of the plug or the extraction of the tooth. In practice, therefore, whenever you find a plugged tooth attacked with gradually increasing pain, the plug should be immediately removed; then, if the pain ceases, and the tooth be of any service, it may be retained. In such case the cavity should be filled daily with cotton wool, saturated in a solution of mastic in spirits of wine; this makes a good temporary plug for the exclusion of food, and may be used till the tooth will bear a more permanent stopping.

Local inflammation of the pulp.—Hitherto I have been speaking of inflammation of the whole body of the dental pulp, and especially when occurring with the pulp-cavity unbroken, or rendered entire by stopping. We now come to consider inflammation of the pulp, induced by exposure, from the removal of a portion of the parietes of the dental cavity by caries or other causes. You have learned that, when the cavity is entire, inflammation attacking the pulp generally becomes acute, and implicates the whole substance of the organ. The same may occur where the pulp-cavity has been gradually laid open by decomposition of the dentine, and the disease may follow much the same course as it would have done had the cavity been entire. It is far more common, however, to have chronic inflammation of that part only which is exposed; and we must now devote a little time to the consideration of such disease so occurring.

The immediate result of partial exposure of the pulp to the action of the fluids that occupy the mouth is increased vascularity, and the establishment of more or less discharge from the exposed portion, the morbid action being frequently unattended with pain. If a tooth in this state be plugged, though the operation itself be so managed as to give no pain, yet inflammation will generally come on within a short time, and destroy the pulp; the active disease arising, as I conceive, from the discharge being confined. Exposure of a very limited extent of surface may exist for a long time, and give but little or no inconvenience; sudden changes of temperature will, however, give a transient twinge of pain: sweets, or any soft food, as bread, when forced by mastication into the cavity, will occasion pain till its removal. This state may continue for an indefinite time, but, sooner or later, the pain, instead of ceasing with the removal of the immediate cause, continues for an hour or two, then ceases, and again returns on the application of any fresh cause of irritation: or the pain may be less severe and more continuous.

More rarely the diseased pulp becomes the seat of extremely severe shoots or darts of pain, occurring twice or thrice in a minute, or even more frequently, with intervals of perfect ease. I remember one case of this character in which the agony was so great that the patient was bathed in perspiration till the tooth was removed.

You may meet with patients who will tell you they have had a grumbling toothache for a month; others again say that they dare not take hot or cold, or sweet or acid fluids, lest they should provoke an attack of pain in a susceptible tooth. When the pain is continuous, the cause is sometimes found to be an acid state of the saliva. If a tooth in this condition be extracted, and the pulp examined, an inflamed patch opposite the seat of exposure, with a few nodules of dentine in the substance of the organ, is generally all that is found. It is in this state of the pulp that the various odontalgic remedies may be effective.

As the decomposition of the dentine progresses, the extent of exposure of the pulp increases, and hence the disease, and consequent liability to pain, also advances, till at length the whole cavity is laid open, and the pulp is either gradually absorbed with the progress of the caries, or is destroyed by ulceration or gangrene, or more rarely may become the seat of a morbid growth. This latter event constituting a peculiar disease, I shall presently speak of it at more length.

If the pulp be removed by *absorption,* the rate of progress will be partly governed by the situation in which exposure has commenced. If the masticating surface of a molar tooth has been destroyed, the body of the pulp will be removed so soon as the aperture into its cell attains a considerable size; while the processes of pulp occupying the fangs will retain their vitality, and the exposed parts of these their diseased condition. If the opening has been made in any other than the masticating surface, the pulp being less liable to injury retains its bulk for a longer period, and frequently suffers but little from absorption till it is exposed on two surfaces. Thus, if caries opens the pulp-cavity, on the anterior surface of a molar tooth, absorption of the pulp may not commence until a portion of the masticating surface be also destroyed. Again, the process having commenced, the whole of the pulp may be absorbed, or only that portion which occupies the body of the tooth.

If *gangrene* supervene upon inflammation, the whole, or only part of the pulp, may be destroyed. Not uncommonly the part contained in the body of the tooth is alone gangrenous, while that occupying the fangs for awhile retains its vitality. In the latter case, I should tell you that there is little or no cessation of pain, such as happens when the whole of the pulp has been at once destroyed.

If the pulp be attacked by *ulceration,* a considerable portion may speedily be lost, or the destructive action may be arrested when but little of the pulp has been sacrificed, leaving a healthy granulating surface. The ulcer is generally excavated, has a yellowish coloured surface, and, so long as the ulcerative process exists, is attended with constant pain. (The specimen on the table is a good example of this condition of pulp.)

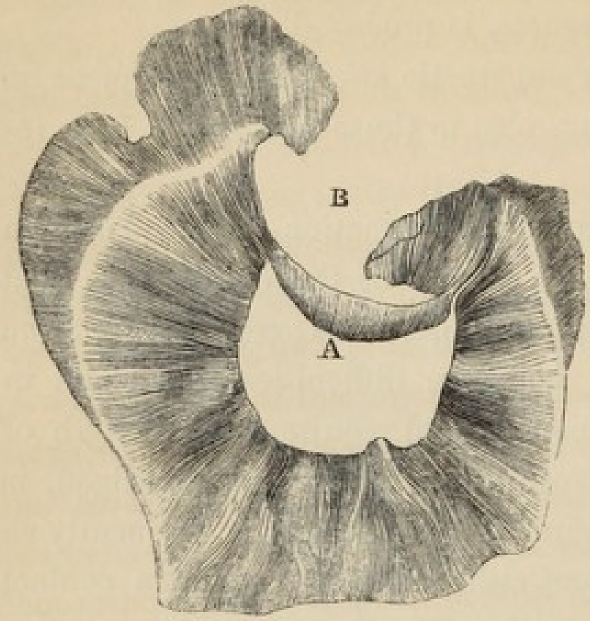
Sympathetic pains in various parts of the head and face, and even of the neck, are amongst the occasional consequences of partial inflammation of the dental pulp. If the pain in the tooth be violent and long continued, slight general disturbance, evinced by fever and restlessness, is produced.

What has been said of sympathetic affections consequent on other dental maladies, applies also to those that spring from inflammation of the pulp.

Treatment.—Local chronic inflammation, consequent on exposure, is almost the only disease of the dental pulp that admits of successful treatment, short of extermination of the whole organ. But even here the difficulties that stand in the way of cure are so numerous, and require such a length of time to overcome, that the result, it must be acknowledged, is very uncertain. The aperture into the cavity is frequently so small, that the remedial agent either does not come in contact with the pulp at all, or else with so small an amount of the inflamed surface, that it produces no useful effect. Then, again, we are frequently quite unable to tell the character and extent of the disease—whether the exposed surface be in a state of acute or of chronic inflammation, whether it is pouring out serous fluid or pus, or whether there be ulceration, or whether there be only irritation, the difficulty arising either from the smallness, or the unfavourable situation of the carious opening in the tooth. Hence we often prescribe at random. When, however, we can get at the seat of the disease, and our patient will persevere in the use of likely remedies, we may generally, by one means or another, restore the tooth to a state of usefulness, and after awhile repair the loss sustained in the crown by a metal plug.

I have told you more than once that the pulp, as disease pursues its way through the dentine, makes an effort to protect itself by forming new dentine in the direction towards which the caries is advancing, and would thus defend itself from exposure by caries, just as it does from exposure by the wearing away of the crown, but that the process by which the protective barrier is formed usually advances much more slowly than that by which the dentine is destroyed. Hence the pulp is laid bare before it has had time to form for itself a new covering. In

Fig. 99.



A Section of Molar Tooth,

The crown of which has been partially destroyed by caries B, and the pulp protected by the development of barrier A of secondary dentine.

Fig. 100.

Longitudinal Section of a Bicuspid Tooth,

In which the disease has burrowed, and has been but partially kept out of the pulp-cavity by secondary dentine.

some cases, indeed (and especially those in which decay has advanced rapidly), no protective effort seems to be made. A few days since, I examined several partially inflamed pulps, taken from the teeth of young patients, in neither of which could I find a single nodule of dentine. The pulps had been exposed by a very small aperture rapidly produced, and were highly inflamed over a surface about as large again as that exposed. The redness was greatest at the exposed point, and from thence, decreasing, was gradually lost in the healthy pulp, not one-tenth part of the body of which was affected, although the pain which led to the extraction of the tooth had been severe and lasting.

Had it been desired, or could the patients have devoted sufficient time to the restoration of the teeth (which our hospital patients unfortunately cannot do), the treatment indicated would be—first, to relieve the pain by some speedy means, and then to protect the pulp from unnecessary exposure by the use of some temporary and readily removable plug; and we should at the same time apply agents which will stimulate without inflaming the surface. The stimulant used should be so modified as to produce an increase of healthy action, and not irritation. The latter effect would be followed by pain and inflammation, while the former produces an increase of function, and, in some cases, a resumption of an office naturally terminated, or unnaturally suspended. By this treatment we may hope to induce a resumption of that action by which dental pulp is converted into secondary dentine.

The treatment, then, resolves itself into two stages. First, the pain—the toothache—must be cured, and then the exposed surface of the pulp must be induced to calcify, or at all events must cease to be a secreting surface. The first point must be quickly gained, otherwise, by the extension of the disease to the periosteum of the fang, the case may become past our reach; while the second will necessarily, from the effect we desire to produce, be extended over a considerable period.

The remedial agents at our disposal for working out the foregoing effects are very numerous and dissimilar. I should fail were I to attempt to enumerate half those that have been proposed for the cure of toothache. There is scarcely a drug that has not been used, and with occasional success; and there is not one that does not frequently fail in producing the desired result. Again, the remedy which has been effective one day will not uncommonly totally fail in allaying an apparently similar attack of pain on the subsequent day. Hence we require variety in our remedies, and discretion in their use.

The remedies themselves may be arranged into groups, in accordance with the manner in which they exert their effects. First, remedies that, by correcting the state of some deranged organ, produce their effects primarily upon distant parts, and secondarily upon the pulp. Thus, medicines that cure indigestion, cure also toothache that has arisen out of indigestion. The same also may be said of remedies that alleviate rheumatism. You are well aware that, where there is general derangement of the system, the difficulty of curing a local ill is greatly increased. Hence, when carious teeth become painful in connection with dyspepsia, the stomach should be restored to health before the greatest chances of success can be gained.

In a second group may be arranged medicines that, by producing increased secretion in one organ, occasion a cessation of morbidly increased action in another. For the cure of pain and partial inflammation of the dental pulp, purgatives, sialogogues, and counter-irritants are the most useful agents to be derived from the class of revulsives. An active purge will not uncommonly abate an attack of toothache, especially if there has been constipation. A mustard poultice, or ammonia, applied behind the ear, will also be effective in some few cases, and may be tried with considerable hope when other remedies have failed, or are not within reach.

Sialogogues are, however, far more useful than either of the preceding agents, and may be tried whenever the pain in the tooth or teeth is urgent. The precaution of previously plugging the cavity of the tooth should, however, always be observed, as those drugs which stimulate the salivary glands would also irritate the exposed surface of the pulp, and thus defeat our end. Pyrethrum acts perhaps more efficiently than any other agent of this nature. It is best applied by placing a small piece of the root (previously bruised) between the gum of the affected tooth and the cheek, where it should be retained until a great flow of saliva is established, or the toothache relieved.

Alkalies, or alkaline carbonates, form a third group of dental remedies. These are useful only in neutralizing acidity of the saliva about the carious opening in the tooth. I have known a very bad toothache cured by a bit of carbonate of soda dropped into the tooth. In all cases of pain in carious teeth, it is very desirable to ascertain, by the use of test-paper, whether the saliva be acid, or whether there be acid in the tooth. In either cases an alkali (and carbonate of soda is as good as any) should be used for neutralization.

In the *fourth group* may be arranged those agents which afford relief by abstracting blood from a neighbouring part.

These are leeches and the gum lancet. A leech on the gum, or free scarification by the lancet, will sometimes relieve pain arising from inflammation of the pulp, although much less frequently than when the pain has arisen from disease of the dental periosteum. When it is very desirable to preserve a tooth, and other less troublesome remedies produce no effect, blood may be taken from the gum; but it must not be promised that the application of a leech will certainly be followed by cessation of pain.

In the *fifth group* may be placed remedial agents which produce either a negative effect, by closing up the aperture into the pulp-cavity, and thus guarding the pulp from the contact of extraneous matter, or a positive effect on the inflamed surface by direct application; or, in other words, *local remedies*. The materials of this fifth group may be again divided, in accordance with the manner in which they produce their effects. The first division includes those agents which act mechanically only; the second, those that affect the diseased action or destroy the diseased part.

The mechanical agents for the cure of toothache produce their effect by guarding the pulp from contact with the oral fluids, and from whatever may be taken into the mouth; also from the contact of cold air, and from sudden changes of temperature—in fact, protect it from all external irritants.

Whatever other treatment it may be necessary to use or to avoid, mechanical measures must always be taken to protect the diseased and naked pulp from the action of all other substances than those we desire to apply for its relief. The carious aperture must be plugged with some suitable substance—something that can be rendered so soft that it may be introduced into the tooth without producing pressure on the pulp, and, when so placed, will afterwards harden. The substances in most common use are bees' wax, various resins, gutta percha, solutions of resins in alcohol, and cotton wool, or lint, or a combination of several of these. That which is generally employed, and is, perhaps, the best, consists of a piece of cotton wool impregnated with a solution of mastic in Eau-de-Cologne. The wool thus armed is lightly introduced into the hole in the tooth, either alone or after the introduction of some more active remedy. The spirit quickly leaves the mastic, and unites with the saliva; the cotton and mastic then form a good firm temporary plug. This should be renewed once or twice in four-and-twenty hours. There are many similar combinations that will answer the purpose equally well. Gum copal dissolved in sulphuric ether may be substituted for the mastic and spirit, and in some cases will prove more effective. A solution of gutta percha in oil of amber or in chloroform, and used with cotton wool, makes a very convenient plug, and is less liable to become offensive than either mastic or copal.

A temporary plug may, however, be made to serve a double purpose, by combining with the mastic an astringent or a sedative, and thus not only guard the pulp from the contact of foreign substances, but also produce some direct action on the diseased surface.

The remedial agents that directly act upon the disease belong to one of the following classes of remedies:—sedatives, escharotics, astringents, or stimulants.

Sedatives, when employed alone, are chiefly used for allaying pain; when in combination with other drugs, for keeping down the tendency to pain. To subdue an attack of pain consequent on partial inflammation of the pulp, after neutralizing acidity about the tooth (if there be any), sedatives may be used, with considerable hope of success. Almost any of the more powerful drugs of this class may produce the desired effect, or many or all of them may fail to afford relief.

Concentrated stimulants, you know, act as sedatives; and from these preparations we may frequently gain great help in assuaging toothache, even after other means have failed. Creosote, essential oils of cloves, cinnamon, and the like, alcohol, sulphuric ether, alum, dissolved in nitric ether, and camphor, are a few of the many stimulants useful in the treatment of odontalgia. They may be offered alone, or in combination with some of the more pure sedatives; such as opium in its various forms, hydrocyanic acid, chloric ether, chloroform, aconite, and others of a similar nature.

I have known several cases in which a bad attack of toothache has been alleviated by the inhalation of chloroform. The patients were unwilling to lose the teeth, though decayed. A mild dose of the vapour was inhaled, the pain in the teeth ceased, and after the expiration of several weeks had not returned. Sooner or later the teeth will again ache, and ultimately must be removed. Chloroform applied on a little cotton wool to the tooth will frequently remove the pain. The best form for application is made by dissolving a little gum mastic in the chloroform, whereby the fluid is thickened, and, when put into the tooth with cotton-wool, will remain there a long time, and keep up its sedative influence; whereas, if the chloroform be used alone, it will be soon washed away by the saliva, and its effect lost.

Escharotics may be used in a diluted form, so as to destroy the surface only, or they may be applied in a more concentrated state, to kill the whole body of the pulp.

Most of you know that an ulcerating or a suppurating surface sometimes becomes extremely sensitive and painful, and that immediate relief is obtained by brushing over the surface of the sore with a weak solution of nitrate of silver. A similar condition, I apprehend, now and then obtains with the exposed surface of the dental pulp, for we occasionally find that a solution of nitrate of silver, gr. iij. or gr. iv. to the ℥j. of distilled water, will allay toothache after the failure of what at first seemed more promising treatment.

If, in spite of palliative treatment, the pain in the tooth still continues, and we have reason to believe that the disease has not extended from the pulp to the dental periosteum, escharotics sufficiently powerful to destroy the body of the pulp may be used, and thus cut short the pain, by the destruction of the pained organ, without necessitating the loss of the tooth. Either of the mineral acids, potassa fusa, nitrate of silver, chloride of zinc, or arsenic, will answer our purpose wherever there is sufficient exposure of the pulp to allow of their efficient application. I have used each with success, and with failure.

If the caustic employed be fluid, a small quantity may be placed in contact with the pulp on a bit of cotton, and retained by a plug of wax. If a solid be used, it will be sufficient to place a small particle in the cavity, and stop it in by a temporary plug. The pain, on the first contact of the caustic, is mostly increased, or, at all events, not diminished; but, if the destructive agent can be and is well applied, the pain ceases within from a quarter to half an hour.

The escharotic will act quickly or slowly, in proportion to the amount of surface to which it is applied. If the painful dental pulp be exposed only over a very small part of its surface, the escharotic will take some time in destroying the whole organ, but, if the surface exposed to the destructive agent be large, then the effect will be produced quickly. It is therefore desirable, before applying remedies of this class, to remove from the tooth all the softened dentine, and thus leave the pulp exposed to the action of the caustic.

Seven years since I used rather extensively the chloride of zinc [a] for destroying diseased dental pulps, and, from the experience I then gained, I am led to consider it to be as good as any, if not the best, escharotic for that purpose. It may be applied alone, or diluted with plaster of Paris, or combined with morphia, and placed upon the end of a temporary plug. The morphia is supposed to diminish the pain induced by the zinc.

The American dentists have for some time past been using arsenic to effect the same end, and, as they report, with great success. The arsenic is to be placed in contact with the pulp, and to be retained by a temporary plug. In the course of half an hour the pulp is destroyed, and is to be drawn out, and the cavity is to be immediately plugged with gold. In my hands the arsenic has oftentimes failed to produce the desired effect; and, had it been ever so successful, I should still have avoided

[a] DRUITT'S *Surgeon's Vade-mecum.* Second Edition. Published 1841.

its frequent use, because a very minute quantity, accidentally swallowed, may produce serious gastric disease.

I think arsenic should be struck off our list of dental remedies, seeing that we have other escharotics that are just as effective in destroying the pulp, and which, if swallowed in the minute quantities we use, can work no evil.

By destroying the pulp you necessarily produce necrosis of the inner portion of the tooth, and this is not very unfrequently followed by inflammation of the periosteum of the fang; hence the value of the treatment by powerful escharotics is much diminished. In the American Dental Journal you will find some papers recommending the use of arsenic, and others condemnatory of the practice, and for the reasons I have stated.

The actual cautery has been recommended by some writers. A friend of mine tells me that, when at Cambridge, he was dreadfully tortured with pain in a carious tooth, and that one day, quite worn out with suffering, he broke off all the prongs but one of a dinner fork; the remaining one he heated red hot, and in that condition thrust it forcibly into the hole in the aching tooth. The pain, he says, ceased in a minute, and that he has not, from that time to this, a period of nearly thirty years, had a single twinge of toothache.

I have never in my own practice used the actual cautery.

Mechanical means are sometimes used for destroying the pulp, and in a single-fanged tooth are effective. In a double tooth, the instrument cannot be got into the several fangs, hence this method of treatment is not available. The method of operating usually adopted is to thrust into the tooth a fine four or five-sided steel instrument, and when it has gone as far into the fang as it will go (and it will go nearly to the apex), to rotate it, by which action the pulp is torn across near its entrance into the tooth.

Dr. Mitchell, in his edition of Keocker's Essay on Diseases of the Jaws, says, *The sole object of stopping carious cavities is to preserve alive the teeth that are affected with them,* and on this ground he objects to the destruction of either a part, or the whole of the pulp, as a means of preserving the teeth for plugging, because (as he considers) the destruction of the pulp entails the death of the tooth. If Dr. Mitchell's estimate of the use of stopping were correct, his conclusion as regards the destruction of the dental pulp would be then but partly true. A tooth holds its vitality by two connections with the system, the dental pulp, and the dental periosteum. To ensure the death of the tooth both these connections must be cut off; whereas in destroying the pulp one only is removed. But I cannot grant that the sole object of stopping a tooth is to preserve its vitality. I think we should be nearer the truth in asserting that the primary object of stopping a tooth is to preserve the enamel and dentine from further decomposition, regardless of whether the remainder of the crown of the tooth be dead or alive. I have shown you that the crown of a tooth may be dead, but if the fang preserves its vitality the tooth may remain useful for years. Nay, we see many teeth in which the whole pulp has been destroyed, and yet the tooth has lasted through a tolerably long life after its destruction. Teeth so circumstanced sometimes become diseased and produce gum-boil, but this happens in only a few cases, and these will not afford just grounds for removing all such teeth on the mere chance of their becoming some day diseased. It is time enough to remove a tooth when it has become the subject of disease.

In the incisors of rodents, that part of the tooth which is in use is removed from its connection with the pulp by the tubuli having ceased to form part of the walls of the pulp-cavity—hence this part of the tooth may be assumed to be dead—to be similarly circumstanced to a human tooth that has lost its pulp, either by death or calcification.

Mr. Wardroper, in a work written on this subject, and on the treatment of diseased teeth generally [a], recommends, in preference to extraction, excising the crown of a carious and aching tooth, and thus destroying the dental pulp; and he does so under the

[a] *The Structure, Diseases, and Treatment of the Teeth.* By WILLIAM WARDROPER.

belief that it is desirable to preserve even the fangs rather than lose the whole of the tooth.

The excision of the crown is attended with almost as much pain as the extraction of the tooth would entail, and the fangs left are very liable to become the seat of disease, which ultimately obliges their removal, and thus necessitates a second operation when one would have done. For these reasons I cannot advocate the intentional adoption of Mr. Wardroper's practice. Should, however, the crown of a carious tooth be accidentally broken off where extraction was intended, and the pain then ceases, the roots may be allowed to remain till their removal is more imperiously called for.

Astringents and stimulants are especially useful in restoring the pulp to a state of health, or in exciting calcification preparatory to plugging the tooth. Sometimes, however, a vegetable astringent, such as tannin, will allay acute pain, and may therefore be employed with that view: when so used, it acts best when combined with ether, or some sedative. This latter is not, however, its most valuable effect.

The pain in the pulp having ceased, mild stimulants or astringents should be applied regularly three or four times a day, and retained in the tooth by a temporary plug. By a steady perseverance in this treatment we have good reason to hope that the exposed portion of the pulp will be induced to calcify, or at all events cease to be a secreting surface, or else to become absorbed. Either point having been gained, the tooth may be permanently plugged. You must, however, before proceeding to plug, quite satisfy yourself that one of these conditions has been produced, otherwise your operation will be mischievous. This information you cannot always gain by inspection; you may, however, feel tolerably secure, if, on examining a temporary plug that has been retained for some hours, you find no evidence of discharge or of offensive odour upon it, and if the cavity, after its removal, seems quite dry.

I have dwelt longer on the cure of toothache when produced by disease of the pulp only and upon the restoration of decayed teeth to a state of usefulness, than I otherwise should, because the subject has been neglected. It is too much the practice in the present day to immediately remove an aching tooth. It would well repay any one who has time and opportunity to devote their energies to the investigation of this subject. Depend upon it, gentlemen, there are many teeth extracted which with care might be saved and rendered serviceable for years. The loss of masticating teeth is frequently the forerunner of obstinate dyspepsia, which, directly or indirectly, by inducing other disease, renders the latter periods of life comfortless, or hurries a man prematurely to his grave.

LECTURE XIII.

DISEASES OF THE DENTAL PULP (CONTINUED).—GRANULATION OR POLYPUS OF THE PULP—ITS NATURE AND TREATMENT.—RECESSION OF THE PULP.—DISEASES OF THE DENTAL PERIOSTEUM.—INFLAMMATION, ACUTE AND GENERAL—CHRONIC AND LOCAL.—SYMPTOMS AND TREATMENT.—RHEUMATIC AND MERCURIAL INFLAMMATION OF THE DENTAL PERIOSTEUM.—MALIGNANT DISEASE IN DENTAL PERIOSTEUM. — HÆMORRHAGE FROM THE DENTAL PERIOSTEUM.

Polypus or granulation of the dental pulp.—After partial destruction of the crown, and especially of the masticating surface of a tooth, and the consequent opening of the central cavity, the pulp instead of perishing may become the seat of a morbid growth. Rising out of the damaged pulp-cavity, you may find a small rounded, smooth-surfaced, vascular tumour, which bleeds from the slightest touch, and constantly emits a most fœtid smell; even the blood that flows from it stinks. The new tissue, as compared with the pulp itself, is endowed with but a low degree of sensibility. Slight pressure, or even superficial laceration, produces but little pain. (Fig. 101.)

Fig. 101.

A Molar Tooth,

In which the pulp-cavity has been laid open by caries, and the pulp, instead of being destroyed, has become the seat of fungous growth or polypus.

The size to which dental polypus may grow is subject to considerable variety. Sometimes the tumour is small, resembling in size and appearance a large granulation; at others, so large as to cover over and completely hide the wreck of the tooth from the centre of which it has sprung. In the latter case the overhanging portion of the tumour may unite with the gum, and thus bury the tooth in a vascular tissue.

Although polypus of the pulp is not necessarily attended with pain, yet, should the new tissue be attacked with inflammation or ulceration, it then becomes extremely sensitive and painful.

Treatment.—The only radical cure is the extraction of the tooth in which the disease has its site. Should, however, your patient object to this measure (and we cannot always make patients do as we would have them), the tumour may be cut off as low down in the fang as it can be reached, and its future growth kept back by the application of astringents. Tannin applied frequently will answer the purpose.

Recession of the dental pulp.—I have already told you that the pulp, under certain conditions, gradually wastes in volume and at last disappears. But there are some cases in which it is gone before we suspect the process of absorption to have commenced. To these I will draw your attention but for a moment, and then we shall have done with the diseases of this small but sometimes most troublesome organ.

Patients are occasionally met with who state that their teeth, one after another, have gradually and painlessly decayed away; that they have never had an hour's toothache or even tenderness of teeth, though now nothing but stumps are left in the mouth. In what manner, at what time the pulp has been removed, we are unable to tell: all that we know is, that it has gone, and all that it is necessary to know is, what should be done with the tooth so circumstanced.

Diseases of the dental periosteum.—By a natural transition we pass from diseases of the dental pulp to diseases of the dental periosteum. Inflammation and its consequences, modified variously, either by the producing cause or by constitutional peculiarity, or both, form the principal diseases of this appendage of the teeth. To the investigation of these we must now lend our attention, and first of all to inflammation so located. The character of the morbid action may be that of ordinary inflammation, or it may be modified by some pre-existing state of the system. The inflammation may take a rheumatic or a strumous type, in patients afflicted with rheumatism or struma, or it may take its character from the past or present influence of mercury on the system. Then, again, the whole, or only a part, of the periosteum may be affected.

It will be best for me to take, first, inflammation of the dental periosteum in its most common, and hence most important forms; namely, active and chronic; and afterwards the various modifications of the disease. Before going further, however, I wish it to be understood that all those cases which terminate in the formation of pus in the alveolar cavity, will be placed under the head of *active inflammation,* while the term *chronic inflammation* will be reserved for those cases, in which the periosteum becomes thickened, the tooth loosened, and the disease in that condition, if left to itself, smoulders on, till at last the tooth drops out. Of course there are many cases of a mixed character, which, in their various stages, belong as much to the one as to the other of these arbitrary divisions; but, with a knowledge of the two extremes, we shall be prepared for a medium case. Neither is it strictly correct to consider all cases of alveolar abscess as the result of active inflammation, seeing that the disease is often slow, and comparatively painless. Yet we must, for the convenience of description, have some division and arrangement of the subject, and the one I have proposed will suit our present purpose.

Active inflammation of the dental periosteum.—The inflammatory action usually sets in with feelings of slight uneasiness and tension, which sensations are attended with a strong desire to press by the opposing teeth, or to shake with the fingers, the affected tooth in its socket. Slight steady pressure of the fang into the jaw gives relief so long as it is maintained, but the uneasiness returns on its withdrawal. At the same time violent and irregular pressure will produce pain. The uneasiness is soon followed by a dull heavy pain, and the tooth feels to be too long. The desire to push the tooth about continues, till disease has rendered the parts so tender that pressure can no longer be borne, and even the mouth cannot be firmly closed without pain. The tooth seems still to lengthen, and on an attempt to move it from side to side feels slightly loose.

These latter symptoms obviously depend on swelling of the periosteum, and consequent lifting of the tooth in its socket.

Early in the complaint there is tenderness and swelling of the gum, and generally of the external gum, opposite the fangs, whose periosteum is affected. In addition to this latter symptom, and often prior to its appearance, the free edge of the gum assumes a deep red colour, without either pain, tenderness, or scarcely any swelling. The neck of the tooth appears encircled with a well-defined red ring. I am not prepared to say that this symptom is always present, though undoubtedly it is seldom absent in the earlier stage; but as the disease advances this appearance is lost in the general inflammation of the gum. The pain becomes more severe, but still preserves its heavy wearing character, and, though not always constant, is seldom absent for many successive hours.

These symptoms lasting, the part of the periosteum most highly inflamed becomes detached from the surface of the fang. The most common seat of this denudation is around the apex of the fang. (Fig. 102.) Into the interval thus formed pus is poured from the separated surface of the periosteum. The fang at this part loses its vitality, and is bathed in pus, which latter gradually increases in quantity, room being made in the alveolus for the dilatation of the abscess at the expense of the bone. In some of the specimens on the table you will perceive that the bone is closely fitted to the neck of the fang, while about the apex the alveolus is hol-

Fig. 102.

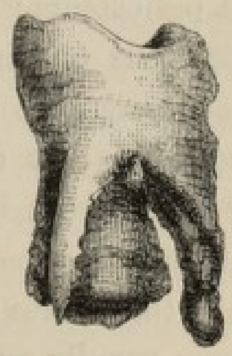
Specimen of an early stage of Alveolar Abscess.

The periosteum at the end of the fang has become inflamed, has separated from the osseous surface of the fang, and the interval thus formed has filled with pus.

The sac has been opened and distended, to show the fang stripped of its periosteal covering.

lowed out into a round cavity large enough to hold a pea. (Fig. 105.) With the formation of pus a process is established for effecting its escape. Either the periosteum becomes detached through the whole length of the fang, and the matter is discharged at the neck of the tooth, or, what is much more common, a hole is formed in the wall of the alveolus, through which the pus gets into the gum. We have then what is commonly called a gum-boil, an abscess in the gum communicating by a small hole through the bone with an abscess in the alveolus. If left to itself, the abscess will work its way to the surface, and the contents will be discharged into the mouth. The symptoms now abate, the pain ceases, and the swelling lessens, but a minute fistulous opening in the gum remains, through which a small amount of discharge habitually escapes. The inner surface or coat of the alveolar abscess, I have told you, is formed by periosteal membrane detached by inflammation, and stretched out from the fang by the gradual interposition of pus. When the abscess breaks, and the contents readily escape, the inner membrane contracts and closes upon, but never unites with, the denuded surface of the fang. While the inner surface of the abscess contracts upon the fang, the outer parts thicken and occupy the space which would otherwise be left between the abscess and the walls of the expanded alveolus. If a tooth be drawn after this has occurred, the coats of the abscess often come out adherent to the fang, in the form of a fleshy appendage, and the tooth is said to have a fungous growth from the fang. (Fig. 103.)

Fig. 103.



Specimen of Alveolar Abscess between the Fangs of a Molar Tooth,

In which situation a portion of the tooth was necrosid.

In removing the tooth, the abscess came away entire, as represented in the figure.

In a few cases in which the inflammation implicates to a considerable extent the adjoining tissues, the abscess, instead of opening on the gum, extends into the cheek, and opens on the surface of the face, and through the opening pus continues to be discharged till the tooth is removed. The following case is illustrative of this point.

An artizan, aged 32. The fangs of the molares and bicuspides of the right side of the upper jaw alone remained, and these were level with the surface of the gums, to the edges of which the cheek was adherent. Pain commenced in the stumps two years since, and at the expiration of twelve months an abscess burst on the surface of the cheek. Since then pus has been discharged from the opening; the cheek is swollen and indurated, and there is considerable pain in the jaw. The stumps were removed. At the end of a week all the pain and swelling had left, and the opening in the cheek had healed. Slight induration alone remained.

In a second case an opening in the cheek of two years' standing healed within a fortnight after the removal of the tooth that occasioned it.

Reunion between dental tissue and periosteum separated by disease, I believe, never occurs. On the contrary, the denuded and consequently dead tooth substance, when in contact with, proves a constant source of irritation to the living and already diseased periosteum; hence, the lasting discharge and consequent fistulous opening. The quantity and the quality of the continued secretion varies. Sometimes it is almost imperceptible and serous; at other times it is abundant and purulent, varying in different individuals, and in the same individual at different times.

Such is the course which active inflammation of the dental periosteum usually pursues when left to itself.

The disease may, however, assume a much more active character; all the symptoms may be aggravated, and, in addition to which, there may be considerable symptomatic fever.

The following case, which occurred in the person of a medical practitioner, will give you a good idea of the severity the disease may assume:—

Case.—T. S., age 30. In 1840, the crown of the left central incisor was broken off by a blow from a cricket ball; I refixed the crown by a pivot. In 1844, the crown had become discoloured, and was replaced by the crown of a mineral tooth. The dentist who performed the operation found it necessary to increase the length of the hole in the stump, for the reception of the pivot. This was done on the 8th of October; on the morning of the 10th, slight pain was felt about the root of the tooth. Towards evening, the pain had greatly increased; the pivot was then removed. The night was passed in pain, and without sleep, and in the morning a fit of cold shivers was followed by heat, which terminated in profuse perspiration. 11th. The pain still increasing, and attended by œdematous swelling of the face; added to which, there was great systematic fever. Pulse 130, full and hard, and accompanied by headache; twenty ounces of blood were taken from the arm, and salines were administered. Fomentations were applied to the face, and a dose of Dover's powder given at bed-time. 12th. Considerable and extending inflammation of the mouth near the pivoted tooth; more swelling of the face; headache rather less severe; six leeches were applied over the gums; blood taken yesterday rather buffy. 13th. Swelling and pain much the same; a small abscess formed in the roof of the mouth near the tooth. This was opened. The fomentations were continued, and the Dover's powder repeated at bed-time. 14th. The abscess in the roof of the mouth was again opened, and a considerable quantity of purulent matter let out; the inflammation, pain, and swelling much the same; six more leeches were applied, followed by fomentation and poultice; the Dover's powder repeated at night. 15th. Symptoms no better; three more leeches were applied to the gums, and the fomentations were continued. 16th. From this time the symptoms gradually abated, but left a small abscess over the stump, from which a considerable quantity of pus escaped.

On the 5th of November he applied to me. There was still pain in the stump; the gum was swollen, and pus escaped from an opening opposite the end of the fang, which, on removal, was found to be discoloured, and evidently dead. The operation was followed by the escape of a quantity of unhealthy pus. From this moment no further inconvenience was felt; the gum healed, and the whole mouth returned to a state of health.

The stump was not transfixed by the second operation of pivoting;—I mention this, because I have seen several cases, where a similar course of events has followed the transfixure of the fang in the operation of pivoting.

An equally instructive case, in which the disease was cut short, occurred in the son of the hospital carpenter, a lad of 14 years of age. He was attacked with severe pain in the canine of the upper jaw on the right side. The tooth was perfectly sound. The pain increased in severity for six-and-thirty hours, and the tooth then felt too long, and was greatly in the way when he closed his mouth, from the pain that was occasioned whenever it was touched by the opposing teeth. There was considerable headache, thirst, and a loaded tongue, and the boy said, "he felt almost light-headed at times." I removed the tooth, and found the fang every where coated with thickened and inflamed periosteum. The pain ceased with the smart of the operation, and there was no return of suffering. Had this tooth been allowed to remain, the case would, no doubt, have followed a similar course to that I just now described. An abscess would have formed in the aveolus, and, after more or less suffering, opened on the surface of the gum. The specimen is before you, and you may contrast for yourselves the diseased of this, with the healthy periosteum of other teeth.

Inflammation of the dental periosteum may, however, move more slowly through its various stages. The inflammatory action may last for some time before the supervention of suppuration, and, in the meanwhile, occasion violent intermittent attacks of pain, not confined to the tooth alone, but often extending to the face and head, in which situations the pain may be far more intolerable than in the tooth itself.

Only a few days since I removed a tooth, with the periosteum inflamed and thickened, which had tormented the patient almost night and day for a fortnight; yet there was no denudation of the fang, or formation of pus. In cases like this you will frequently find that dental exostosis has commenced on the surface covered by the inflamed tissue, slight in amount, perhaps, yet distinguishable.

In other cases, again, the separation of the inflamed tissue occurs only at the apex of the fang, through the canal of which the pus oozes; but the relief is then only partial, and the periosteum continues to thicken, and the alveolus to enlarge, to make way for the increase in size of the diseased organ. The pain is intermittent, and often simulates in its character tic douloureux. The specimen before you, and from which the figure was taken, caused, in conjunction with several teeth similarly affected, severe facial pain, which had lasted, on and off, for some months, till the patient was quite worn out. (Fig. 104.) The condition I have described is more frequently found in stumps than in teeth where the crown is but partially decayed; and it is common to find the fangs of several contiguous stumps in a similar state.

Fig. 104.

Inflammation and thickening of the periosteum of the Fangs, without any disposition to Gum-boil.

The pus in this case is secreted in small quantities, and escapes through the canals of the fangs.

The points only of the fangs are denuded of periosteum.

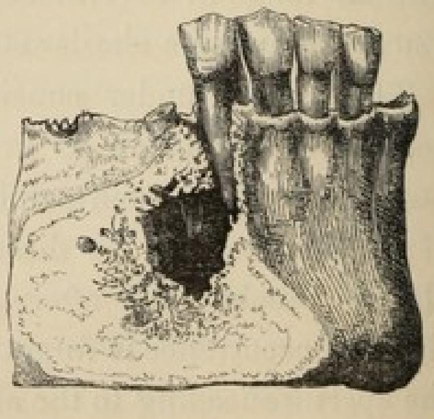
The disease under consideration may assume yet another degree: it may begin so gradually, and advance towards suppuration so slowly and painlessly, that the patient is not aware of its existence till he discovers a tumour on the gum, or the abscess breaks; and afterwards so little inconvenience is felt that the occurrence is forgotten, till, from some cause or other, the aperture leading to the alveolus which contains the remnants of the disease becomes closed, when pus re-collects; and even then but little pain may attend the process. The pus is again liberated, and comfort is restored. Sooner or later, however, the inflammation becomes more severe, and the patient is obliged to seek a remedy in the removal of the tooth.

Cases of this passive character are sometimes productive of sympathetic pain, and should not, therefore, be lost sight of. The gum, too, over the affected alveolus, frequently becomes thickened, minutely nodulated on the surface, and assumes a mottled hue.

During the present year (1848) a female, aged 25, applied to have a painful stump removed. It proved to be the fang of the second bicuspis of the upper jaw. The gum was thickened, and a long thin riband-like granulation grew out opposite the end of the diseased stump. The granulation was half an inch long and very flexible, and from the end of it oozed a little pus, which, no doubt, came from the alveolus. The tooth was extracted, and at the end of a week the tape-like granulation had disappeared.

In any case where the inflammation is acute, and the system in an unfavourable state, the diseased action may, and often does, extend to the periosteum of the jaw, and, if not speedily subdued, occasions thickening of the bone, or, even worse, may cause necrosis of a considerable portion. I have known three-fourths of the under jaw lost from disease commencing in the dental periosteum of one tooth. In more favourable instances, the disease may creep on only to the adjoining teeth, occasion their loss, and then end. In the great majority of cases, however, the inflammation does not spread: the pus makes its way to the surface, and there is left a fistulous opening in the gum, with thickening of the surrounding parts. Enlargement of the alveolus, in which the disease occurs, is common

Fig. 105.



Enlargement of the Alveolus of the Canine Tooth,

Consequent on inflammation of the dental periosteum.

to all cases, the degree being proportioned to the extent of the disease. (Fig. 105.)

Active inflammation of the dental periosteum may arise without our being able to trace the cause: the tooth, and the neighbouring parts may be, so far as we can see, healthy. In nineteen cases out of twenty, however, it follows or results from, or is an extension of, inflammation of the dental pulp, or is consequent on necrosis of the whole or a part of the fang.

Treatment.—I told you, in a previous lecture, that local bleeding is frequently ineffective in inflammation of the pulp: the reverse is the case where the dental periosteum is the seat of disease. Here it is our best remedy. If used sufficiently early in the disease, it seldom fails to produce relief, and frequently cuts short the disease. One or two leeches should be applied, by the help of a leech-tube, to the gum opposite the end of the root of the affected tooth, and in connection with this treatment an aperient should be taken. Care should be taken not to move the tooth by mastication or by other means.

The various toothache nostrums which I have mentioned, excepting only sialogogues, are utterly useless in the treatment of this disease. If, however, the inflammatory action has gone on for a day or two, it is probable that suppuration cannot be avoided, especially if the affection has spread to the gum. In that case, the tooth should be removed, and the gum, if there is reason to suspect that pus has made its way into it, should be freely incised.

Extraction of the tooth, however skilfully performed, is not always followed by cessation of pain; on the contrary, the degree of suffering is sometimes for awhile increased, arising, no doubt, from the laceration of the inflamed tissues. The duration of the after pain will be proportioned to the extent of the inflammation, and to the amount of sympathetic pain previously suffered.

In all cases of pain after extraction, the sufferer should be directed to hold strong and hot decoction of poppy-heads in the mouth, and to renew the mouthful when it ceases to feel hot. This application should be continued till the pain abates, which will generally be, even in the worst cases, within an hour or two.

If from any cause the tooth may not be removed, we must then do what we can to relieve the pain, and to reduce the disease to a state of passive gum-boil. If there is reason to believe that pus has not been formed, a leech should be applied to the gum, and aperients given; but, should you find a circumscribed swelling in the gum over the tooth, it is pretty certain that pus is making its way outwards, and the part should be freely incised. By this means, the escape of the pus is hastened, and consequently much pain saved. A small fistulous opening will remain for the exit of the pus unless there be a way through the fang by which it may get free. It is quite possible that the coats of an abscess situated in the alveolus may embrace the necrosid extremity of the fang, and cease to secrete; in which case, the gum would perfectly heal, and the end of the tooth would be in a similar position to an encysted foreign body. But I do not think this is of common occurrence, neither could it be expected, when it is considered that the fangs of teeth admit, under pressure, of a slight degree of motion.

Chronic inflammation of the dental periosteum.—Under this head I include those cases in which there is no tendency to the formation of an abscess.

This form of disease may implicate the whole or only a portion of the investing membrane of the fangs.

If the whole periosteum be affected, the tooth becomes loose, the alveolus absorbed, and the edge of the gum inflamed. With this there is but little pain, unless the tooth be so situated that it is frequently pressed upon. The gum gradually sinks with the absorption of the alveolus, and the tooth drops out or is removed.

In some cases there will be a slight discharge of pus from the edge of the gum. By the process I have described, old people frequently lose their teeth. They will tell you their teeth are quite sound, but that they drop out one by one. If you examine the mouth of a patient so complaining, you will probably find teeth in the state I have just noticed.

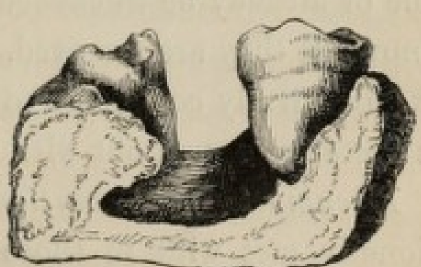
Any source of irritation to the gum, such as ligature round the neck of the tooth, or irritation of the periosteum by oblique pressure on the crown of the tooth in such a manner as to force it out of its place, will induce chronic inflammation of the dental periosteum even in young persons. The accumulation of tartar on the necks of the teeth is also productive of this malady.

The treatment must consist of removal, if possible, of the exciting cause, scarification of the gums, and the local application of astringents and stimulants.

Tannin rubbed on the gums frequently does great good. The compound spirit of horse-radish is both an agreeable and useful application in these cases, especially when the gum participates in the disease. In aged people treatment is but palliative; the disease goes on, the alveoli waste, and the tooth falls out. The gum then, and not till then, returns to a healthy state.

When a part only of the periosteum is affected, the disease presents quite a different aspect, and usually occurs in connection with stumps, the crown of the tooth having been destroyed by caries. The periosteum about the extremity of the tooth becomes thickened and nodulated; the socket widens as the disease advances, until the neighbouring alveolus is laid open. With this state there is occasional and sometimes severe pain, not necessarily confined to the seat of the disease, often not in the affected alveolus at all, but in the jaw, or in the cheek-bone, or in the ear. The edge of the alveolus seldom becomes absorbed, so that the fang is held firmly in its place. (Fig. 107.)

Fig. 106.

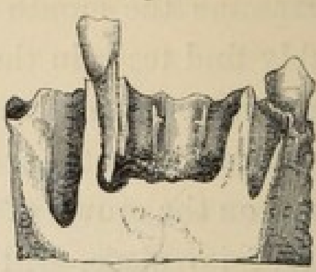


Absorption of the Alveolar Plate,

Between the second molar and the dens sapientia of the lower jaw, from inflammation of dental periosteum of the stump of the second molar.

When there are three crownless fangs in a row, and the periosteum of one only the subject of chronic inflammation about the end, it is extremely difficult, if not impossible, to tell which that one is, unless there is tenderness on pressure, or the margin of the gum is encircled with a red line, neither of which symptoms are constant.

Fig. 107.



A Section of the Front Part of the Lower Jaw,

Showing the manner in which the alveoli became enlarged, and their septa destroyed, in chronic inflammation of the dental periosteum.

This bulbous state of the dental membrane (often termed fungous) is occasionally found in connection with dental exostosis, and sometimes with necrosis, when the extent is very slight; but in the latter case it is disposed to become active, and end in alveolar abscess.

There is but one method of treatment—the affected tooth should be removed.

Whenever you find a patient suffering pain in the jaw or face, or ear, and is unable to state the exact seat of pain, but is disposed to ascribe it to the teeth, you will do well to remove any stumps that are found in the mouth; for the periosteum of one or all may be thickened and diseased, and this you will not know till they are removed. Very generally the diseased tissue is more firmly connected to the tooth than to the alveolus, and is therefore drawn out with the tooth.

Rheumatic inflammation of the dental periosteum is occasionally met with in those who are suffering from a general attack of rheumatism, in which case all, or the majority of the teeth, become slightly loose are raised in their sockets, and, when pressed on, give great pain. Astringent applications may be used, though local remedies will do but little good. It is by general treatment addressed to the primary disease that this state of the teeth will be cured, and this does not fall within the province of the dentist. You will find an account of the malady, and the treatment to be used for its cure, in Dr. Graves's clinical lectures.

A slight and transient attack of the condition in question is very common. The patient tells you he has caught cold in his teeth; the teeth feel slightly loose and painful, especially when firmly closed, but that the unpleasant sensation will go off in a day or two, as similar attacks have done before.

Inflammation of the dental periosteum is a constant attendant on salivation induced by mercury; and in this, as in all other cases produced by agents taken into the stomach, the effect is equal in the periosteum of all the teeth, and the whole periosteum of each tooth. The inflammation may end, if the cause be continued, in death of the part, but is seldom, I believe, productive of alveolar abscess. The gum participates more or less in the disease and its consequences. If the condition be continued for any length of time, the alveolar processes become more or less absorbed; and, on the subsidence of the disease, the gums are found to have left the necks of the teeth uncovered.

After repeated and long-continued salivation, so much absorption of the alveoli takes place that the teeth drop out for want of support.

Dr. Watson, in his lectures, mentions the following substances as occasionally causing ptyalism. Preparations of gold, of copper, of antimony, and of arsenic; also castor-oil, digitalis, iodide of potassium, and opium. The same condition is also sometimes produced by pregnancy. Dr. Hawkins mentioned to me one case, in which salivation and inflammation of the dental periosteum, and loosening of the teeth, arose from the frequent administration of small doses of croton oil; and another case, in which similar symptoms were induced by sponging the upper half of the body once a day for a fortnight with nitro-muriatic acid.

The cause of the disease having been discontinued, a stimulating wash should be used: and I learn from our apothecary, Mr. Corfe, that brandy and water is found to be one of the most efficient. Tannin applied to the gums is also very effective. Scarification should be avoided, as there is a predisposition to sloughing when the system is under the influence of mercury. The patient should be enjoined to move the mouth as little as possible, and especial care should be taken to keep the teeth at rest. Strict cleanliness of the teeth and mouth should, however, be observed: and the offensive odour and taste, which usually accompany salivation, may, if oppressive, be in a measure subdued by combining a little chloride of lime with the stimulating wash.

Malignant disease sometimes commences in the dental periosteum, and from thence extends to the jaw. It cannot, however, I believe, be recognised at its commencement; and when it has advanced, and implicated the jaw, the case comes under the province of general surgery: hence, it would be out of place to enter into the history and treatment in these lectures.

Hæmorrhage from the dental periosteum.—It occasionally happens, after the extraction of a tooth, that blood continues to flow from the wound till the life of the patient becomes endangered; and there are many cases on record where life has been lost from this cause.

Usually the bleeding ceases within a few minutes after the removal of the tooth, and the alveolus becomes plugged with coagulum. In hæmorrhage the coagulum forms, but blood ooses by the side. The cause of this state arises from a peculiar condition of the whole vascular system, which is termed the hæmorrhagic diathesis, or perhaps sometimes from the conditions of the vessels of the part only. The patients themselves generally tell you that they are subject to bleeding from the nose, and that they have often the greatest difficulty in checking the flow of blood.

I have met with three cases of hæmorrhage from the alveolus within the last five years, and these have occurred recently.

The first was in a lad of eighteen. I removed for him a second bicuspid of the upper jaw; two days afterwards he returned with a pale and wretched countenance, and said that the gum had bled at short intervals ever since the tooth was drawn. The alveolus was cleared of coagulum, and a piece of lint, tightly rolled into the shape and size of the root of the tooth, was loaded with the leaf of the matico reduced to powder, and then introduced into the alveolus. The bleeding ceased within a few minutes, and did not again return.

The second case occurred in a female—a robust cook. A molar of the lower jaw was extracted; 36 hours afterwards she returned, and was evidently suffering from loss of blood. The gum, she stated, had bled ever since the tooth was drawn. A leaf of matico was softened and rolled up, with the under side outwards, and introduced into the bleeding socket, the coagulum having been previously cleared away. The hæmorrhage stopped within a few minutes. Three days afterwards the young woman's mistress wrote to say that the gum had not since bled, but that her servant still felt very weak.

The third case occurred in a young man of five-and-twenty. He returned after the hæmorrhage had lasted only six hours. Similar treatment was adopted, and with the same favourable result.

Previous to the introduction of piper angustifolia matico by Dr. Jeffery, the common practice was to roll up a piece of lint, and, after saturating it with a strong styptic, such as the muriated tincture of iron, or a solution of nitrate of silver, to introduce it into the bleeding alveolus, there to be retained by a compress of lint pressed on the part by the closure of the jaws. The mouth is kept shut by a bandage passed under the chin and over the crown of the head. A narrow strip of lint, saturated with a styptic, and gradually introduced into the bleeding alveolus, is, in some cases, a more convenient manner of application than the rolled plug.

Dr. Reed, of Edinburgh, has invented an instrument, of which he has published an account, for producing pressure on the bleeding part in maxillary hæmorrhage.

Should the ordinary methods of treatment fail, the dentist may succeed in arresting the bleeding by making a plate of metal, or other unyielding material, to fit accurately the surface around the bleeding part, and then confining it either by compress or by ligature to the adjoining tooth or teeth. This will prevent the blood from escaping out of the alveolus. Such an apparatus must be specially constructed for each case, and might be made in one or in two hours at most. In great need, a piece of sealing-wax, moulded to the form when warm, might prove of great value.

LECTURE XIV.

ABNORMAL CONDITIONS OF THE ALVEOLI.—NECROSIS.—ALVEOLAR EXOSTOSIS. — ABSORPTION OF THE ALVEOLI. — DISEASES OF THE GUMS.—INFLAMMATION, ACUTE AND CHRONIC, OF THE GUMS.—SALIVATION. — ULCERATION OF THE GUMS. — TUMOURS OF THE GUMS.—EPULIS.—POLYPUS.—VASCULAR TUMOURS OF THE GUMS.—BLUE GUM.—SALIVARY CALCULI, OR TARTAR.—DISEASE OF THE ANTRUM.

I SHALL pass over the symptoms and treatment of those diseases of the jaw which are common to all bones, because they are treated of in your surgical lectures. Those abnormal conditions, however, which occur in connection with, and exercise an influence on the teeth, I shall notice so far as the treatment affects the teeth.

Necrosis of the alveoli.—Death of a portion of the alveolar arch is far from uncommon. The greater part of the jaw may be necrosid, or the disease may be confined to the socket of a single tooth, or even a portion of the socket. It may occur at any period of life, and to either jaw, but is more frequent in the under jaw. Sometimes we find necrosis of the alveoli in quite young children. Two or three of the sockets of the temporary teeth are lost, including also the cells containing the partially developed permanent teeth. Again, we find the same disease in old people, affecting perhaps the sockets of their few remaining teeth. An old man of sixty, recently in attendance at the hospital, lost the central incisors, with their alveoli, by necrosis; and these were the last of his teeth.

The symptoms of necrosis of the alveoli are similar to those indicative of the same disease, or of exfoliation occurring in any other bone, and the treatment must also be similar. Mechanical injuries of the jaw are frequently productive of necrosis. The extraction of diseased teeth unskilfully performed is a frequent cause of death of a small portion of the jaw; and this catastrophe may, and sometimes does, follow the drawing of a tooth, however dexterously managed. In the great majority of cases, however, diseased teeth play an important part in the production of the disease, and have therefore to be considered in the treatment.

The dental pulp becomes exposed by caries or injury of the crown, inflames, and the inflammation extends to the dento-alveolar periosteum, and from thence to the jaw, and thus produces necrosis.

The teeth situated over the dead bone loosen and drop out, or more frequently, perhaps, are removed by the surgeon. There can be no doubt of the propriety of removing the tooth that has occasioned the disease, but it becomes a question whether sound teeth loosened in necrosis should be at once removed. In the following case, read at the Medico-Chirurgical Society, by Mr. Sharp, the teeth were loosened by necrosis of the jaw, but afterwards became quite firm and useful, and, as it would seem, by the formation of new alveoli. The sequestrum was exhibited at the Society, and figured for the Transactions. I have since had an opportunity of examining the sequestrum, and my friend Mr. De Morgan has been kind enough on this, as on many previous occasions, to make a drawing of the specimen a little more favourable for showing the alveoli than that contained in the Transactions. The case was reported as follows:

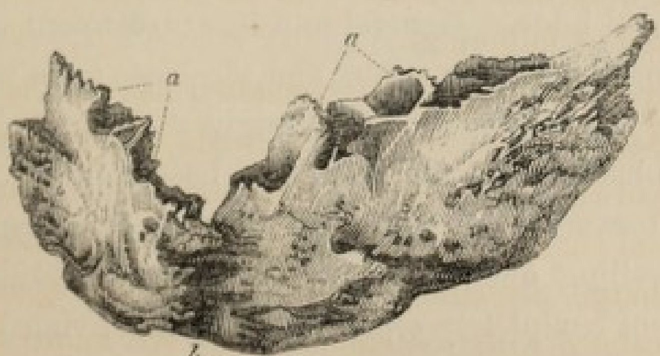
"Esther Watson, aged 20, consulted me, on the 8th of September, 1842, for an extensive necrosis of the lower jaw, with ulceration of the integuments under the chin. The mouth and lower part of the face, from the tumefaction, the ulcers, and the fœtid discharge, presented a very disagreeable appearance. It had commenced with toothache about six months before, the pain being followed by an inflamed swelling, the swelling by abscess, and the abscess by ulceration. No effectual treatment had been adopted to arrest the progress of a very painful disease.

"It immediately occurred to me that a fungus arising out of the fang of the decaying tooth had been the origin of the mischief; and my first object was to remove this by extracting the tooth. The posterior bicuspid of the left side of the lower jaw was accordingly drawn, and a small fungous growth was found attached to one of its fangs. On examining the jaw with a probe through the ulcerated openings, a large extent of denuded bone was felt, but it appeared to be firmly attached. My further attempts were therefore limited to prescribing an alum gargle to be freely used to cleanse the mouth, and zinc ointment to be applied externally.

"By this means the *comfort* of the patient was greatly promoted, and time was allowed for the process of separation to advance: they were continued, with the occasional application of a poultice, for three months.

"On the 13th of December, it being evident that the dead bone was completely detached from the living, the existing openings under the chin were thrown into one, and somewhat enlarged by two small incisions. The bone was taken hold of by a pair of forceps, and immediately, without pain or hæmorrhage, extracted. The portion removed amounted to about two-thirds of the entire lower jaw, and contained several of the alveolar processes, as may be seen in the annexed woodcut.

Fig. 108.



The Sequestrum viewed from above and anteriorly.

a, a. Sockets of the bicuspid teeth, with a portion of the socket of the left canine.
b. The symphisis.

"A slight dressing was applied to the wound, and, on desiring the patient to open her mouth, to my very agreeable surprise, I found the entire set of excellent teeth (with the single exception of the one I had extracted) perfectly fast, and in their proper places.

"On the 5th of January, 1843 (in three weeks), the wound was very nearly healed, and the face had now recovered a perfectly natural appearance, having lost the swelling and inflammation which had disfigured it for so many months. She then returned into the country, and, as far as I have been able to learn, has since continued quite well."[a]

I am not aware that a similar case has been since reported. We have, however, had an out-patient admitted under Mr. De Morgan, whose case, so far as it was seen, followed very closely to that described by Mr. Sharp. The patient was an Irish woman of about five-and-thirty. She stated that she was attacked with violent toothache, at first confined to one tooth, that the pain afterwards extended to the jaws, and that the jaw became swollen. When she came to the hospital, there was considerable thickening of the front and right side of the lower jaw, with three fistulous openings in the gum, through which dead bone could be felt. The sequestrum, which was not detached, seemed to extend from the front to the side of the jaw as far back as the second molar, over which part the teeth were sound, but very loose. Pressure on the teeth produced pain; but, when moved about, the fangs did not grate upon denuded bone. General and local treatment was adopted for subduing the inflammation, and the loose teeth were allowed to remain. At the end of a fortnight the pain and inflammation had subsided, and the teeth had become more firm. Two months afterwards the teeth had become comparatively firm, and the swelling about the jaw had greatly subsided, but the dead had not completely separated from the living bone. The woman now thought very lightly of her malady, and could not be persuaded that there was any disease left worth her attention; and from that time she has been lost sight of.

Then, as regards teeth loosened by necrosis of the jaw and

[a] *Medico-Chirurgical Transactions*, vol. xxvii. page 432.

alveoli, it will be well to let them remain if they are sound, and are not, so far as we can tell, stripped of their periosteum, and do not occasion irritation. Much w ll be gained if they are by nature refixed in new sockets; and, though the probabilities are greatly against the occurrence of this event, yet we need risk nothing in taking what chance there may be. Wherever there is fibrous tissue there may be formation of bone; and it is possible that, if the dento-alveolar periosteum escape destruction, it may contribute to form new alveoli.

Alveolar exostosis.—After a tooth has been pulled out, the vacated socket is gradually filled up from the bottom by bone. This growth of bone in the socket sometimes takes place without the previous removal of the tooth, and thus gradually forces the tooth out of its natural position, or out of the jaw. This happens more commonly to the central incisors of the upper jaw than to any other teeth.

You may sometimes see people in whom one front tooth looks longer than its fellow, the one having been protruded by exostosis in the socket. In other cases, again, the teeth are forced apart by thickening of that portion of the alveolus that passes between them, or they may be pressed outwards or inwards by osseous thickening of the outer or inner wall of the socket. The fangs of the displaced teeth are sometimes also shortened by absorption.

The disease will have its way in spite of treatment: hence in most cases treatment is but an addition of evil to that consequent on the malady. Eventually the tooth is forced out, or becomes so much displaced, or discoloured from exposure of the fang, that its removal is necessitated.

Absorption of the alveoli.—In advanced age the alveoli become absorbed, and the teeth, however sound in themselves, fall out. The process commences on the edge, and gradually advances towards the jaw, till the whole of the sockets are removed. This, which is a natural occurrence in the old, constitutes a disease when it happens to the young or middle-aged, and produces premature age in the jaws. Frequent or long-continued salivation, scurvy, purpura are a few of the many constitutional conditions that lead, directly or indirectly, by producing increased vascularity of the gums, to premature absorption of the alveoli. Necrosis of the fangs, either suddenly produced by a blow or otherwise, or gradually by consolidation of the dentinal tubes of the fangs, the use of a very hard tooth-brush, the accumulation of tartar, the presence of ligatures, whether of silk or metal, round the necks of the teeth and in contact with the gums, by inducing irritation in the edge of the gums, lead to a like result.

In cases arising from any of these conditions, the disease may be arrested by first removing the cause, and afterwards employing astringents to the gum.

Premature alveolar absorption sometimes, however, occurs without any accompanying disease of the gums, teeth, or periosteum, and in such case is not favourably influenced by treatment. This form you will find running through the various members of a family, and descending from father to son. The sockets of many or only a few teeth may waste away, while others remain unaffected; those of the front teeth being most frequently absorbed.

The anterior part of the socket of a very prominent tooth is sometimes absorbed early in life; and this mischance, both of position and absorption, happens more frequently to the canines than to any other teeth.

The patient should be enjoined to scrupulously avoid all sources of irritation of the gum, to use a very soft tooth-brush, and to prevent the accumulation of tartar on the necks of the teeth.

DISEASES OF THE GUMS.

Acute inflammation of the gums.—This disease is of rather rare occurrence, except as the consequence of specific agents administered for the cure of disease.

There are, however, a few cases on record of spontaneous salivation, in which the gums have been highly inflamed. I saw, a few months since, a case in which the gums of the upper jaw, and especially of the anterior part of the jaw, had become highly inflamed without any assignable cause. The pain in the mouth was great, and the flow of saliva excessive; the disease yielded to free scarification, astringents, and occasional aperients.

In salivation produced by mercury, the effect is first discernible upon the gums. Some hours previous to the coming of the metallic taste, and to the fœtor of the breath, and also to the soreness and discomfort which mark the influence of mercury on the system, the gums show indications that these conditions are about to appear—in fact, that the patient will in a few hours be salivated. The state of gum I am about to describe is, in fact, a premonitory sign of ptyalism, for should it appear, and the mercury be immediately discontinued, yet salivation will come on. The sign is this:—the adherent portion of the mucous membrane of the gums assumes an opaque white colour, contrasting strongly with the non-adherent portion, which preserves its natural hue or becomes more red. The free edge of the gums is movable, but that part which lies over the edge of the alveoli is firmly tied down to the periosteum; and, as the edges of the alveoli present a festooned line, so the whitened mucous membrane presents a corresponding festooned line. Again, where the mucous membrane is loosely reflected from the gum to the cheek, the natural colour is preserved. The whiteness of gum is produced by an increased secretion of epithelium, which, from being thicker and more opaque, renders the colour given by the vessels to the subjacent tissue less apparent.

The surface of the mucous membrane, when deprived of epithelium, is studded over with innumerable small conical elevations, or papillæ. The thickened epithelium is readily rubbed off the tops of the papillæ, while it retains its full thickness in the hollows between them; thence, if closely inspected, the gums will not be seen to present a uniform white hue, but a mottled aspect; and this because the epithelium is thin over the papillæ and thick between them, and therefore more colour shows through at one part than at another.

With the increased thickness there is a decrease of tenacity between the scales that form the epithelium, for the surface may be much more readily rubbed off than when in its natural state.

This curious and useful premonitory sign of coming ptyalism was, I believe, first noticed, and its value pointed out, by Mr. Corfe; at all events, he first of all drew my attention to the fact, and I am not aware that it has been described by any author. Since, however, Mr. Corfe mentioned the result of his observations as to the constancy of the sign, I have verified for myself its presence in all cases of salivation that have come under my notice, and from these I have written the foregoing account.

If you would make use of this indication in your practice, it will be necessary that you should carefully note the state of the gums at the time the mercurial treatment is commenced, for it is quite possible that other agents may produce a similar state of gum, and that such may exist previous to the exhibition of mercury.

Chronic inflammation of the gums.—This form of disease is very common in the middle and later periods of life, and when once established is apt to prove obstinate.

The surface of the gums becomes minutely nodulated, and the secretion of epithelium increased; the papillæ are increased in prominence, while the substance of the gum is generally thickened, and the edges about the teeth become thick and round. The disease may be confined to the gum, about two or three teeth, or may extend over the whole mouth; the extent depending upon whether the cause be local or general.

The amount of pain consequent on this malady is subject to considerable variety, both in degree and character. In some cases but little uneasiness is complained of unless when eating, while in others the mouth is seldom free from pain. Then, again, in others it comes and goes irregularly, or, sometimes, regularly; the pain may come on every evening towards bed-time, and last for several hours. In any case the severity is usually increased in damp weather.

Chronic inflammation of the gums, if allowed to pursue its own course, may lead to one of two very opposite results; the alveoli may become absorbed, or they may become thickened and spongy. In either case the teeth eventually are loosened, from the diseased state of the gums spreading to the dental periosteum.

This form of disorder is very commonly the result of indigestion, when general; but when confined to part of the mouth it usually follows pre-existing disease of the dental periosteum, of stumps, or faulty teeth.

Treatment.—The cause should be removed—the affected gum should be from time to time lightly scarified with a sharp lancet, much in the manner that granular conjunctiva is scarified; astringents should be frequently applied, and of these tannin is the best: this powder should be rubbed with the finger twice or thrice a day over the affected part. Teeth that have been loosened by inflammation of the gums tend to keep up the disease by their mobility; the patient may not, however, consent to their removal, especially if the front teeth are the ones implicated. In this kind of case I have seen great benefit follow the use of compound spirits of horse-radish, and also spirits of scurvy-grass; they should be applied to the affected gum, three or four times a day, with a bit of soft sponge.

There is a singular modification of chronic inflammation of the gums, in which the gum, instead of thickening and becoming irregular on the surface, seems rather to decrease in size, assumes a very smooth and polished surface and mottled aspect; the disease often extends over the surface of the hard palate, and is attended with acute intermittent pain; the pain 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 cases of this complaint that have come under my notice have been confined to poor middle-aged females, in whom menstruation was becoming irregular, or had altogether ceased; and they have always been cured by the regular use of mild aperients. I have usually given a small dose of sulphate and carbonate of magnesia twice a day, and at the end of a week or nine days the pain in the gums has ceased, and that structure has assumed its healthy appearance.

Ulceration of the gums.—The gums are frequently the seat of ulceration: a small, round, excavated ulcer appears, of a yellowish white colour, very painful when touched, and hence troublesome. It may occur in any part of the gums, but when it is situated between the teeth its existence is not readily recognised; hence patients have had sound teeth removed to relieve pain which was, in fact, not in the tooth, but in the interdental gum. Ulcers of this kind not uncommonly make their appearance on tumours of the gum, in situations where they cannot be seen, and so give much trouble.

There is one unfailing and almost instantaneous remedy—this is, nitric acid; the ulcer should be touched with the acid diluted with an equal part of water; a camel's hair pencil is the best instrument for applying the remedy.

I told you in a previous lecture that polypus of the pulp sometimes attains a considerable size, spreads over the edges of the fang from which it has sprung, and unites with the surrounding gum, thus burying the stump in the new tissue. When in this state, spreading ulceration sometimes attacks the surface of the new texture, and would destroy it but that it is constantly growing at the base, and thus affords material for the ulcerative process to consume. I have seen one case of this nature, in which the surface of the ulcer looked like malignant disease; the surrounding parts had not, however, the induration peculiar to that frightful malady. The stump was felt buried in the mass with a sharp steel probe, and removed, and then the gum speedily returned to a healthy state.

Tumours of the gums.—Tumours occasionally grow up in the gums, having originated in the vessels or vascular canals of the bone, in the periosteum, or in the substance of the gum itself.

When arising from either of the former tissues, the tumour is termed *epulis;* while those springing from the gum itself, being similar in structure to the gum, are usually called *polypi,* or *granulations* of the gum.

Epulis.—This species of tumour, itself fibrous, is developed in the fibrous tissue about the bone, from which it continues to grow, and presses before it the tissues of the gum; hence externally it resembles in colour, and generally in surface, the gum; or the surface of the tumour may be rough, and then it looks like a wart on the gum. The growth is generally slow, but gradually progressive, and usually unattended with pain, and the tumour, although tolerably vascular, is not prone to bleed.

The surface of the bone on which the tumour rests becomes more or less affected, the degree being proportionate to its duration and magnitude. The Haversian canals in this part become much dilated, and they contain portions of the tumour; for should it be excised down to the surface of the bone, but the canals left, the tumour speedily reappears; while if the affected bone be also excised the disease does not recur.

Osseous tissue may be increased in quantity by a diminution in the calibre of the Haversian canals, or by an addition to the surface; or it may be diminished in quantity by the dilatation of the Haversian canals, or it may die, but in neither case does the tissue itself undergo any change; it is but a matter of *more* or *less,*—of life or death. Hence when epulis seems to grow from, or out of, the bone, it does not belong to the osseous tissue, but to the contents of the Haversian canals that traverse that tissue.

Osseous spiculæ not uncommonly shoot from the surface of the jaw into the tumour, and in some cases isolated nodules of bone are found in its substance; in the latter feature epulis strongly resembles fibrous tumours of the uterus.

Epulis is strictly a fibro-cellular tumour, composed of interlacing fibres, mingled with nucleated cells, in every stage of advancement towards the formation of fibres. This disease may form in any part of the gums, but it most commonly springs up in that part which passes between the teeth.

Your patients will tell you that they first of all found a small lump on the gum, but that it gave no pain, and hence, for awhile, did not engage the attention. As it increased in size, however, the teeth at its base loosened, were separated from each other, and got out of place. As the growth advances, the tumour becomes softer, more vascular, is indented by the teeth, and subject to ulceration, in which case it also becomes painful; sometimes it will assume very much the appearance of malignant disease. If a tumour of this nature be left to itself, it may gradually attain a considerable size, and lead to great displacement of neighbouring parts, and disfiguration of the face.

When the disease has become formidable from its size or character, the treatment falls to the province of the operative surgeon; and to surgical writers I must refer you for a more detailed account of the disease and its treatment, but I would especially recommend your perusal of a clinical lecture on the subject, by Mr. Cæsar Hawkins, published in the "Medical Gazette," in June 1846.

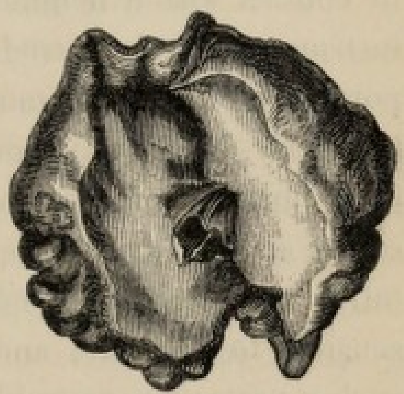
Whatever be the extent of the tumour, extirpation and subsequent excision, or destruction by escharotics, of the surface of the bone from the canals of which it has grown, is the only sure manner of removing this otherwise obstinate disease.

In the majority of cases it is difficult if not impossible to assign correctly the cause of epulis. In a few individuals, however, the affection is obviously occasioned by a diseased tooth or a stump. The following case came under the care of Mr. Arnott, to whom I am indebted for the particulars and the figure.

In a female, aged 40, a firm tumour occupied the space vacated by the second bicuspid, and the first and second molars of the left side of the under jaw. It rose to a higher level than the adjoining teeth, and was broader. The whole depth of gums corresponding to the alveolar processes was occupied by the tumour, which was in colour similar to the gum, excepting the upper part and edges, which were a little abraded. The surface was smooth, and pressure on the tumour gave no pain. The wisdom tooth was embedded in the lingual side of the mass. The patient stated that five years ago the second molar was broken off, and the stump left in, and that some time afterwards a tumour began to form about the part from whence the tooth had been broken. A fortnight since the embedded wisdom tooth was extracted, and the tumour was excised to the level of the gum. A fungous growth sprung up from the excised surface, in which darting pains were felt. The first bicuspid having been extracted, the tumour with the alveoli at its base was removed with cutting forceps, and the exposed surface of the jaw treated with potassa fusa.

The tumour, when divided, showed a dense fibrous structure, and nearly in the centre was found completely embedded, and adherent, the stump of a second molar, the crown of which had been broken off five years before. (Fig. 109.)

Fig. 109.



A Fibrous Tumour from the Lower Jaw, With the stump of a tooth in its centre.

I have related this case because the cause of the disease may be traced as closely to the stump as it is possible under the circumstances. I say as closely, for it is just possible that the tumour might have appeared if the stump had been absent. Yet, admitting the doubt, this is one of the most conclusive cases of tumour arising from a tooth I have ever met with. In a work recently published, an attempt is made to trace almost every disease of the jaw to bad and neglected teeth, coupled with an assertion that such cases may be cured by treatment addressed to the faulty teeth[a]. The cases on which the opinions are founded are not to my mind conclusive; indeed, it would rather seem that in many cases the teeth are injured by, instead of occasioning disease of the jaws.

Polypus, or fungus, of the gum.—This disease is essentially

[a] Keocker *on Diseases of the Jaws.* Edited by Dr. Mitchell.

hypertrophy of the gum, arising from mechanical irritation. If a tooth decays away on one side to below the level of the gum, and leaves a sharp margin in contact with the gum, a tumour frequently forms from the gum, spreads into, and partially fills up, the hole in the tooth, or the vacancy between the two decaying teeth. The tumour is usually composed of dense fibrous tissue, covered with epithelium; is almost insensible, unless ulcerated, when it becomes very painful. If the tumour be removed, it will grow again and again, except the bad tooth be removed, and then it will speedily disappear. These tumours show on section an undulating fibro-cellular tissue, covered by a thick layer of epithelium.

Caries sometimes attacks that surface of a tooth which lies in contact with a neighbouring tooth, in which case, before an instrument can be introduced to excise the softened dentine, a portion of the tooth must be cut away; and it is sometimes necessary, before the operation of plugging is completed, to cut away portions of the tooth as low down as where the gum becomes attached. This operation is sometimes followed by irritation and slight polypus of gum. The new growth is highly sensible to pressure, and, if food is forced by mastication on such a part, pain resembling toothache is felt. A small ulcer will sometimes form in this situation, and the pain simulate toothache so closely, that the patient desires that the tooth may be drawn; and I have seen teeth removed in such cases. The best application for the relief of this troublesome state of the gum is sulphate of copper applied every day or two. I have found a little powder, introduced on a quill and dropped on the part, to be the most convenient mode of application; the relief is often instantaneous. The remedy should be continued some little time after the gum has ceased to give trouble. Other escharotics would no doubt answer equally well. If a sharp edge of tooth, or of projecting stopping, produce the irritation, no local application will be useful until the source of mischief is removed by the file or by other means. A similar state of gum is sometimes produced by the presence of a jagged piece of tartar, in which case the disease subsides with the removal of the cause.

Vascular tumours of the gums.—The gums are occasionally the seat of vascular tumours closely resembling in physical characters ordinary nævus. I have met with two cases of this disease: one of these I will describe. A female patient, of about 25 years of age, stated that some time past she observed a small red pimple between the front teeth of the upper jaw, which bled every time she cleaned her teeth; that it gradually grew and spread on the surface of the gum, both in front and behind the teeth, and that with its increase of bulk the front teeth had separated and loosened; and that at times she suffered a good deal of pain in and about the tumour, which had become tender on pressure and very liable to bleed.

When the patient first came to me, the central teeth were separated about the eighth of an inch, were loose, and very tender. The tumour occupied the interval, and reached half way down towards the edges, and had spread itself over the gum immediately in front of the teeth for about half an inch, and covered a similar space on the palate behind the teeth. It was of a bright scarlet colour, and soft in texture, and could by steady uniform pressure be deprived of colour, and reduced to the level of the surrounding gum, but immediately sprung up by refilling of the vessels, on the removal of the pressure. The pain in the tumour was very irregular, both in severity and continuance; some days she scarcely felt it, while on others she had few moments of ease: pressure, however, even with the tongue, was at all times attended with, and followed by, pain; the tendency to bleed, too, had been, and still was, a source of great alarm to the patient.

The patient was directed to apply tannin in powder to the surface of the diseased part every three hours. With this treatment the tumour gradually diminished in size, became less vascular, and finally altogether disappeared.

The second case was similar to the one narrated, and yielded to similar treatment.

I do not recollect to have seen a description of this disease; neither have I seen any other cases than the two now mentioned.

Blue gum.—Dr. Watson, in his lectures, when treating on colica pictonum, says—"Very recently a most curious symptom, pathognomonic, I believe, of the presence of lead in the system, has been pointed out by Dr. Burton; and, now that it has been pointed out, one can hardly understand how it escaped us so long. It is a blue or purplish line running along the edges of the gums just where they meet the teeth."[a] A paper on this subject, by Dr. Burton, was read at the Medical and Surgical Society, in January 1840.

It is not my purpose to say any thing on the general effects of lead on the system; but I shall take this opportunity of relating to you a few observations on blue gum induced by lead, and the conditions necessary to its production. My position at the hospital has enabled me to make many inquiries into this curious phenomenon, which would naturally escape the observation of those, whose vocation does not lead them to inspect, in large numbers, the teeth and gums of healthy subjects.

It has been observed that the presence of teeth is necessary to the colouring of the gum. This is not all, however: the necks of the teeth must be encrusted with tartar, otherwise the edge of the gums will not receive the blue tinge: in fact, the teeth are necessary only as affording lodgment for the tartar. I conceive, that, if tartar were held in constant contact with the edge of the gums by any other means than its lodgment on teeth, the gums would be equally tinged. I have frequently seen the gums about teeth encrusted with tartar very blue, and in the same mouth the gums about teeth free from tartar, perfectly natural in colour.

The colouring of the gum may be the sole indication of lead in the system. I not unfrequently find among my patients those whose gums are blue, but who declare that they have

[a] DR. WATSON'S *Lectures on the Practice of Physic.*

never suffered from colic or any other effect of lead; and, indeed, a few of these say they have not, to the best of their knowledge, been exposed to lead.

A short time since, a gentleman applied to me to remove a troublesome tooth. I found the necks of the teeth encrusted with tartar, and the edges of the gums intensely blue. He stated, on inquiry, that he had just returned from China, and that during the voyage he had been salivated for syphilis, but that he had not, so far as he knew, been exposed to the action of lead, either by inhalation or any other mode.

The continuance of tartar on the teeth is necessary to the continuance of blue gum. If the whole of the tartar be removed from the neck of the tooth, the blue tinge on the gum will gradually fade, while its intensity will be preserved about the teeth on which the tartar is allowed to remain. I cannot tell you how long it will be before the colour will be wholly gone, when the tooth is allowed to remain, because the tartar may reaccumulate, and thus defeat an experiment instituted to ascertain that point. When the tooth is removed, however, the blue stain disappears in two or three weeks, as the following case would indicate:—I was called to remove an aching tooth for a lady who had taken two or three doses of acetate of lead for the suppression of uterine hæmorrhage. The gums exhibited the characteristic blue line. Nine days after the extraction of the tooth, the gums had come together, and the union was marked by a transverse blue line. At the expiration of three weeks the blue line had wholly disappeared.

In another well-marked case of blue gum the patient had nothing to do with lead in any way, and had not been in the neighbourhood of recently applied paint; but he was employed silvering mirrors, in which mercury and tin are the metals used.

These are not solitary instances in which I have found strongly marked blue gum, and yet no other indication of the presence of lead in the system, or of the exposure of the patient to the action of lead. Hence I am forced to suspect that other metals may produce a similar discolouration of the gum. Should future investigation prove this suspicion to be well founded, the diagnostic value of this state of gum in relation to lead will be diminished.

In endeavouring to trace by what process the gums are stained blue, it must be borne in mind that the tartar itself is often similarly discoloured, especially where it is in contact with the gum. The colouring material is probably sulphuret of lead, or a similar salt of some other metal. Tartar, being very porous, admits into its substance fluids charged with animal matter, which may there be decomposed, and furnish sulphuretted hydrogen, as a product of decomposition. Supposing a salt of lead to be present in the tissues of an adjoining part, a sulphuret of lead would be formed, which would give the colour in question to the tissue in which the formation took place. This action would be continuous so long as the metal remained in the system, and the tartar remained to afford a site for decomposition, and to hold the products against the gum.

The saliva itself contains sulphocyanic acid, and from this source sulphur might also be furnished.

Traces of lead may be found in the tartar of those affected by that metal.

Tartar a salivary calculus.—The saliva, together with oral and pulmonary mucus, holds in solution various salts, which are precipitated in a greater or less quantity on natural or artificial teeth in those situations where the solvent fluids remain at rest. Epithelial scales, and other extraneous matters, that may be floating in the oral fluids, or are entangled between the teeth, become impacted in the precipitated salts, and thus contribute to form the concretion usually called *tartar*. And, in in addition to these, infusorial animalcules are said to be met with in recent tartar, and their remains in that which has been dried.

Simon says, "Tartar on the human teeth consists of earthy phosphates, epithelium-scales, a little ptyalin, and fat; and when examined under the microscope there are seen abundance of pavement epithelium and mucus-corpuscles: and, in addition to these, numerous long acicular bodies and infusoria of the genera vibrio and monas."

According to Berzelius, tartar is composed of—

Earthy phosphates	79.0
Salivary mucus	12.5
Ptyalin	1.0
Animal matter soluble in hydrochloric acid	7.5[a]

Dr. Wright gives the following as the constituents of healthy saliva:—

Water	988.1
Ptyalin	1.8
Fatty acid	.5
Chlorides of sodium and potassium	1.4
Albumen with soda	.9
Phosphate of lime	.6
Albuminate of soda	.8
Lactates of potash and soda	.7
Sulphocyanide of potassium	.9
Soda	.5
Mucus with ptyalin	2.6

Berzelius gives the following as the constituents of nasal mucus, to which the bronchial mucus is very similar:—

Water	933.7
Mucin	53.3
Alcohol-extract and alkaline lactates	3.0
Chlorides of sodium and potassium	5.6
Water-extract, with traces of albumen and phosphates	3.5
Soda combined with mucus	3.9

Tartar has been described by dentists as of several different kinds, and named from the variations of colour and density it presents. Thus, one sort is called black, another green, a third yellow tartar. The division is not, however, so far as I know, based upon any chemical difference, and may therefore be disregarded. I conceive that in most instances

[a] Simon's *Animal Chemistry*, translated by Dr. Day.

these physical variations are traceable to the time occupied in the formation, or to the habits of the individual.

Thus, when the tartar collects quickly, it is usually soft and yellow; and, on the other hand, when the process is slow, it is dark and hard. Then, again, in those who smoke much, the tartar is of a deep brown or black colour. In teeth where one fang has been necrosid, and stripped of periosteum, the surface of the dead fang is often studded with modules of very hard greenish tartar. This tartar, during the time of its deposition, has been bathed in pus secreted from the lining membrane of the socket. The tartar is not an active corrosive agent, producing the destruction of the fang, as some dentists have supposed, but is consequent on its death and denudation.

We commonly find the concretion the most abundant about the posterior surfaces of the front teeth of the lower jaw, or about the buccal surface of the molars of the upper jaw, if from any cause those teeth are not used in mastication.

If a vertical section of a piece of tartar, carefully removed, be made, it will be found to present an inclined plane, the base of which lies in contact with the gum. The surface towards the tongue, or cheek, is usually smooth, but that against the gum is rough; and it is to the latter additions are mostly made. The gums become irritated and inflamed from the contact of the rough surface of the tartar; the alveoli become absorbed, and the gum recedes, making way for the further accumulation of the salivary salts. To the dental tissues themselves the tartar does no direct injury, but its effect upon the gums and alveoli is destructive, and hence indirectly upon the teeth by depriving them of their sockets.

Careful daily brushing will do much to prevent the accumulation of tartar on the teeth, but should it accumulate it must be removed from time to time by instruments fitted for the purpose.

Tooth powder that will dissolve the tartar will also dissolve the teeth, and therefore may not be used.

Diseases of the antrum I have no practical acquaintance with. I have now been a constant attendant at the Middlesex Hospital for more than twelve years, where upwards of ten thousand patients are seen annually; and out of this number I have not seen a single case of disease of the antrum, and have heard only of one. However, this disease is occasionally met with, and is sometimes produced by diseased teeth. Inflammation of the dental periosteum of the molars of the upper jaw is communicated to the lining membrane of the antrum, and that cavity becomes filled with pus. The natural opening is obliterated or closed by the disease, and hence the pus, by accumulating, distends the bony walls of the antrum.

The remedy consists in removing the diseased fangs, and perforating the antrum with a trocar through the socket of the second bicuspid, or the first molar. By this means a ready passage is given to the pus. I believe it is often necessary to inject stimulating fluids into the antrum through the aperture; for the lining membrane, when once diseased, is a long time in returning to a healthy condition, if left tŏ itself. For a further account of this disease, I must refer you to your surgical lectures, and to surgical works.

LECTURE XV.

OPERATIONS ON THE TEETH. — SCALING THE TEETH. — PIVOTING OR GRAFTING TEETH.—PLUGGING OR STOPPING TEETH.—ON THE EXTRACTION OF TEETH. — GENERAL RULES TO BE OBSERVED. — ON EXTRACTING INCISORS, CANINES, BICUSPIDES, AND MOLARS.—THE EXTRACTION OF STUMPS. — THE INDUCEMENT OF ANÆSTHESIA PREPARATORY TO EXTRACTING TEETH.

Operations on the teeth.—We have now arrived at the third division of our subject, namely, to *Operative Dentistry*. I have in previous lectures told you when operations should be had recourse to; I must now tell you how these operations are to be performed. The subject being altogether mechanical, I can only direct you how to proceed, and what, with our present knowledge, constitutes success. I cannot give you dexterity; the attainment of that will depend on your own perseverance and manual aptitude.

Scaling.—This operation consists in removing the tartar from the teeth, and is performed by the help of small steel instruments, of various forms, suitable to the parts upon which they are intended to operate. The instrument-makers will furnish you with a great variety of patterns from which to choose: those on the table are the ones I make use of. The point of the instrument should be inserted under the base of the tartar, and by pressing it towards, and a little outwards from, the crown of the tooth, detach the tartar in a mass. Having broken away the bulk of the tartar, each tooth must be freed from the smaller adherent particles, by carefully scraping its surface with the edge of the scaler. The intervals between the teeth must be treated in a similar manner, till every tooth is completely freed from the concretion. The teeth may then be well rubbed with a piece of cane, or a brush, or a piece of soft wood, loaded with fine pumice powder, or powdered turkey-stone, and after this again with a little precipitated chalk. By these latter processes the surfaces of the teeth are well polished, whereby their appearance is much improved, and their liability to become again encrusted diminished.

The patient should be directed to well brush the teeth, night and morning, with precipitated chalk, flavoured to the taste of the user. Should the saliva be acid (you will learn this by the use of test-paper), then the dentifrice should contain a portion of carbonate of soda: ℥vij. of chalk, and ʒj. of carbonate of soda form a good alkaline powder.

If the teeth are discoloured, patients will often ask you to restore them to their original whiteness. This cannot be done. Acids will for a time improve their appearance, by dissolving the outer surface of the enamel, and thus exposing a new surface, but they soon again become discoloured, and decay. Nothing can be more mischievous to teeth than the use of acid tooth powders, neither should any but an impalpable powder be used, otherwise the teeth would be worn into deep grooves, and be ultimately destroyed.

Areca nut charcoal has the effect of making the teeth look very white, and its use need not be objected to, because it is free from silex; charcoal made from wood should be forbidden, for it contains silex, and will wear the teeth.

In choosing a dentifrice, your first care must be to ascertain whether or no the saliva is acid, and is acting upon any of the teeth. And this point must determine whether the polishing powder shall contain a soluble carbonate or not.

Several years since, a notice appeared in the "Medical Gazette," stating that sugar acted directly on the teeth. I put some teeth into sugar and water, and into honey, but at the end of six months I could not find that they were at all affected. Latterly much has been said against camphor as destructive to the teeth, though, as far as I know, with insufficient reason.

Plugging or stopping teeth.—A well-stopped tooth, if the operation has not been too long postponed, is perfectly restored to its former durability and usefulness. I removed last year, from an old man, a molar tooth that had been plugged for thirty years, and had been serviceable till within the last two years, when it became loose from absorption of the socket. You will often see teeth that have been stopped ten and twenty years.

Seeing, then, that so much may be gained in preserving the teeth, by this operation, you cannot give too much attention to its practice; for, while it is among the most useful, it is the most difficult operation the dentist has to perform. The operation is divided into two parts; the preparation of the cavity for the reception of the plug, and the insertion of the plug. In the preparation of the cavity two points must be gained, otherwise the subsequent steps of the operation will be ineffective.

The first of these is, to completely remove all the softened dentine; the second, to get a firm and regular orifice, of sufficient size to enable the plug to be inserted, and at the same time not too large. If the cavity in the tooth be large and the opening small, it will be almost impossible to make the plug solid in those parts of the cavity which are overhung; and, on the other hand, if the opening be large, and the cavity small and rounded at the bottom, like a saucer, the plug will not be retained. The best form of cavity has a circular orifice, with perpendicular walls; in fact, cylindrical.

The situation of the disease must regulate our manner of proceeding. If the cavity be situated in the opposed side of a molar, the tooth must be cut away with a sculper or graver, till an excavating instrument can be used. If the sides of the front teeth are affected, a piece of vulcanized caoutchouc should be strained tight, and then introduced between the teeth; this, in endeavouring to regain its former figure, will separate the teeth sufficiently for the operator. When the masticating surface of a tooth is carious, there is no difficulty in the operation; if the extent of the disease be slight, it may be removed by a broach of proper size. Having reduced the cavity, as nearly as attainable to the conditions I have described, the chips must be washed out, and the cavity wiped dry with cotton-wool, and the plug inserted.

In making the plug, our aim must be, first, to so perfectly fill the cavity that all moisture shall be excluded; and, secondly, to so form it that it shall be sufficiently hard to resist, equally with the tooth, the wear of mastication. Unless these two conditions are fulfilled, our work will be imperfect, and ultimately fail.

Gold or tin foil are the best materials for making plugs. Whichever of these be chosen, the method of use is the same.

There are four methods of introducing foil for making a plug. In one the metal is folded into narrow strips, proportioned in width and thickness to the size of the cavity. One end of the strip is, by means of a conveniently shaped stopping instrument, pressed to the bottom of the cavity. The strip is then bent, and a fold passed to the bottom of the hole, leaving the first fold projecting above the surface. Fold after fold is introduced, till the cavity is tolerably full. A wedge-shaped instrument is then introduced, and the gold pressed towards the walls of the cavity; more gold is, by a similar process, pressed into the cavity so obtained. This process is repeated till the wedge cannot be forced into the plug. A flattened instrument is then used to compress the gold in the cavity. When we can make no further effect on the surface of the plug by compression, the surface is filed smooth and burnished. By a careful adherence to this plan, we make a plug composed of layers of metal, arranged parallel to the walls of the cavity, and therefore not liable to fall to pieces or come out. But, on the other hand, had we made the folds at a right angle to the walls, and parallel to the bottom of the cavity, layer after layer would have peeled off, till little or none of the plug remained, and the decay would have proceeded to the destruction of the tooth.

In the second method, a piece of foil of sufficient size is rolled hard, and spherical between the thumb and finger. This is gradually forced into the cavity, care being taken to get it well in round the outer walls. When the plug has been rendered as solid as possible, the superfluous portion is cut or filed off, and the surface burnished.

The third method of using metallic foil is a combination of the two preceding ones. A piece of foil that will readily go into the cavity is rolled up loosely. When in its place, a wedged-shaped instrument is passed into its centre, which has the effect of spreading the gold towards the walls of the cavity. The centre is gradually filled with folds of gold in the manner I have described. The wedge is used again and again, till it can no longer be made to enter. The gold is then compressed on the surface, and the superfluous portions removed, and the surface burnished. When the plug is finished in either of the manners I have described, the circumference should be examined by a sharp steel probe. If this can be made to enter at any part, the hole so made should be enlarged by thrusting in an instrument as large as can be introduced, and the hole filled.

In the fourth method of plugging, the foil is rolled into short lengths, proportioned to the depth of the cavity to be plugged. These, with the assistance of a fine pair of forceps, are packed into the tooth, much in the manner you would proceed to pack cigars into a tumbler. A wedge-shaped tool is from time to time thrust between the lengths of the foil, to force them towards the walls of the cavity. When the tool can no longer be made to enter, the surface of the plug is cut level with the surface of the tooth, and burnished.

Either of the foregoing methods of plugging will answer, if well done. But, of these, I prefer introducing the metal in folds. The situation of the cavity, and also the size, will have something to do with the selection of the plan of operating. Then, again, one person will be more apt at one manner of procedure than at another. All these matters of detail must be learned in practice. I should exhaust your patience, and greatly exceed my limits, were I to attempt to describe every variety in form and situation of cavity, and every modification and plan useful in plugging.

Where the cavity of a tooth is so large that the walls are too thin to bear the pressure necessary to the insertion of a gold or tin-foil plug, the amalgam of silver or of palladium may be advantageously used. Having prepared the cavity as for the use of foil, a little mercury is triturated in a glass mortar with a small quantity of precipitated silver or palladium, till they unite and form a paste, which is well squeezed in a piece of wash leather, to force out as much as possible of the mercury. The paste is then again rubbed in the mortar, or in the palm of the hand, and then introduced into the cavity. The cavity, however, must be first well dried with lint, and care must be taken to get the amalgam in close contact with the whole circumference of the cavity. The plug so formed hardens in a few hours, after which the surface should be well burnished.

The American dentists condemn this kind of plug, as it seems to me, somewhat unjustly. It is undoubtedly far inferior to either the gold or tin-foil plug, but it can be used where they cannot, and it is surely better than none. I have seen a mere shell of a tooth, that would have broken away on the first attempt at introducing foil, rendered useful for years by an amalgam plug.

Before leaving the subject, let me warn you that unless the cavity be well prepared by the total removal of the softened dentine from the walls, and by getting a good, firm, and well-shaped orifice, free from acute angles, no plug will answer, and least of all the amalgam. It will fall out or become loose within twelve or eighteen months, and frequently in much less time, and decay will proceed. Teeth plugged with silver amalgam usually become stained of a deep blue-black colour. When the palladium amalgam is used, there is little or no staining, if the excavating be perfect. The latter amalgam is, therefore, preferable.

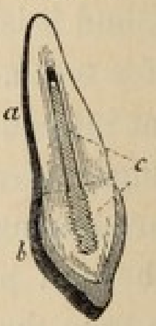
The operation of pivoting or grafting.—When the crown of a single-fanged tooth has so far decayed that it cannot be plugged, and yet the root remains sound, a new crown may be fastened into the root, by means of a piece of gold wire, called a pivot: hence the name pivoting. (Fig. 110, c.)

The operation is commenced by sawing or cutting off the crown of the faulty tooth. The pulp is then destroyed by passing up the cavity of the tooth a fine broach, and giving it a turn or two, by which the pulp is torn across near the extremity of the fang. The surface is then filed, with a half-round file, even with the edge of the gum, and the pulp-cavity is enlarged and made cylindrical by a drill or broach, similar in size to the wire we propose using for the pivot.

We must now select a tooth, whether mineral or natural, corresponding in size, shape, and colour, to the one lost, and from this the root must be removed, and the crown fitted accurately, by filing, to the surface of the fang to which it is to be attached.

A hole must now be drilled into the fitted crown, (Fig. 110, *b*,) and a screw cut in it; a screw must also be cut upon the wire, which must be screwed into the crown, and a sufficient length left projecting from the crown to occupy the hole drilled in the fang. The projecting part of the pivot is rendered a little rough, to retain a very thin coating of floss silk. In this condition it is passed into the fang, and, if the adjustment has been carefully performed, the new crown will fit so accurately to the fang, that the artifice cannot be detected. (Fig. 110.)

Fig. 110.



A Pivoted Tooth.

a. The fang.
b. The new crown filled and pivoted to the fang.
c. The pivot screwed into the crown, and fitted into the fang of the tooth.

The Americans sometimes use compressed wood instead of gold wire for the pivot. You will sometimes find it very convenient to adopt this plan in renewing a pivot, or when the hole in the stump is necessarily rather large.

Pivoting, though the neatest, is more frequently followed by mischievous results than any other operation performed by the dentist; and so common are these, that many surgeons consider the operation unjustifiable. Some degree of pain and tenderness is almost always felt during the first few days after the operation, and unfortunately it is not uncommon to have considerable inflammation, ending in suppuration, as in the case I cited to you in Lecture XIII. But the consequences may be even worse than in that case.

The following statement was placed in my hands by a medical man who had some knowledge of the case which is related. —— ——, Esq., aged 25 years, tall and thin, but apparently in very good health. On his marriage trip he visited Paris, and there had the misfortune to break off a front tooth. Wishing to conceal the accident from his wife, he went immediately to a dentist. The tooth was pivoted (and I have no doubt carefully, for the dentist was one with a great and just reputation), and the necessary concealment seemed insured. From the time of the operation, however, he had severe pain in the stump, which pain increased for four or five days, when he left Paris for Rouen. Upon arriving there the pain had become excessively severe; he consulted a medical man, but it was too late. Trismus came on within twenty-four hours, and was soon followed by tetanus and death.

On the extraction of teeth.—This is not the first time I have treated on the extraction of teeth. In 1841[a] I described and figured, with some pleasure, what I believed to be new and much improved forms of tooth-forceps, as possessing great advantages over the key instrument, then almost universally used. Now, after the lapse of seven years, I am again on the same subject, and I shall proceed with increased pleasure; for during the interval the instruments in question have come into general use. To borrow an instrument-maker's phrase, "no other tooth instruments will sell now;" whereas, previous to the date of my paper, they had no such instruments to offer for sale.

Nay, in further testimony of the value of the improved forceps, a member of my own profession, after ordering a set of my instrument-maker, found them, on trial, so serviceable, that he was induced to write a little work minutely describing them, and strongly recommending their general adoption, to the exclusion of the instruments then in use[b]; though, for the

[a] *Medical Gazette*, June 4th, 1841.

[b] *Observations on the Extraction of Teeth.* By T. Chitty Clendon, 1843.

honour and good name of our profession, I regret to say he altogether neglected to acknowledge by whom the instruments of which he had availed himself, and was describing, were designed and brought to their present state of utility, and published. Indeed, so anxious has this author been to take to himself whatever credit there may be in the improvements, that he has allowed or induced many makers to stamp his name on each instrument[a].

It is enough, however, that our means of operating have been improved, and that this improvement, whereby suffering is diminished, has been generally adopted. It matters not to the patient who invented or improved, or gave to the profession the instrument with which the tooth is removed, so long as that instrument is of the best kind, and skilfully used.

A few dentists have for many years been in the habit of purchasing their tooth-instruments in the rough, and filing them up into whatever shape they deemed best, but what this shape was, or is, remained a secret. Indeed, those who purchased finished instruments very commonly ordered the maker not to make known any of the particulars of their construction. This time of professional secrecy has passed, or is fast passing away, much to the credit of our profession, and to the advantage of the public.

I shall not have space to give you a history of tooth-drawing, and of the various instruments at different times in use, but must content myself with describing, as briefly as possible, the means and methods of operating we now employ.

In extracting a tooth, the following conditions should be fulfilled:—First, the whole of the offending organ should be removed.

Secondly, It should be removed with as little injury as possible to the structures in which it is implanted.

Thirdly, The patient should be spared all unnecessary pain in the operation.

That method by which a tooth, or the remains of one, can be

[a] The testimony on which this is grounded will be found in the Appendix.

removed most certainly, quickly, and at the same time with the least amount of injury to the adjoining parts, will also remove it with the least pain; the suffering being in most cases proportioned to the duration of the operation.

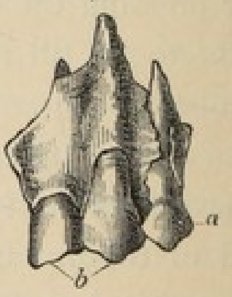
To fulfil these indications, recourse must be had to an instrument so formed that it shall grasp the tooth alone, and, by the required force applied nearly in the axis of the tooth, remove it. Such instruments are forceps; but forceps so constructed that they shall accurately fit the tooth to be extracted, and so fashioned at the jaws, nibs, or blades, that they shall readily separate the gum from the neck of the tooth, to which point they shall arrive by simply placing the extremities of the jaws at the edge of the gum, closing the handles, and at the same time pressing the instrument firmly and steadily in the direction of the tooth, till it comes in contact with the free edge of the alveolar process.

As the teeth are variously shaped, so will it be necessary to have forceps of different forms; in fact, a pair fitted to each kind of tooth. By forceps so constructed most teeth may be removed in less time than by any other tooth-extracting instrument at present in use; also with less pain to the patient, and without inflicting any farther injury to the gums and alveolar processes, than must necessarily result from the forcible separation of a tooth from its natural attachments.

An instrument which in its employment requires that force should be applied to the contiguous parts as well as to the tooth to be extracted, is imperfectly adapted for the required purpose; or an instrument which, by its form and mode of application, requires that greater force should be used than would be necessary for the dislodgment of the tooth, supposing that force to be applied in the most advantageous direction, is also an imperfect instrument, and but ill fitted for the purpose for which it was designed. Such, however, are the imperfections of an instrument till recently in very general use for the extraction of teeth—the "key;" in the application of which the fulcrum is rested on the alveolar process, between which and the fulcrum the interposed gum is subjected to considerable pressure: just as much, indeed, as may be necessary for the dislocation of the tooth. By this treatment the gum is often considerably bruised, sometimes so much so as to lead to suppuration of the injured part, and always to an unpleasant degree of soreness. The force used in extracting a tooth with the key must be much greater than the actual force required to effect the operation, because the power is applied solely in a lateral direction—a direction in which the tooth offers great resistance, especially in molares of the lower jaw, where the lateral alveoli are strong, and composed of dense bone.

There are several specimens on the table of two and three teeth, with their alveoli, torn away from the jaw, in attempting to extract a single tooth with the key. These accidents could not have occurred had forceps been used. (Fig. 111.)

Fig. 111.



The Lateral Incisor and Canine b, and the first Bicuspid a, with their Alveoli, from the left side of the Upper Jaw;

Torn away in one mass in attempting to extract the bicuspid *a* with the *key*.

I am quite aware that there are many and eminent dentists who use and speak very highly of the "key" instrument; and no doubt it is very much to be preferred to the forceps which were ordinarily kept by surgical instrument makers: forceps applicable to no one tooth in particular, when applied touch only at two or three points, and are quite incapable of being passed down to the neck of the tooth, unless the gum be previously cut away, and even then very imperfectly.

Dr. Flagg, of Boston, has contrived forceps for the extraction of every kind of tooth. I have not been able to obtain a view of any of his instruments, but, from the description and plates given of them in Fitche's "System of Dental Surgery," I believe they are unlike those on the table.

A work entitled "Operations on the Teeth," by Mr. Snell, contains a description, with plates, of a form of forceps used by the author for the extraction of the molares. The principal aim of the inventor was to have two points of metal coming out from the edge of each jaw of the instrument; the object of these points being to be passed between the fangs of the teeth. These forceps admit of but very limited use, as the fangs of the molars, especially the second and third, are likely to be agglutinated; which condition, in each particular instance, is known only after the tooth has been extracted. But, besides this, it is a matter of some difficulty, in any case, to get these two points between the fangs; and unnecessary pain is thereby inflicted, supposing the tooth could have been removed without this violence.

In those instruments a point was made to project from the middle of the edge of the jaws, which, on grasping the tooth, should pass under the body of the crown and between the fangs. The forceps were unfitted for, and did not come into, general use on two grounds:—1st. The fangs of the second and third molars are often united, in which case the point or points would be worse than useless; and we cannot know for certain the state of the fangs till the tooth has been removed. 2nd. The insertion of the points is always attended with greater pain than results from seizing a tooth with adjusted forceps; and, excepting some cases which I shall afterwards describe, is attended with no compensating advantage.

All forceps whatever should embrace the tooth they are used to extract at its neck; the neck being situated between the termination of the enamel and the free edge of the alveoli, and covered by gum. In order to arrive at this part of the tooth without difficulty, or unnecessary pain to the patient, the jaws must present an inclined plane, terminating in an edge. The external surface of the jaws of forceps, when closed, should present something like a cone, or parts of several cones, with the apex or apices cut off; and a perpendicular section should present an inclined plane, terminating in an edge, and more or less curved, as may be suitable to the particular instrument. The length from the joint to the edge of the jaws should on no account be greater than will be necessary to allow sufficient space for the reception of the crown and neck of the tooth, so that no strength may be lost.

An average tooth should be selected and given to the forceps-maker, and he should be instructed to make the jaws fit the neck of the tooth exactly, leaving sufficient room for the crown of the tooth to be free from pressure, but not more than will be necessary to clear the enamel.

The fangs of all teeth having a general conical form, forceps, when well made and applied, should be but as a lengthening of the cone towards its base. For removing teeth which are not decayed down to the gums, the ends of the jaws should be square or slightly rounded; but when nothing but the fang remains of a tooth, rounded ends are the more convenient, as with that shape they are readily introduced between the fang and inclosing alveolus. Instruments for extracting stumps should be made altogether lighter, the jaws thin and sharp at their edges, so that they may be made to cut rather than tear the membrane connecting the fang with the adjoining tissues. (Fig. 127.) But I shall say more on the extraction of stumps presently.

Forceps should be constructed and used upon the principle of lengthening the tooth for the extraction of which they are intended: thus enabling the operator to move it from side to side, or to rotate it if the fang be single, and of a shape admitting of such motion.

After these lateral movements for destroying the membranous union have been effected, the tooth may, unless the fangs have some peculiar position or shape, be raised in a perpendicular direction, leaving as little injury from its removal as the operation can admit.

When forceps are used for the extraction of teeth, the operation is divided into three stages:—1st. The seizure of the tooth; 2nd. The destruction of its membranous connection with the socket; 3rd. The removal of the tooth from the socket. When you commence operating, it will be of great service to you, and advantage to those operated on, that you should pay strict attention to these stages, and that each should be well and efficiently executed before you proceed to its successor; for, should the tooth be unskilfully seized, the crown will be broken off in the attempt to detach the tooth from the periosteum of the socket, until which is effected, the fangs cannot be removed from their bony cells. You will find that a tooth will resist a great force applied in a line with its axis, or, in other words, if you attempt to pull a tooth straight from its socket.

In seizing a tooth, the jaws should be closed lightly on the tooth, and inserted under the free edge of the gum, and then *forcibly* driven down to the edge of the alveoli, or even a short distance into them. I say forcibly, because all beginners, and even some practised in the use of forceps, are liable to failure because they do not use sufficient force: they seize the tooth at the edge of the gum, instead of at the edge of the alveolus.

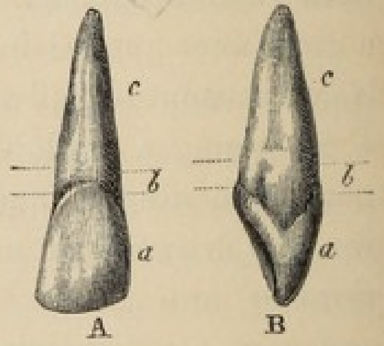
I wish to impress upon you the absolute necessity of laying hold of the tooth as far down towards the fangs as you can possibly get the instrument. An old and successful operator, when instructing another in the use of forceps, said—"Push the jaws of your forceps into the sockets as though you intended they should come out at the top of the head, or under the chin."

The manner of effecting the second stage will depend on the shape of the tooth to be removed; as will also the third, and to this we will now address ourselves. But different shaped teeth require forceps shaped to them. It will be necessary, therefore, to describe partially the teeth, and then the forceps individually, that the peculiar shape of each instrument may be understood. Before doing so, however, I should state that it is quite impossible for any person to extract teeth properly, whatever instrument may be used, especially if the forceps be chosen, unless the operator is perfectly acquainted with the form of each tooth, with the relative position and size of the fangs, with their direction in the alveoli, with the general form of the alveoli themselves, and with the directions in which they offer the greatest and the least resistance.

We will now consider how the operation of extraction is to be performed on the different teeth; and we will first take the incisors, canines, and bicuspid teeth, and afterwards the molares.

A section through the neck of an incisor of the upper jaw will show that the anterior is larger, and forms part of a greater circle, than the posterior surface. Now the end to be attained in the application of forceps, is to apply them over as large a surface as possible, that the pressure may be diffused, and the chance of fracturing the tooth by the pressure of the instrument avoided. To extract these teeth, therefore, the jaw to be applied to the posterior surface must have a smaller curve than that for the anterior. When the forceps are closed upon the tooth, they should embrace not only the anterior and posterior surface, but a part of the lateral surface also. A cylindrical tube of thin metal, when pressed upon equally in every direction, will resist enormous force; but if the pressure be confined to one or two points, a comparatively trifling power will crush it: it is so with a tooth.

Fig. 112.

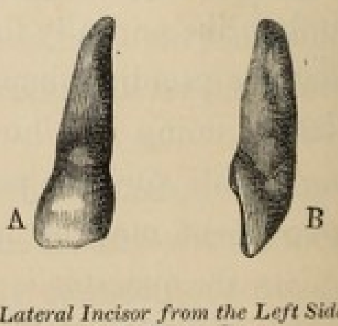


Central Incisor from the Left Side of the Upper Jaw.

A. A front view.
a. The posterior side lying against the lateral incisor, as distinguished from the anterior side, which lies against the fellow central tooth.
B. A side view.
a. The labial or front surface, as opposed to the lingual or back surface; the latter terminates in the basal ridge, which is intersected by the lower of the two dotted lines.
b. The neck.
c. The fang.

The lateral incisors require forceps made upon the same principles as the central teeth, but somewhat less in size. These are liable to greater variation in external dimensions than any other teeth. Sometimes they are very small indeed; at other times they are almost as large as the neighbouring teeth. It will be advantageous,

Fig. 113



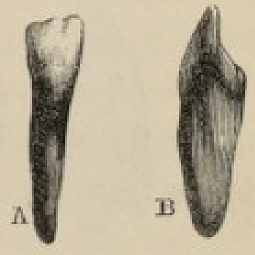
Lateral Incisor from the Left Side of the Upper Jaw.

A. Front view.
B. Side view.

therefore, to have different sizes of instruments from which to select.

The forceps having been well pushed up to the alveoli, and the tooth firmly grasped, attempt, by a firm and steady turn of the wrist, to twist the tooth in its socket, and, so soon as you feel it give, it may be drawn from its socket with little effort.

Fig. 114.

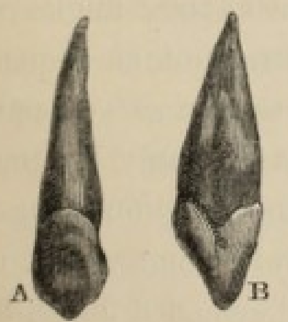


Central Incisor from the Right Side of the Lower Jaw.

A. Front view.
B. Side view.

The incisors of the lower are smaller than those of the upper maxilla, and much more compressed laterally. Forceps for the extraction of these teeth will require to have the jaw which is to be applied to the posterior smaller than that for the anterior surface of the neck. The jaws of the instrument should be straight; but it will be found convenient to have the handles curved, so as to avoid the upper maxilla when the mouth cannot be opened wide. When the tooth is grasped, it must be forced outwards, accompanied with the slightest possible degree of rotation, and, when it is felt to yield, drawn upwards.

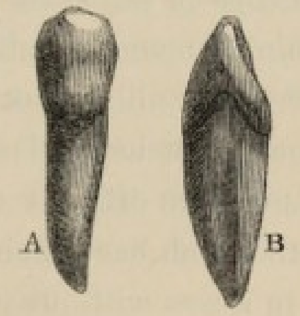
Fig. 115.



Canine from the Left Side of the Upper Jaw.

A. Front view.
B. Side view.

Fig. 116.

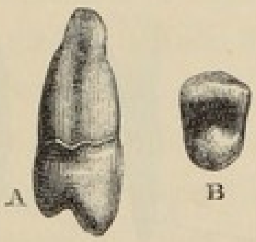


Canine from the Right Side of the Lower Jaw.

A. Front view.
B. Side view.

The cuspidati require for each a pair of forceps made upon the same plan as those for the removal of the incisors, except that they must be rather larger and stronger. Those for the cuspidati of the lower jaw should, like forceps for the incisors of the lower jaw, have the handles slightly bent. Sometimes these teeth are very small, in which case forceps adapted to the adjoining teeth may serve for their removal. The cuspidati, whether in the upper or the lower jaw, may be detached from their membranous connection with the jaw by a rotatory movement, and will then leave the socket readily.

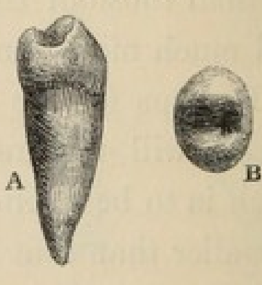
Fig. 117.



Bicuspid from the Upper Jaw.

A. Side view.
B. View of the masticating surface.

Fig. 118.



Bicuspid from the Lower Jaw.

A. Side view.
B. View of the masticating surface.

The bicuspides will be extracted with instruments similar to those already described, except that there will be a little difference in the jaws, which must be accurately fitted to the neck of the tooth. These teeth are not very frequently liable to much variety in size, so that an instrument which is well adapted to an ordinary bicuspis tooth will apply itself to almost all. I have forceps in which the jaws are bent at right angles with the handles, and open laterally, for the extraction of bicuspides of the inferior maxilla. But they do not answer so well as straight instruments, it being less convenient to apply the necessary force, and more difficult to regulate its direction. In extracting teeth which have their fangs laterally compressed, and are placed in a row with other teeth of like-shaped fangs, the only available movement will be at right angles with the row, and in the direction of the greatest diameter of the fangs. This may be obtained whether the forceps be straight or rectangular; but with an instrument of the latter shape the movement must be effected by rotation of the wrist, with a motion upwards. The centre of the rotatory movement will be either at the extremity of the jaws of the instrument, or else in a line with the handles of the instrument and wrist. Force applied in this manner would seem to be given at great disadvantage, and much expended on the alveolus; there inflicting injury, which, although in the vast majority of cases may not be complained of by the patient, yet will prevent the mouth from so speedily recovering from the operation.

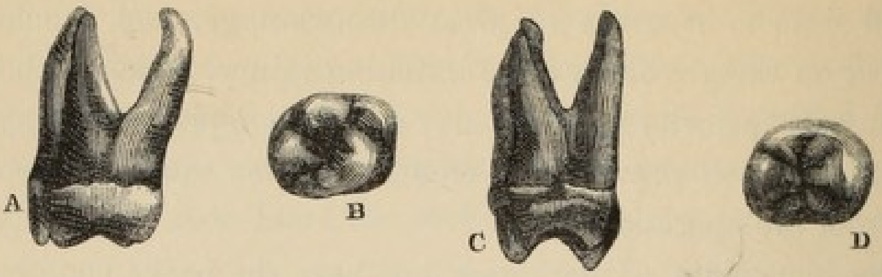
The bicuspides of the upper jaw have the necks compressed laterally. In removing them, whatever be the form of the instrument used, the force must be first applied in a direction outwards and at an angle to the dental arch. The tooth should be moved outwards and inwards, and then drawn downwards. But it must be borne in mind that, in forcing it outwards or inwards, we desire only to break its connections with the socket, and not to draw it out; and that, if the force be continued in this direction with the hope of removing the tooth, it will be broken off.

The bicuspides of the lower jaw have more conical fangs than those of the upper, and hence may be detached by rotation, and then lifted out of the socket.

When I say rotation, I do not mean that the tooth shall be twisted a half or even a quarter turn, but that it shall be twisted till the attachments are felt to give way. If more force is required to effect this than you deem judicious to employ, then the direction of the twisting may be changed, or the movement abandoned. There are some teeth that vary so much from the usual form of root that they cannot be turned in the socket. The degree of force that it is necessary to employ, in this and in all other cases of like operations, can be learned only in practice.

On extraction of the molares.—The molares of the superior maxilla have three fangs—two external, one internal. Of the two external fangs the anterior is the largest, and is placed in a plane external to the posterior fang, which is shorter as well as smaller. The third, the internal fang, is thicker and of greater length than either of the others, and is situated opposite to the posterior external fang, and to the space between that and the

Fig. 119.



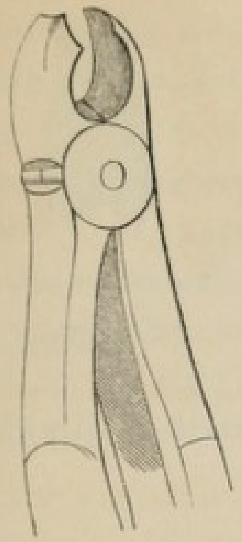
First and Second Molares from the Left Side of the Upper Jaw.

A. The first molar viewed from behind, showing the three fangs.
B. View of the masticating surface of the first molar, showing the four cusps.
C. The second molar.
D. The masticating surface of the second molar.

anterior external fang. The divergence of the fangs takes place at the point where the tooth becomes concealed in the alveolus, leaving the neck with a form such as would result from the agglutination of the fangs, having the described relative position. (Fig. 121.) At this point the forceps should be applied for the removal of the tooth. Instruments—for it will require two, one for each side, right and left—must be made upon the same general principles as those already described. The jaw for the external surface of the tooth must have two grooves—the anterior the larger, the posterior smaller, and upon a plane internal to the anterior groove. The jaw for the anterior surface must have but one groove, and that fitted to the base of the internal fang. (Fig. 120.) From the position of the molares of the superior maxillæ, the jaws of the instrument for their extraction must necessarily be bent at an angle with the handles. This angle should not be more than is absolutely necessary, for the more the instrument deviates from straightness, the greater is the difficulty of using it. The angle in my own instrument is not less than 135 degrees, and I think it would be better were it even larger. The handles should have a general curve in the opposite direction to the jaws.

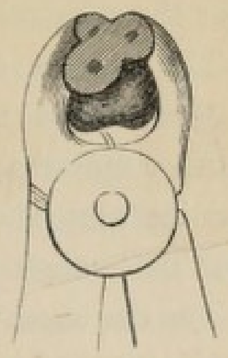
The molares of the superior maxilla have the two external fangs parallel to each other in their direction in the alveoli. The internal, which is not only the largest but the longest also, diverges from the two preceding fangs, and passes upwards and inwards towards the internal wall of the antrum, and is inclosed

Fig. 120.



Forceps for extracting the Upper Molar Teeth on the Right Side of the Jaw.

Fig. 121.



Similar Forceps,

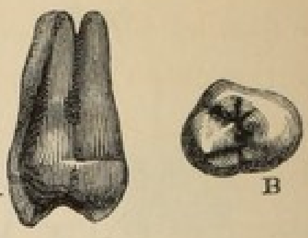
With the jaws embracing the neck of an upper molar, which has been cut through at that part to show the adjustment of the instrument.

in tolerably dense bone. The external alveoli are composed of thin and porous bone. In removing these teeth, then, the tooth being firmly grasped at its neck, the first motion should be slightly inwards, to disengage the fangs from the external alveoli. The force should then be directed downwards and outwards, in the direction of the internal fang. If these precautions be observed, no difficulty will be found in removing the superior molares. The first and second molares of the superior maxilla are so nearly alike in size and shape, that an instrument well fitted to one will serve equally well for the removal of the other.

The first molar, however, when left alone by the previous removal of the second molar and the second bicuspid, and the vacated alveoli have been filled with solid bone, offers great resistance to extraction, and is sometimes broken off in the attempt. Indeed, an isolated tooth surrounded by firm bone is always more difficult to extract, and requires more care, than one of a continuous row of teeth.

In the third molaris, or dens sapientia, of the upper jaw, though the fangs are often united into one conical mass, yet the shape of the neck of the tooth is so like that of the preceding teeth, that an instrument which is suited for the removal of the anterior molares is often quite well adapted for the removal of the wisdom teeth. The dentes sapientiæ are, however, sometimes much smaller than the other molares; in which case a smaller instrument might be required, but that, when of small size, they are for the most part removed by the application of so slight a force that any instrument which can apply itself at all will serve for their extraction.

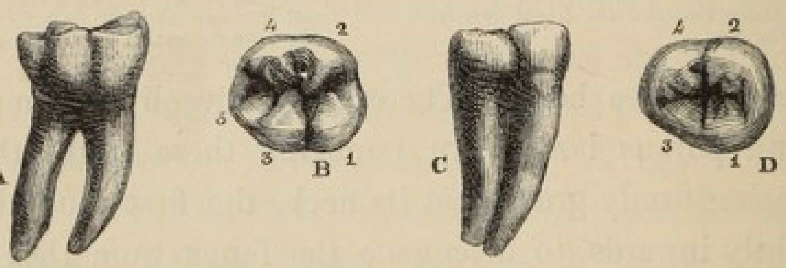
Fig. 122.



The Third Molar of the Upper Jaw.

A. Posterior view.
B. The masticating surface.

Fig. 123.

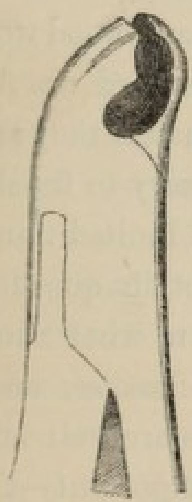


The First and Second Molares from the Right Side of the Lower Jaw.

A. The first molar seen from the outer or buccal side.
B. View of the masticating surface, with the five cusps indicated by figures.
C. A similar view of the second molar, with the fangs connate.
D. The masticating surface of the second molar, with the four cusps figured.

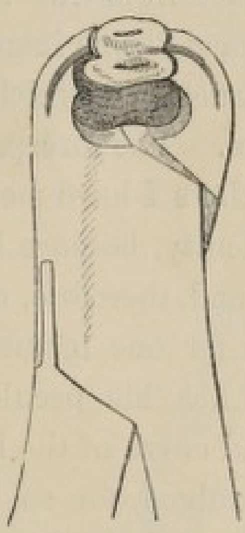
The molares of the inferior maxilla having two fangs, and these being situated, with respect to each other, directly anterior and posterior, give the neck of the tooth formed by their junction a central groove upon the external and internal surfaces; and, as these are the surfaces to be grasped by the forceps, the jaws of the instrument must have a corresponding form. Of the fangs, the anterior is in each direction the larger, being both broader and thicker than the posterior fang. These teeth stand rather obliquely, while the external lateral surface, being larger than the internal, gives a line passing through the centre of the neck of the tooth, from without inwards, a direction slightly backwards as well as inwards. From this conformation it becomes necessary to have forceps for each side, right and left. The jaw of the instrument to be applied to the inner side of the neck of the tooth must be rather posterior as well as smaller than that for the outer side, since the inner surface of the tooth is on a plane somewhat posterior to the outer surface. The jaws of the instrument must be bent at an angle of not less than 135 degrees. The handles straight, or nearly so. I saw a pair of forceps something upon this plan, except that one pair only was made, and that equally applicable for the extraction of molares of the lower jaw of either side; the grooves in the jaws being exactly opposite to each other, and of equal size. The jaws were also bent at a right angle with the handles.

Fig. 124.



Forceps for extracting the Molar Teeth of the Right Side of the Under Jaw.

Fig. 125.

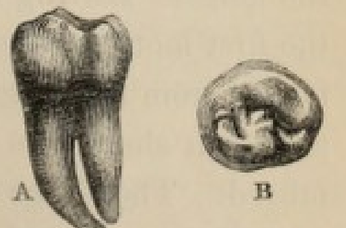


Similar Forceps,

In the grasp of which is a molar tooth cut off through the neck, to show the adaptation of the jaws of the instrument to the neck of the tooth.

The dentes sapientiæ of the inferior maxilla, if situated on a plane with the anterior molares, may be removed with the same instruments; for although the fangs are often united in a mass of conical shape, yet the grooves on the outer and inner surfaces are marked. These teeth are, however, not unfrequently situated in the angle formed by the junction of the lateral and ascending

Fig 126.



Third Molar from the Left Side of the Lower Jaw.

A. The side view.
B. The masticating surface.

rami of the jaw; in which case the forceps for their extraction should be shaped at the edge so as to fit into the so-formed angle, and made also with the jaw for the inner side of the tooth longer than that for the outer side, since, in such cases, the inner margins of the alveoli are on a lower level than the outer.

I should not neglect, however, to mention, that the handles of forceps may be made to hold various positions as regards the jaws of the instrument. Those given in the wood-cut will project from the anterior part of the mouth when the tooth is seized. But instruments may be had in which, when applied, the handles will project from the sides of the mouth. Mr. Evrard has recently made some instruments with these forms of handles, in the construction of which both ingenuity and good workmanship are shown. The forceps made by Mr. Evrard are far superior to any others I have met with; unfortunately they are obtained with difficulty, because he finds it necessary to finish each pair himself, and, therefore, can produce but a limited number. But to return for one moment to the subject in question. Every operator has his peculiar opinions as to what should be the shape and curve of the handles of tooth-forceps; and they may all be indulged, for so long as the jaws are well adjusted, the form of the handles is comparatively unimportant—they may be bent which way you will.

In removing molares of the lower jaw, the blades of the instrument should be carefully thrust down to the free edge of the alveoli, which part of the operation is easily effected, in consequence of the decreasing size of the teeth from the crown to the fangs. Having obtained firm hold of the neck of the tooth, the first motion should be inwards, by which the tooth is detached from the external plate of the alveoli: this being done, the tooth should be forced outwards and upwards, and so removed. The fangs of these teeth have, however, not unfrequently a curve backwards; if, therefore, a tooth of this kind offer considerable resistance when its extraction is attempted, the movement, after the tooth has been forced laterally, should not be perpendicular, but in a curved direction, similar to the inclination of the fangs.

Hitherto I have assumed that a considerable portion of the crown has remained, and that the tooth, therefore, could be readily grasped at its neck. But it often happens that the tooth has decayed away, or has been broken off even with, or below, the edge of the gum, in which case the instruments I have at present brought to your notice are inapplicable. We must use stump-forceps, or the elevator, to effect the removal of such teeth. There are three forms of stumps, single, double, and triple. Single-fanged teeth necessarily have only a single stump, but the molar teeth may have their fangs united by the neck. If the neck be destroyed, then the fangs will remain as so many single stumps. For the extraction of single stumps we require one kind of instrument, for double another, and for triple-fanged stumps a third.

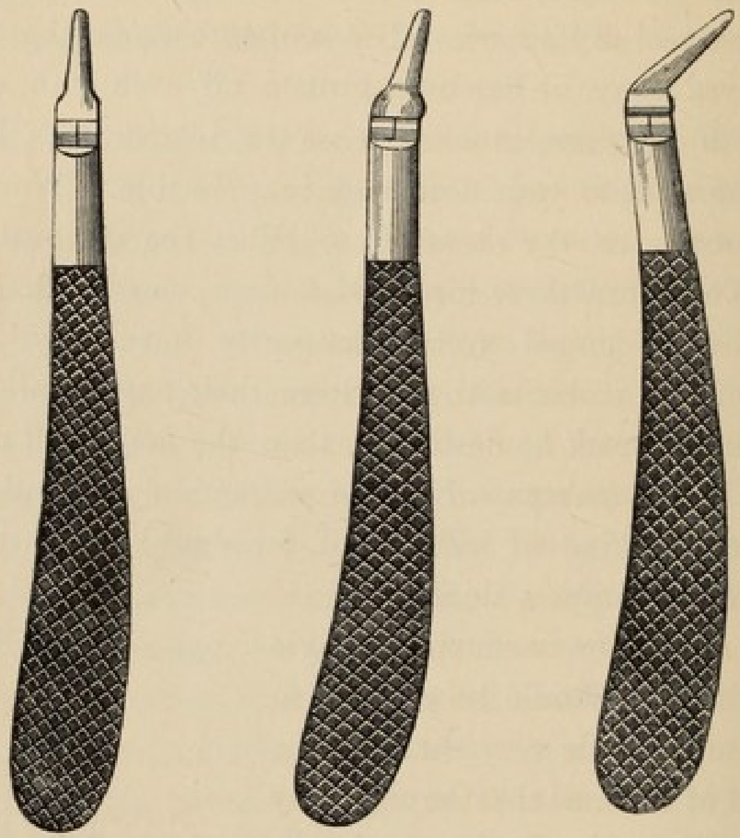
Fig. 127.

Forceps for Extracting Stumps,
With the jaws made so as to fit the stump throughout its whole length.

In forceps for removing single stumps the jaws should be grooved to fit the stump, made very sharp at the edge, and of steel, so that the edge may be renewed from time to time on the oil-stone. When the instrument is closed, they should hold the stump, and fit to its whole length. (Fig. 127.)

The general defect in these instruments is, that they are not open enough near the joint, and the consequence of this is, that in closing they press on and crush the stump at its broadest and most fragile part, instead of embracing it lower down in the alveolus, where it is sound and can resist pressure. The jaws of forceps for removing single roots should be similar in all cases, but they must be placed at different angles with the handles of the instruments to suit different parts of the mouth; and the handles themselves must, for molars of the upper jaw, be slightly curved. (Figs. 128, 129, and 130.)

Figs. 128, 129, *and* 130.



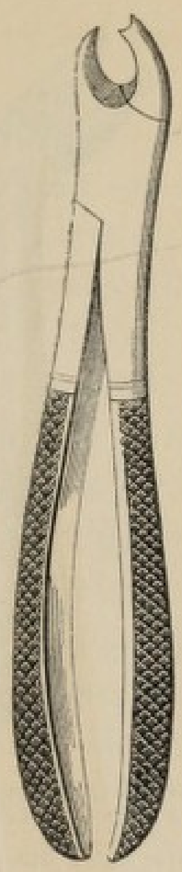
Forceps, with Jaws similar to Fig. 127.

But differently placed as regards the handles, to enable the operator to reach the various situations in which stumps may be placed.

The stumps of molar teeth of the upper jaw are often very firmly united by the neck of the tooth. In cases of this description, I have long been in the habit of using an instrument something like those described by Mr. Snell, but which I first saw in the possession of Mr. Rogers, who kindly allowed me to make a copy. One jaw is made to fit to the surface of the inner or palatine fang, while the other is formed into a sharp point, directed inwards, and destined to pass through the alveolus and between the fangs. (Fig. 131.) In using these instruments you require a right and a left pair. The palatine jaw must be forced well into the alveolus of that stump, and the point brought opposite to the division of the two external fangs, and forced through the gum and alveolus in between them.

Your grasp of the stump will then be so firm, that by moving it laterally the fangs will become detached from the surface of the socket, and be readily extracted; or else they will break apart, in which latter case each one can be readily extracted by forceps for single stumps. Before, however, applying these forceps, it is necessary to make a V-shaped incision in the gum, over the external fangs, with the apex directed upwards, into which the point of the instrument should enter, otherwise the gum might be torn.

Fig. 131.



Forceps for Extracting Tri-fanged Stumps.

This instrument is for those on the right side of the upper jaw.

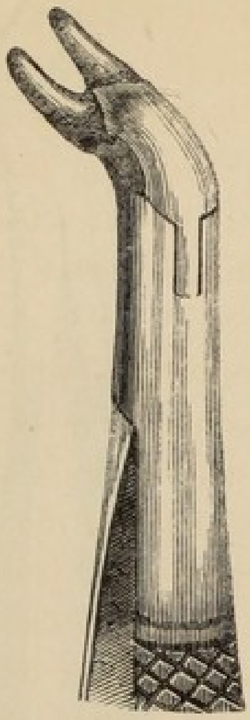
I need scarcely tell you that these instruments are only applicable to stumps of the first and second molars, and sometimes not to the latter. Stumps of the wisdom-teeth are generally removable by forceps for single fangs, as they are not deeply implanted or large, or we may use the elevator.

The double stumps remaining from molars of the lower jaw require for their removal, forceps, the jaws of which terminate in points. This instrument must be used much in the same manner as the corresponding instrument for triple stumps of the upper jaw. The points, after the gum has been lanced, must be brought opposite to the bifurcation of the fangs, and, by closure of the handles, forced between them. This instrument may, when sufficient of the neck of the tooth remains to direct the course of the jaws, be thrust down and closed, instead of being passed through the alveoli. (Fig. 132.)

The elevator is the best instrument for removing stumps of the wisdom teeth of the lower jaw.

I will now give you some account of this useful instrument,

Fig. 132.



Forceps for Extracting Two-fanged Stumps of the Lower Jaw,

Figured with a stump in the jaws of the instrument.

Fig. 133.

An Elevator,

With one side slightly grooved, to facilitate sharpening.

for the introduction of which into general practice I believe we are chiefly indebted to Mr. Bell.

The part applied to the tooth is in shape something like a spear-head. Two sharp edges meet in a point, the one side being flat or conical, while the other is rounded. The instrument is furnished with a good strong and large handle, and altogether is about five inches long. The edges and the point must be kept good by the frequent use of the oil-stone. Hence, it is convenient to have one surface hollowed, for then the edge can be renewed with less trouble. (Fig. 133.)

The elevator may be used in two manners. The point may be forced into the alveolus, and then, by turning it towards the tooth to be removed, and making a fulcrum of the alveolus or an adjoining tooth, prize out the offending tooth much in the same manner you see a pavior raise a flag-stone; or the point may be stuck into the side of a stump, and, by pushing it outwards in a line with the axis of the stump, force it from its socket. This latter plan can only be adopted when the stump is loose, or the alveoli lowered by absorption, so that the power by which the stump is retained is diminished.

Where two teeth are standing together, either may be removed by forcing the elevator edgewise between them, and turning it, when in that situation, towards the one to be extracted. The round side will rotate against the one, while the lower edge will cut into and raise the other from its socket.

Teeth are not exempt from irregularities of form, which, however, are principally found in the fangs; one fang is divided into two at its apex, or is bent at its termination; yet even these varieties do not materially affect the shape of the neck of the teeth, which part is so uniformly the same that it is rare to find a tooth to the surface of which the described forceps will not apply themselves with tolerable and sufficient exactness. There are teeth, however, which deviate so much from the regular form, that no forceps, unless made for each particular tooth, would be well suited for its extraction, were it not that such teeth are generally small, and offer but little resistance when their removal is attempted.

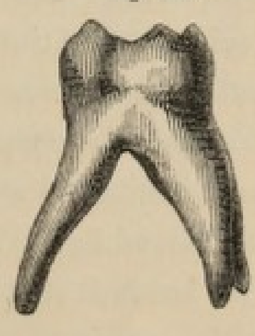
Irregularities in the shape and direction of the fangs, however, lead to serious inconvenience, and account for the occasionally unavoidable fracture of one or more fangs, or of the alveolus: and these are evils we cannot foresee. Thus, when

Fig. 134.

A Tooth, in which the Fangs first Diverge, and afterwards Converge,

And thus inclose a piece of bone, which, on an attempt to extract the tooth, acts as a rivet, and must be torn away, or the fangs must break.

Fig. 135.



A Tooth, in which the Fangs Diverge

To such an extent that its extraction could not be effected without either bringing away a piece of alveolus, or breaking in the jaw one of the fangs.

fangs first diverge and then converge, they inclose a cylindrical piece of bone, which must be torn out with the tooth, or the tooth must be broken. (Fig. 134.) Then, again, fangs may diverge to such an extent that one of the fangs must be broken off, or a piece of alveolus must be detached when extraction is attempted. (Fig. 135.) Sometimes a single fang will be bent almost in the form of the letter S, so that its extraction becomes almost impossible. Hence it follows, that however excellent our instruments, however skilful our operators, yet that teeth will now and then be broken off, and that portions of the alveoli will be detached with the teeth in performing the operation of extraction.

In describing thus cursorily the various dental operations, I have trusted to giving a general description of the principles which should direct your proceedings, rather than weary you with minute details of instruments and their use. These details you must deduce from a careful consideration of the form and position of the tooth to be operated on, and also from a diligent use of the experience your operations will place at your disposal. Three lectures, instead of one, might have been occupied on this subject, and even then have left some points untold. A minute description of mechanical details would not, however, have made you good operators. Careful and well-directed practice will alone give you dexterity.

The superinduction of anæsthesia in dental operations.—We live in an age that will be long famous in the annals of medical science, for the discovery and full recognition of the principle that the powers of voluntary motion, and of sensation, may, for awhile, be suspended, without materially endangering the life and health of a healthy individual; and that this condition can be adduced at will. To Dr. Morton, a dentist of Boston, we are indebted for this discovery. He found, that by inhaling the vapour of ether, mixed with atmospheric air, this state is induced; and, when so induced, he removed defective teeth without the patient being conscious of the operation.

No sooner was the fact reported in this country, than our hospital surgeons, and dentists, busied themselves in experimenting on the subject, and induced the state of insensibility in their patients previous to operating on them, and in the majority of cases with the happiest results. Fearful operations were gone through and no pain was felt; the patients awoke as from a pleasant dream, and found to their joy that diseased limbs had been removed during their sleep. At first the reports were all in favour of the new agent, but as time passed on, and the cases multiplied, we heard, at intervals, of unfavourable conditions produced by the inhalation of ether. The effects were more lasting than the operation required; and, in one or two instances, the patients died without ever having fully recovered from the effects of the anæsthetic agent.

The power to produce anæsthesia by ether having been fully recognised, experiments were instituted to test the effects of other similar fluids. Dr. Simpson, of Edinburgh, found that chloroform, similarly administered, not only induced the same effects as ether, but that it did so more rapidly, and more agreeably to the patient. This proved to be a great boon, for the ether was very disagreeable to many, and often induced a good deal of irritation and consequent coughing and a profuse flow of saliva, thus rendering the inhalation difficult.

Dr. Simpson, in a pamphlet on chloroform, makes the following comparison between this fluid and ether when used as anæsthetics:—

"1. A greatly less quantity of chloroform than of ether is requisite to produce the anæsthetic effect; usually from a hundred to a hundred and twenty drops of chloroform only being sufficient; and with some patients much less. I have seen a strong person rendered completely insensible by six or seven inspirations of thirty drops of the liquid.

"2. Its action is much more rapid and complete, and generally more persistent. I have almost always seen from ten to twenty full inspirations suffice. Hence the time of the surgeon is saved; and that preliminary stage of excitement, which pertains to all narcotizing agents, being curtailed, or indeed practically abolished, the patient has not the same degree of tendency to exhilaration and talking.

"3. Most of those who know from previous experience the sensations produced by ether inhalation, and who have subsequently breathed the chloroform, have strongly declared the inhalation and influence of chloroform to be far more agreeable and pleasant than those of ether.

"4. I believe that, considering the small quantity requisite, as compared with ether, the use of chloroform will be less expensive than that of ether: more especially, as there is every prospect that the means of forming it may be simplified and cheapened.

"5. Its perfume is not unpleasant, but the reverse; and the odour of it does not remain, for any length of time, obstinately attached to the clothes of the attendant,—or exhaling in a disagreeable form from the lungs of the patient, as so generally happens with sulphuric ether.

"6. Being required in much less quantity, it is much more portable and transmissible than sulphuric ether.

"7. No special kind of inhaler or instrument is necessary for its exhibition. A little of the liquid diffused upon the interior of a hollow-shaped sponge, or a pocket-handkerchief, or a piece of linen or paper, and held over the mouth and nostrils, so as to be fully inhaled, generally suffices in about a minute or two to produce the desired effect."

Dr. Snow, who is a great authority on the administration of ether or chloroform, after referring to a form of apparatus he used for giving the vapours, goes on to say—"By means of this inhaler, it was, I believe, first ascertained that every patient might be rendered insensible by ether, and that all failures must arise from inefficient means of administering the vapour, and not from any idiosyncrasy of the patient. After observations for a few months of the exhibition of ether in this uniform way, I was enabled in the course of last autumn to submit to the profession a description of etherization divided into degrees, which I still consider to be correct, and to be equally applicable to the effects of chloroform, and other agents of a similar kind.

"I divide etherization into five degrees, which may be called degrees of narcotism. The division was made according to symptoms which may be observed before an operation begins, leaving out of the classification the immunity from pain, which can only be ascertained during the operation, and which, curiously, does not correspond uniformly with the state of the patient in other respects. In what I called the first degree, there is exhilaration, or altered emotions and sensations of some kind; but the patient still retains consciousness and volition. In the second degree, the mental functions may still be performed, but only in an irregular manner; there may be ideas of a dreaming kind, and voluntary efforts in accordance with them, or the patient may be passive. When mental excitement occurs, it is chiefly in this degree, in which the functions of the cerebral hemispheres seem to be impaired, but not yet abolished. In the third degree, these functions appear to be totally suspended, but those of the spinal cord and its nerves still continue to some extent; the orbicularis palpebrarum may contract when the eyelids are touched; there may be other involuntary motions resulting from external impressions, and groans or cries may occur, but no sounds of an articulate kind. There are also sometimes, in this degree, involuntary muscular contractions as an effect of the vapour—apparently a kind of excitement of the spinal cord. In the fourth degree, no movement is obvious, except that of respiration, which is unaffected by external impressions, and goes on regularly, though often with snoring or even some degree of stertor. It would seem that the whole of the nervous centres are paralyzed by the vapour, except the medulla oblongata. In killing animals with vapours, I have observed the breathing to be difficult, or feeble, or otherwise impaired, before it finally ceased; this stage I call the fifth degree. There can be no doubt that these degrees of narcotism correspond with different proportions of vapour which are dissolved in the blood at the time—proportions which I hope to be able to determine. A certain quantity of vapour disturbs the functions of the cerebral hemispheres; an additional quantity appears altogether to suspend these functions, and to impair those of the spinal cord, and probably of the cerebellum; a still larger quantity to suspend these latter functions, but to leave the medulla oblongata more or less unaffected. As the vapour escapes from the blood by the lungs, its effects go off, the patient passes from the fourth degree to the third, from that to the second, and so on, if the inhalation be not renewed.

"It is seldom possible to perform an operation without signs of pain unless the narcotism is carried as far as the third degree, although, if performed in the second degree, the patient, being unconscious, might not remember the pain, memory being the continuance or revival of knowledge or consciousness, which is something superadded to mere sensation, and not the same thing. Some cases have indeed been met with, in which it is stated that patients felt no pain, although they had never lost their consciousness. I have not seen any such case. I do not, however, deny the possibility of it, but I am inclined to think it a mistake, and to believe that in these cases the patients had been unconscious without knowing they had been so, and had recovered their consciousness whilst still inhaling, before the operation began. My reasons for believing so are, that, as vapours are often administered, the strength of them diminishes as the process goes on, by the cooling of the sponge or other apparatus, or by the liquid becoming exhausted, thus affording the patient an opportunity to recover; that on recovering, even after a long operation, the patient often asserts that he is not yet insensible, until he finds proof of his error; and that I have often known patients to be conscious during some part of an operation without feeling it, after they had been unconscious previously."

In addition to these effects on the nervous system, the circulation and respiration suffer a change. During the first moments of inhalation the pulse is quickened, and the respiration is a little irregular, either from the timidity of the patient, or the unusual sensations produced by the chloroform. As the narcotic effect becomes evident, the pulse usually becomes less frequent and more feeble, and the respiration more regular. I have frequently observed that, immediately preceding complete insensibility, the patient takes two or three deep gasping inspirations. After this the respiration is slow, noiseless, and superficial.

The pulse is slow and soft, and the power of the voluntary muscles is suspended, though the tone as yet continues. If the inhalation of the vapour be still persevered in, the pulse becomes still more feeble, and the breathing stertorous; the skin is bathed in perspiration, the face and lips are pallid, and the patient sinks down in the chair like one dead. And if the vapour be continued death soon follows. But if it be withdrawn, the patient, after remaining insensible for a few minutes, gradually returns to consciousness. At first there is giddiness and inability to stand, and the intellect is confused. But this condition soon subsides, and, at the end of thirty or forty minutes, the patient has regained his usual state of feeling and health, excepting, perhaps, some slight feelings of depression.

In a female, aged 25, during the removal of a tumour from the axilla, the pulse fell to 30, and the respiration to 2 in a minute. The inhalation was discontinued, and the cold water thrown in the face, and in ten minutes consciousness returned.

The following is typical of the most favourable effects of chloroform in the inducement of anæsthesia.

A female, aged 30 years, inhaled from a funnel-shaped sponge, impregnated with forty drops of the fluid. The breathing was at first rather irregular, and the pulse was quickened. In a few seconds the respiration became tranquil, the pulse quiet and full. The head fell back, and, at the end of two minutes from the commencement of inhalation, she was perfectly insensible. The pulse was then feeble, the respiration slow, and rather feeble, and the face pale and expressionless, and damp with perspiration. Two molar teeth were removed, but without any change in the appearance of the patient. The face still had its pale blank look, and the blood trickled from the corners of the mouth. Within a minute, however, consciousness began to return, and at the expiration of fifteen minutes from the time the inhalation of chloroform was begun, she reported herself quite recovered.

She felt nothing of the tooth-drawing, but said she had had agreeable dreams. Nothing could be more gratifying than the results of this case: a painful operation had been performed, and, in the place of suffering, the patient had had an agreeable sleep. Now, if this case were an example of the invariable effects of chloroform when given for its anæsthetic powers, it would be unkind and inconsiderate, both for the mental and bodily suffering of our patients, were we, in a single instance, to recommend that an operation so trivial and transitory as extracting a single tooth should be done without the previous exhibition of chloroform. But, unfortunately, there are many evil results that occasionally follow its inhalation, which though not (numerically) sufficiently important to cause a moment's hesitation as to its use in serious operations, yet quite of sufficient magnitude to occasion a pause when the operation is itself unimportant, and short in duration.

Dr. Warren, surgeon of the Massachusetts General Hospital, relates, in his essay on etherization, the following, amongst other cases of evil resulting from the inhalation of ether. "The principal known ill effect produced by excessive etherization of the nervous centres, is a state of general convulsions, without signs of asphyxia. This is sometimes so violent, as apparently to threaten life; but by the immediate suspension of the ether, and the free affusion of cold water, the convulsions cease, and do not recur. A young medical gentleman underwent an operation for a contraction in the hand, extended to about fifteen minutes. On the first inhalation he had very agreeable visions, imagining he saw the twelve apostles, one of whom assured him, that the success of the operation would serve as an evidence of the truth of Christianity. This agreeable dream was interrupted by the strokes of the scalpel; intelligence was restored; he became restless; demanded more ether, and this being administered, insensibility returned, followed by a convulsion threatening the extinction of vitality. But, on the free application of cold water, the frightful agitations ceased, and permitted a satisfactory conclusion of the incisions." In the following page, Dr. Warren says, "There are a few cases in which ether renders the patient unmanageable; and although most of them may be successfully treated by prolonged etherization, yet, when the proposed operation is not very painful, it seems best to relinquish the inhalation. In October, 1847, a patient was to be operated on for the radical cure of an inguinal hernia. We did not wish to use ether, because the pain of the operation would be very slight; but as he strongly demanded it, the sponge was applied for ten minutes without any satisfactory effect. The inhalation being continued, he became uneasy, and finally so ungovernable, that the operation was postponed." Towards the conclusion of the work, Dr. Warren gives a series of general conclusions from the facts that have come before him, and which he has related. Amongst them is the following:—"7th. Operations very short, and not very painful, especially those about the head and neck, are best done without ether."

Ether is now but rarely used, and if it were employed, there is, I think, sufficient evidence in Dr. Warren's work, and in the various papers that have from time to time appeared in the medical periodicals, to necessitate the conclusion that its use should be discontinued in ordinary cases of extraction of teeth, and that it should be employed only in serious operations in which there is great and prolonged pain.

I have already described the most favourable effect of chloroform, I will now bring to your notice some cases in which the results were less fortunate, that you may judge for yourselves whether it is wise to use it on trivial occasions.

Previous to the discovery of the anæsthetic effects of chloroform, Mr. J. Bell brought to the hospital a little chloric ether, or terchloride of carbon as it was then called, that its effects might be tested. A female patient from the venereal ward was brought by her nurse to have a tooth removed. She was speedily rendered apparently insensible by inhaling the chloric ether, and the tooth, a first permanent molar, was removed. She did not seem to feel the operation—there was no expression of pain. In a few minutes after the removal of the tooth, the patient regained her consciousness. She then said that the operation gave her great pain, and described it so accurately that no doubt remained that she felt the usual amount of pain; but the power to move, she said, was suspended; she could not move in the slightest degree any part of the body, so that the power to express pain was paralyzed. The ether was given in the morning; during the day she fainted several times, had headache, and felt altogether unwell, and was very angry at us for giving her the ether. She said that she had never fainted before, and that the ether had made her ill.

As the disposition to faint was no doubt caused by the chloric ether, I did not again use this drug. Chloric ether consists of chloroform, with 80 per cent. of alcohol.

The stomach is sometimes deranged by chloroform. I have known of several cases in which distressing sickness was excited by the inhalation, and in one instance this lasted for twelve hours, and was compared by the patient to violent sea-sickness.

During inhalation the patient sometimes struggles so violently, that it is only by force that the inhalation can be continued. Only a few weeks since I failed to produce suspension of the muscular power, though assisted by the medical attendant, so violently did the patient resist. Yet, on recovery, he was unconscious that he had resisted. In a second case, two gentlemen came with a patient, and with their assistance in holding him, I succeeded in removing two teeth. On recovery, he recollected neither the struggling, nor the extraction of the teeth.

I have become acquainted with two cases in which the imagination was strangely affected for several weeks after the inhalation of chloroform. A lady between the age of thirty and forty suffered pain from several unsound teeth. Accompanied by a lady who had recently lost a little girl, and by her husband, she applied to a dentist. Chloroform was administered, and the tooth removed. She felt great difficulty and anxiety when inhaling, and wished to discontinue, but the dentist reassured her, and she went on. Her first sensation, on recovering, was the sound of her own voice, calling bitterly for the little girl who had recently died. This affected her very much, and she fell into a violent hysterical fit. On recovering she was conveyed home, but still bewildered, and at times hysterical. For three weeks she at frequent intervals heard her own voice calling for the little girl, and this was immediately succeeded by a fit of violent hysterical crying. Her friends became very anxious for her safety, both mentally and bodily, for she suffered in health, as well as from these occasional hallucinations. Any attempt to read or to write brought on a violent headache, and in addition to these evils her nights were, comparatively, sleepless. She eventually recovered by the use of tonics, stimulants, and generous living. This is her own account. Her friends state that under the operation she evinced no signs of pain; but that previous to the time she recollects hearing her own voice, she had been calling for the child, had asked its mother to restore it to her, and expressed the most bitter feelings of regret at its loss.

The lady has had a tooth out since, but not with the chloroform. She seems very much averse to its use, and says nothing would induce her to take it again.

In the second case, the hallucination took a different form. The patient, a young lady, under thirty, required three teeth to be removed. Her ordinary dentist declined giving her chloroform, on the ground that it was dangerous in all cases, and that it was not necessary or right to give it in tooth-drawing, or any other trivial operation. Hence she sought a stranger who was less punctilious. She was soon rendered insensible, and three teeth were extracted during the time. On recovery she remembered the extraction of the three teeth, and described the operation correctly, and declared it was attended with great suffering; but she believed the pain to be imposed for sins she had committed; that in truth she had been in purgatory, and had suffered there, and had again to go she said. At first her friends thought she was joking, but after a little time they discovered that, when unoccupied with external objects, the mind constantly fell back upon this idea. In addition to this, she was very nervous and excited, and in the evening asked to have some one to sleep in her room. This proved fortunate, for during the night she was attacked with a fit of collapse. Brandy was freely administered, and a medical man sent for, who with stimulants restored her. For a fortnight after the inhalation she continued very miserable, and subject to the frequent recurrence of these hallucinations. Her condition caused great alarm to her friends, who could not tell how long it might continue, and did not feel justified in leaving her for a moment alone while in that uncertain state of mind. In each of these cases, the patients were reported to be of highly nervous temperament, and subject, under great excitement, to hysterical crying.

Mr. O. Clayton related to me a case in which catalepsy, with a tendency to coma, was induced by the inhalation of ether, and lasted for four days. The pupils were dilated, and the patient was insensible to all that was passing around her; but could be partially roused for a moment by loudly shouting in her ear. She took no food, and drank only when forced to do so. If the arm was raised it retained the position for awhile, and then slowly fell back on the bed. There seemed great reason to fear a fatal termination.

The patient was a servant-maid, and predisposed to slight attacks of hysteria. She required a tooth to be removed, and asked to take ether. She recovered from the more urgent symptoms under the use of stimulants, but did not regain her usual state of health. Neither has she done so at the present time, though many months have elapsed since she inhaled the ether.

I am indebted for the following interesting case to the kindness of my friend Mr. Chalk, who obtained the details from

Mr. Bird, of Haverstock Hill, in whose practice the case occurred. It appears that two ladies repaired to a dentist's, one, to have teeth removed when under the influence of chloroform, the other, as companion to the patient. In giving the history, Mr. Bird uses the words of his patient and her friend, and his own in relating the treatment and its result. The patient says—"Wishing to have two teeth extracted, I applied to a highly respectable dentist, for permission, in the first instance, to see one of his patients inhale the chloroform, which he kindly allowed, and afterwards appointed the next day for the time of my own operation. I accordingly went, accompanied by a female friend, and took my seat in the operating chair; the process of inhalation was commenced. I distinctly recollect hearing the gentleman say, 'she is now under its full influence;' and he commenced the extraction, when I gave as loud a scream as I did on any previous occasion of tooth-drawing—although I felt a very pleasant soothing sensation." The inhalation was repeated; and here I must let her friend speak:—"The second tooth, a stump, was then taken out without the least signs of pain; her countenance became ghastly, and my friend was in as complete a state of intoxication as could well be borne—almost pulseless—scarcely breathing, and I made up my mind she would die, and suggested the propriety of calling in medical assistance. The windows were all thrown open—brandy administered, and two bottles of eau-de-Cologne consumed in bathing the face." This state lasted three hours, when she was lifted into her carriage, and taken home, with directions to let her go to bed and remain quiet. This was about 7 in the evening; she laid nearly all night in a restless half unconscious state, until 5 o'clock the next morning, when, reaction taking place, I was sent for, and found my patient in a high state of delirium—obliged to be held down in bed; leeches, blisters, &c., the usual mode of treatment, was adopted, and in four days she regained her senses. I am sorry to add that I sometimes find a vacancy in her manner, which leads me to forebode insanity sooner or later—a condition which I never observed previous to the inhalation, although I have been acquainted with my patient for ten years."

You will all of you remember the case that terminated fatally, near Newcastle-upon-Tyne. A girl, about fifteen years old, previous to having the toe-nail removed—a painful but not dangerous operation—inhaled chloroform, and died of its effects in about three minutes. Sir John Fife examined the body, and at the inquest stated, that he considered the fatal result was owing to some constitutional peculiarity in the girl, which could not have been foreseen. The lacteals were gorged with chyme. She had inhaled soon after a full meal.

I am not aware that chloroform, given preparatory to the extraction of teeth, has proved fatal in this country. A sad instance has, however, recently occurred in America. The following details are taken from an American periodical, "The Dental News Letter," for April, 1848:—

"*Report of the Principal Facts connected with a Fatal Case of Chloroform Inhalation, which occurred in Cincinnati, on the 23rd of February,* 1848.

"GENERAL HISTORY.—The subject of the following report, Mrs. Martha G. Simmons, was at the time of her decease thirty-five years and ten months old. Her husband states that she generally enjoyed excellent health; sometimes she was 'nervous,' and suffered occasionally with neuralgic pains about the face, and pain in the ear, apparently arising from decayed teeth. She also suffered at times from 'sick-headache.' She was the mother of six children, five of whom are still living; her last accouchement occurred eight weeks previous to her death. Nothing unusual occurred, either at the time of parturition, or subsequently; her health remained good, and the ordinary quantity of milk was secreted.

"On the 23rd of February she dined at a quarter past 12 o'clock, and after dinner walked to a dentist's, a distance of about three-fourths of a mile, for the purpose of having some roots of teeth extracted. She arrived at the dentist's 15 minutes before 3 o'clock, appeared slightly flushed from the exercise of walking, but exhibited no alarm on account of inhaling the chloroform.

"At 3 o'clock, 16 minutes after her arrival, Mrs. S. commenced inhaling chloroform. Mrs. Pearson and Mrs. Cross, two female friends, were present, and report the following as the events which occurred :—'The respiratory movements appeared to be free—chest heaving. While inhaling, *the face became pale*. At the expiration of about *one minute*, the instruments were applied, and four roots of teeth extracted. The patient groaned, and manifested what they regarded as evidence of pain, while the teeth were being extracted, although she did not speak, or exhibit any other sign of consciousness. As the last root came out, which was about two minutes from the beginning of the inhalation, patient's head turned to one side, arms became slightly rigid, body drawn somewhat backwards, with a tendency to slide from the operating chair. At this instant, Mrs. Pearson states that she placed her finger upon the patient's pulse, observed that it was feeble and immediately ceased to beat; respiration also ceased *about* the same time. The face, which was previously pale, now became livid, as also did the finger nails; the lower jaw dropped, and the tongue projected a little at one corner of the mouth, and the arms were perfectly relaxed. The females regarded her as being then quite dead. Efforts were made to resuscitate the patient—ammonia was applied to the nostrils, cold water dashed in the face, mustard, brandy, &c., applied. The patient was now removed from the operating chair, and laid on a sofa; but she did not breathe, nor exhibit any sign of life, after being placed in the recumbent position.'"

It will strike you that in many of the cases in which the inhalation of anæsthetic agents has done mischief the patients have been females, and most of them have exhibited indications of an hysterical diathesis. This is the more unfortunate, as hysterical females seem to feel pain more acutely than any others. Hence in them an otherwise trivial operation becomes serious, and the need for immunity from pain more imperative.

I have brought before you the untoward results that occasionally follows the inhalation of chloroform, not with the view of prejudicing you against its use in proper cases, but to guard you against using it needlessly,—that you may properly proportion the risk to the advantage. So far as we know, not one in five, or perhaps ten thousand, would be killed by chloroform, if it be cautiously administered. But, supposing even one in ten thousand will be killed, and we cannot tell which that one will be, it is surely unwise to take even that risk, merely to avoid pain that is very bearable, and will not last more than three or four seconds. We surely use a great power to overcome a very trifling difficulty, when we give chloroform preparatory to extracting an ordinary tooth.

The remedy in my mind seems strangely out of proportion to the evil to be avoided.

Then again, if the mind is to be disturbed for a week or fortnight, (and these cases are not so uncommon,) is it well to take that chance merely to avoid a transient pain?

Distressing nausea for a day would be, to me, a far greater evil than the pain occasioned by the extraction of an ordinary tooth. I say an ordinary tooth, because sometimes there is inflammation of the gums, or a peculiar shape or position of a tooth, or other complication, that makes the operation unusually painful.

If such complications exist, or if several teeth have to be removed at the same time, then, the pain being greater, we are, perhaps, warranted in using a powerful antidote.

With some state of the system it is deemed dangerous to exhibit chloroform, however desirable the immunity from pain may be. Mr. Curling, in his Address delivered at the Hunterian Society, says:—"There are certain states in which the full effects of anæsthetic agents cannot be produced without danger; as in organic diseases of the heart, especially a dilated or weak heart; and in tendencies to congestion of the brain in plethoric individuals. We are not often called upon to operate under such circumstances, and it will be the duty of the surgeon to discriminate accordingly. But these cases constitute no objection to their being given to the majority of persons about to undergo operations. We might as reasonably exclude some of our most valuable remedies, such as morphia, digitalis, and prussic acid, from the Materia Medica, as object to the use of anæsthetic agents, because there are particular conditions of disease and of the system in which they operate injuriously; or because an excessive dose is calculated to cause death."

Supposing we decide upon narcotizing on a patient before removing a tooth, it becomes a question how far the narcotism should be carried, whether we should strive to get perfect immunity from pain, or whether we should be content with lessening its degree; and what should be our treatment of the patient during, and after, the narcotism.

To arrive at a satisfactory conclusion, requires that we should consider the manner in which the phenomena that indicate narcotism succeed each other,

The order in which the various vital powers are suspended is not always the same. Thus, in one case, it is seen that the patient retains the power to see, hear, and feel, so as to recognise contact, while he is unable to feel pain; when, in another, the senses are paralyzed, but the knife excites cries, and efforts to resist. Then again, in a third case, the senses and the voluntary muscular system are equally narcotized. But whichever of the three conditions are present, the patient, after recovery, is equally oblivious as to what has been done during the time he was under the influence of the chloroform.

I believe it is generally agreed by those who are conversant with the exhibition of chloroform, that when the pupil dilates, and the eyelid falls involuntary, that then an operation may be commenced; and that a higher degree of narcotism is unnecessary. Now this is, I think, going farther than is needful to insure immunity from pain in an operation like tooth-drawing. I have found it sufficient to gain partial insensibility. On many occasions the patient has been perfectly aware of the steps of the operation, has felt the instrument grasp the tooth, and then a dragging, and yet little or no pain. If you direct a patient to tell you when he feels himself going off, and at that moment extract the tooth, he will feel little or no pain. I have adopted this plan when necessitated to exhibit chloroform, under the belief that the less the degree of narcotization the less will be the risk of injury to the patient.

I prefer the minimum dose of chloroform in dental practice on another ground.

When serious operations are performed, and a large amount of chloroform is given to gain immunity from pain, and save the patient from the shock to the system that would otherwise result from the operation, the patient is carried to bed and is kept perfectly quiet, and possibly sleeps till the effect of the narcotic has gone off. Not so in dental practice. The patient inhales the vapour, falls into a state of insensibility, the tooth is taken out, and, so soon as he recovers sufficiently, returns home. The case, so far as the dentist is concerned, terminates here; we hear no more of the patient. But, unfortunately, there are many instances in which the medical attendant does. His case begins where the dentist's ends. The patient is attacked with headache, with sleeplessness, or sickness, or collapse, or some other indication of indisposition.

Mr. Isles, of St. Andrew's Court, Holborn, related to me the case of a female, in which the inhalation of an anæsthetic was followed by great nervous irritability, excitement, and sleeplessness, which was succeeded by an attack of phrenitis, from which the patient narrowly escaped with her life. Probably the dentist who gave her the vapour heard nothing of this.

The narcotism ordinarily induced by dentists, previous to extracting teeth, is certainly less in degree, and less prolonged than that produced when serious operations are performed. Yet I believe that the results are more mischievous. I cannot see why this should be the case, unless it is that with the dentist the patient is roused up, and required to use the mind before it has fully regained its proper condition; and that the use, when only partially recovered, is productive of injury.

On this ground, I think it is desirable that, in dental operations, the minimum amount of chloroform that will insure anæsthesia should be used; and further, that the dentist should not use it at all unless the case be such as to necessitate it.

There is almost an endless variety of instruments for exhibiting chloroform, any of which will answer the purpose. Dr Simpson recommends the use of a funnel-shaped sponge, and I think this is the best. The open part should receive the mouth and nose, and the chloroform should be placed on the smaller or opposite part of the sponge, so that the fluid may not come in contact with the skin. The sponge should at first be held a little way from the face, and gradually brought nearer, till it covers the mouth and nose.

Dr. Simpson recommends the speedy induction of narcotism. Dr. Snow thinks that there is danger in producing insensibility too rapidly, and therefore recommends that it should be induced gradually, and in not less time than two minutes.

In administering an anæsthetic, I would recommend the observance of the following precautions:—

1st. *Never give it in less than four or five hours after a full meal.*

2nd. *Observe strict silence and quiet during the time of inhalation, and until the patient has recovered from its effects.*

In dental surgery, the operation may be commenced with the first signs of insensibility; but, in more serious and prolonged operations, the effect must be carried further, and kept up by occasional inhalation till the operation is completed.

On recovery, the patient should be kept perfectly quiet, and allowed to lie down and sleep if so disposed. Talking should be discouraged until the recovery is complete, otherwise there will be headache.

If the return to consciousness be alarmingly slow, the windows should be thrown open, cold water dashed in the face, and ammonia held to the nose.

If there be collapse after recovery from the narcotism, stimulants must be administered.

When permanent depression follows narcotism, stimulants, with generous living, seem to answer.

In my next and last lecture I shall give you a slight account of the means we possess of replacing lost teeth.

LECTURE XVI.

THE NECESSITY OF MASTICATION EITHER BY NATURAL OR ARTIFICIAL TEETH.—THE CONSTRUCTION OF ARTIFICIAL TEETH.—THE ADJUSTMENT, THE USE, AND THE MEANS TO BE ADOPTED FOR THEIR PRESERVATION.—CONCLUSION OF THE COURSE.

I PROMISED, before concluding the course, to give you some account of artificial teeth—their construction, their use, and their management. I will now redeem my pledge; but I must be brief, for we have but one lecture at our disposal, and the subject is a large one.

The duration of human life is proportioned to the perfectness or imperfectness with which the various functions that collectively constitute life are performed. These functions are the work of organs on materials submitted to their action. It is obviously necessary that, before organs can work well, they shall be well formed, and fully endowed with power to work. But it is equally necessary that the materials submitted to them shall in all respects be such as they can readily, and without unusual effort, act upon.

Digestion is one of these functions, and it is one of the first and most important; for without it others can go on but for awhile, and if it be deranged others are thrown out as a consequence. Digestion consists in the reduction of the various articles taken as food to a pultaceous mass called chyme, from which the more purified nutriment, chyle, is taken up and carried into the circulation.

The reduction of food to chyme is in great part a chemical action: a fluid is furnished by the stomach which dissolves the food, and in so doing reduces it to chyme.

Substances, irrespective of their relative solubility, are dissolved quickly or slowly in proportion to their degree of permeability or comminution, or, in other words, in proportion to the surface exposed to the action of the solvent. So it happens that a solid morsel swallowed whole may remain in a healthy stomach many hours before it is dissolved, while, had the same morsel been crushed or broken up into many pieces, and in that process mixed with saliva and then swallowed, it would have been reduced to pulp in an hour. In the one instance the function of digestion, so far as the production of chyme is concerned, is duly performed, in the other it is retarded. Hence it is of paramount importance that the food, before it is introduced into the stomach, should be properly crushed, divided, and thus rendered pervious to the gastric juice; in other words perfect mastication is necessary to perfect digestion. To effect this purpose, we are provided with a special apparatus, with suitable crushers—with teeth. To the dentist is intrusted the care of these important organs, to keep them in repair, and to replace them when lost.

I have told you, in the preceding lectures, how to preserve them, how to repair them: I will now tell you how they may be replaced. How, on the one hand, you may preserve the probabilities of life by preserving the organs of mastication; how, on the other, you may regain the lost probabilities by forming efficient substitutes for the lost organs.

But there are other though less important, yet sufficient reasons, why we should use our best endeavours to preserve our natural teeth, and, when lost, to replace them by artificial teeth.

Teeth—and especially front ones, natural or artificial—are necessary to distinct articulation; and we owe it to ourselves, and we owe it to those with whom we converse, that we should be readily and distinctly understood—that our utterance should be perfect.

The absence of teeth deprives the face of much of its character, and especially of its agreeable character; and here, also, we owe it to ourselves, and more especially we owe it to those about us, and also, though in a less degree, to all with whom we meet, to preserve our natural and healthful appearance by all available means. It is not natural for young or middle-aged people to be without teeth, and it is not unnatural for old people to have them. We are in no danger of overrating the value of the dental apparatus, so long as we consider it as one of the many parts that compose the human system, the well-being of each of which is necessary to the well-being of all the others, and therefore to health and comfort, and through these to longevity.

I will now endeavour to give you some account of the various kinds of artificial teeth, of the principles on which they are severally constructed, and of their applicability. I cannot, however, give you a detailed description of their manufacture; neither would the description be useful if I did. The constructive processes must be seen to be understood, and practised to be learned. Nor can I enter into details on the modifications in form that the peculiarities of individual mouths may require. To do so would occupy many lectures instead of one. On the contrary, I can only sketch briefly the general principles of construction, and, in doing so, shall confine my remarks to complete or nearly complete sets, or half-sets, unless it be otherwise stated.

The natural teeth have fangs, which pass through the gums, and are socketed in the jaws. In artificial teeth we must have a corresponding part to the fangs, but here it must be spread over and rest upon the gums, and through it, as through the fangs of natural teeth, the pressure of mastication must be communicated to, and borne by, the jaws. This part we will call the *base*, or *foundation*, since from it the crowns of the false teeth must rise. The base is an essential part of all artificial teeth, whether they be few or many; and upon the accuracy with which this fits the gums, will the usefulness of the imposed teeth depend. Indeed, unless it fits tolerably, the teeth cannot be worn; and for this obvious reason, that the pressure of mastication will be communicated to those parts only of the gums on which the base bears. If the area of these be small, the parts will be bruised; if they be still smaller they will be cut. The greater the area over which the pressure is diffused, the less will it be felt; the smaller, the more. We all know what would be the consequence if the area were reduced to an edge or a point; yet there are not wanting instances where, from inattention to these simple facts, the bases of false teeth are so badly constructed that the gums are bruised or cut the first time they are worn, and this from the ill-fitting or insufficient size of the base.

Hence, in estimating what would be the probable value of artificial teeth, the first consideration will be, whether the base can be made to fit perfectly, and whether of sufficient extent. If both these points can be and are attained, the base will, when pressed on the gums, bear pretty equally over the whole surface it covers, and, when so pressed, will squeeze from between itself and the surface of the gums both the saliva and the air, and will then be retained in its position with considerable force by the atmospheric pressure acting on the non-filling surface only. And further, it may be foretold that, if the subsequent stages of construction are successfully conducted, the new will be very useful substitutes for the lost teeth.

The base of artificial teeth is usually formed of either sheet-gold, or of dentine—the dentine of the hippopotamus, or of the walrus-tooth—and by the following means:—Bees-wax, previously softened by immersion in hot water, and well kneaded, and then placed in a horse-shoe shaped tray of suitable size, is introduced into the mouth, and carefully pressed against the gums until they are perfectly imbedded. The tray of wax is then very carefully withdrawn, and, if successfully, will present a perfect mould, or counter cast of the gums. Into this wax impression plaster of Paris is poured and allowed to set, after which it is removed from the wax by softening the latter. The plaster then presents a cast, a fac-simile in size and form of the gums—supposing, of course, the wax impression to have been correct.

It was usual in my work-room, and I believe in all others, to assume the cast of the gums to be correct, and upon that faith to proceed to construct the teeth from and to fit the plaster cast so obtained, until about two years since, when I had the gratification to discover means whereby the correctness of the cast could be readily tested before proceeding to construct the teeth. Since that time I have always availed myself of the test previous to commencing the teeth.

The means I allude to, with other appliances for teeth-making, formed the subject of a patent, in 1846. It consists in the compounding of a material like in composition to extremely hard sealing wax, but which is soft and plastic at the temperature of boiling water, though hard and unyielding at that of the human body. This material, when softened, is moulded on the plaster cast into the shape of the required teeth. Thus we have, at little or no cost of time, a model of the new teeth, on which, by the aid of a little hot water, we can work any required changes, should it, on being placed in the mouth, need any. And this, of course, will depend on the faithfulness of the cast on which it has been moulded. If the cast be correct the model will fit equally well both the cast and the mouth, but should the cast be faulty the model made on it will not fit the mouth, whereby we discover the error in the cast, and proceed to its correction. The faulty cast is thrown away, and the composition model is slightly softened by immersion in hot water. When in this state it is carefully moulded to the surface of the gums, and then allowed to harden. When hard it is again put in the mouth, and, if found to fit, is used to furnish a plaster cast in the same manner as the bees-wax impression did in the first instance. By these means we obtain a known *perfect* cast, to which we may make the new teeth without fear of failure. Should gold be chosen for the base, casts in metal, zinc, or brass, are made from the plaster cast, and from these again counter-casts, or reverses in lead are made, between which and the cast gold plate is hammered, until it has assumed the form, and fits perfectly to the surface of the cast, and, of course, also to the gums.

If dentine be chosen for the base it is usual to cover the plaster cast with red pigment, and to place upon it a block of dentine in the position it is required to take when fitted.

The block will at first touch only at one or two points, and these will be marked by the adhesion of a little of the pigment. The points so indicated are cut away with sculper; the contact is renewed and the reddened points again removed. In renewing the contact between the block of the dentine and the paint-covered cast, great care should be taken to keep the two in the same relative position as on each preceding occasion. This tedious and somewhat uncertain process is repeated again and again, to the extent of many hundreds of times, till the block is cut to fit the surface of the cast. The superfluous portions are then removed, and the base so made is then prepared for the reception of the teeth.

In my own work-room the base is carved by a patent machine, which altogether supersedes the hand carving and the pigment. A model of the required teeth is made in the moulding composition, and this is fixed in the machine, and then copied into dentine, with much saving of time, and without the possibility of error.

For the invention of this instrument I had the honour to receive a gold medal from the Society of Arts.

The base, so far as its gum-fitting surface is concerned, having been finished, we have next to select the teeth with which the base is destined to be armed. Teeth used in making artificial teeth are of three kinds; natural teeth, mineral, and carved teeth—that is, teeth carved out of dentine. The latter, when dentine is used for the base, are carved out of the same block in one piece. When natural or mineral teeth are selected they are fixed to the base by pins.

In speaking of artificial teeth, dentists divide them into front teeth and side blocks. The front teeth are like, and have the same names as the natural teeth, including the bicuspides; while those corresponding to the molar teeth are made in one continuous piece, and are called the side blocks of the piece. I should here tell you that the teeth with their base, whether few or many, are termed by dentists a *piece*, an upper or under piece, as they may be for the upper or lower jaw.

The teeth are fixed to the base by pins passing through, or nearly through, the centre of each tooth, and soldered to the gold or rivetted through the dentine, according as the base may be composed of the one material or the other.

Should a tooth when in wear come off its pin it may be temporarily refixed by wrapping a little flos silk round the pin, and then replacing the tooth.

The piece having been so far finished, the *bite*, or closure of the upper and under teeth, must be adjusted; that is, the teeth of the two jaws must be so adjusted that, on closing the mouth, all meet at the same moment. Should the teeth of one side meet before those of the other side of the mouth, the piece will be displaced at each attempt at mastication; or if the more posterior parts meet before the anterior teeth the same result would occur. If, when the teeth are put in, the error is considerable, the more prominent parts will be readily seen, and may be removed, but when the bite or closure is nearly perfect recourse may be had to pigments. The upper or under teeth, as the case may require, must be covered by the paint, and the points of contact, when marked by closing the mouth, removed by the sculper or file, until, on trial, all parts receive equally the colour from the opposing teeth.

In my own practice I use the composition I have before spoken of. The piece is moulded in this substance, and the parts corresponding to the side blocks and teeth slightly softened by heat, so that, when the mouth is closed, those parts which are too prominent will yield till the proper level is obtained. The bite thus obtained is copied into the artificial teeth.

Artificial teeth are retained in the mouth by three different plans; (1st.) by spiral springs attached by their ends to the pieces of the two jaws, when the set is complete, or, when the under teeth are perfect, to caps fitted to these teeth. The springs themselves are made of gold wire, twisted spirally round a small piece of cylindrical steel. They are fixed to the teeth by a swivel or loop, through which a pin passes to the base or to the blocks; while the swivel itself terminates in a piece of wire, which exactly fits into the interior of the spring, into which it is pressed. With this arrangement the springs are readily detached, even by the patient. Should the spring fit too loosely on the swivel, a little flos silk should be wrapt round the latter before pressing it into its place in the spring. And this, too, may be done by the patient, should a spring accidentally leave the swivel.

(2nd.) By clasps, or bands, of elastic gold, passing partly round the natural teeth that remain, but so placed as to be out of sight when the mouth is opened. The clasp is attached in a part only of its length to the base, the remaining portion is left free, and springs open to receive the tooth. If at any time the clasp does not firmly embrace the tooth, it is only necessary, in order to make it do so, to bend the free portions towards each other; it will then again take firm hold.

(3rd.) By the pressure of the atmosphere. The gum-fitting surface is so accurately fitted to the surface of the gums, that both the saliva and the air are excluded, whereby the pressure of the atmosphere acting only on that surface of the teeth exposed to the tongue, holds them in tightly against the gums.

Teeth on the latter principle, though the most difficult to construct, are the best kind when well constructed, seeing that they are wholly independent of any remaining natural teeth of the same jaw, and also of those of the opposite jaw.

In advanced age, the alveolar ridge, which supports and gives convexity to the gums, is completely removed, and the roof of the mouth becomes quite flat. In such cases, teeth on the pneumatic principle will not be steady, but, on the contrary, they will glide about just as you have seen two flat metallic surfaces slide readily off each other even by their own weight, though they required considerable force to separate them when applied at a right angle to their surfaces. From these facts you will readily infer, that teeth so made will, if fitted with perfect accuracy, be effective in proportion to the amount of surface presented in the base, and to the convexity of the gums.

The amount of atmospheric pressure will, of course, be proportioned to the surface of the base, and the freedom from lateral sliding in proportion to the convexity of the gums, unless there be teeth remaining in the jaw to steady them.

Pneumatic teeth are usually made of dentine, while those retained by clasps commonly have a gold base. Sometimes, however, the base is made of dentine, and fitted round or between remaining natural teeth, and is thus retained. Then, again, teeth may be constructed so as to be retained by a combination of two of these plans.

Indeed, the combinations and modifications of plans in the construction of artificial teeth are very numerous, and upon the successful adaptation of these to special cases does the skill and usefulness of the dentist depend. No two mouths are exactly alike, and hence no two admit of precisely the same form of teeth; out of this variety arise the difficulties to all, and the failures of the unskilful, and the success of the skilful.

The base having been completed, the teeth mounted and fixed, and the bite adjusted, the teeth must be given to the patient for wear, who must be directed to return on the following day should the mouth feel sore. If, when your patient returns, you find on inspecting the mouth that the base of the teeth has pressed on one part more than another, and caused redness, the base at that part must be filed or bent away; and these operations of adjustment must be repeated from time to time till the teeth become easy; always taking as your guide the state of the mouth rather than the statement of the patient.

You might at first thought suppose that artificial teeth, when well made, would require no after-adjustment to the mouth; and in many cases they do not,—in others they require but very little: yet, again, they may require a great deal; and for the following reasons:—the base may press equally on all parts of the gums, but all parts may not bear pressure equally. Then, again, some parts of the jaw may be covered with a greater thickness of gum than others. Under pressure the thicker parts of the gum will yield, and leave the thinner to sustain the pressure that should be equally distributed over the whole. The points so pressed on will necessarily become sore, unless the piece be adjusted to relieve them.

The first effect, on putting in a set of artificial teeth, is most unquestionably great discomfort; the mouth feels filled, the speech rendered difficult and indistinct, and mastication impossible: yet, within a fortnight, or three weeks at most, and often within even a week, all those difficulties vanish, and the patient tells you he could not do without the new teeth. Distressing nausea is amongst the occasional early consequence of wearing artificial teeth, but this also subsides with a little patience.

To masticate well with false teeth requires both time and perseverance, the ability being acquired sooner or later in proportion to the aptitude of the individual. But all may acquire it if the teeth be well made, and properly adjusted, so that pressure on them does not produce pain.

There are a few persons, however, whose jaws are so formed that sufficient available bearing surface for the base can scarcely be found. There are others, again, in whom the lining membrane of the mouth is so irritable, either naturally or from habits of intemperance, that the presence of artificial teeth cannot be borne—or, at least, without great effort. But if the effort be made and continued, and the teeth are good in construction, and well adjusted, success, even in the most difficult cases, will be consequent.

Artificial teeth must be regarded by the wearer as tools, the use of which have to be learned by patient trials. The first time you take up a joiner's plane you cannot work it, nor would you expect to do so without previous practice; so, with artificial teeth, you have no right to expect to masticate effectively with them until by practice you have learned their use. I would recommend that patients before they wear new teeth should carefully examine them in their several parts, and actions, and thus learn how they should be used, and what is to be expected of the teeth, and what is to be expected of themselves in acquiring the art of artificial mastication. If this expedient be adopted, many ill-conceived attempts, and consequent failures productive of disappointment, will be avoided.

It is of great importance that you should know how to preserve false teeth, for in the absence of proper attention they are soon destroyed, and still sooner become offensive. The wearer often seems singularly unconscious of the offensive odour arising from neglected teeth—not so, however, the bystander; he is almost poisoned by the offensive breath of his neighbour. Dentine is used in the construction of most sets of teeth, and this substance you are aware, if neglected, is soon acted on by the saliva, and gradually suffers decomposition: hence arises the stench.

I have told you on several occasions that dentine, when highly polished, resists the solvent action of the saliva. The patient should pay great attention to this point. The surfaces of the teeth should be well brushed with a little precipitated chalk at least twice a day; and, after brushing, rubbed with a dry soft towel, or handkerchief, or a piece of wash leather. By these means a beautifully polished surface may be retained.

When not in the mouth, the teeth should be kept in a well-stoppered glass jar, filled with two-thirds of spirits of wine, and one-third water. The antiseptic quality of the spirit aids much in preserving the dentine, and, moreover, keeps them sweet. By great attention, cleaning, and emersion in spirits of wine when out of use, artificial teeth will last quite as long again as they would if these means were neglected.

Artificial teeth cannot be too well kept, but they can be very easily, and frequently are, too ill kept. If the base be gold, and the teeth mineral, still they should be well cleaned each day; if the base be gold, and the teeth dentine, there is yet greater need of frequent and careful cleaning. If the base be of dentine, and the teeth natural teeth, the piece will soon be destroyed if cleaning be neglected.

Nothing short of never removing artificial teeth from the mouth should be more strongly deprecated than the habit some people have of taking them out only once or twice a week, and at other times cleaning them in the mouth. They cannot be well cleaned when in the mouth, and the surface of the mouth cannot remain healthy when perpetually covered.

It must be borne in mind that the gums are covered with epithelium, and that it is the nature of this tissue to be perpetually forming below, while it is suffering perpetual loss from its surface. The scales are rubbed off by the tongue and food. Now if the epithelium be perpetually covered by the base of artificial teeth, the formation will still go on, but the loss from the surface will be retarded. The outer epithelial scales may separate, but cannot escape from the surface; they, therefore, accumulate under the base of the teeth, and there become highly offensive. After awhile the mucous membrane inflames, and the development of epithelium is suspended or vitiated; the scales no longer adhere to each other to form a membrane. If the teeth be removed after the mouth has got into this condition, the surface which has been covered will be found red and vascular, and will bleed on the slightest touch. The fitting surface of the teeth will be coated with a white sebaceous matter highly offensive.

Artificial teeth should not, as a habit, be worn during the night, unless their presence is necessary to the comfort of the patient, or for the preservation of the remaining natural teeth. In either case it is desirable that the patient should have a set for the night—a set with a much smaller base than those used for mastication; and, when practicable, a piece fitted to one jaw only, and extended to the opposite jaw for the gums to close on. All that is required of night-teeth is, that they shall keep the jaws apart. The surface of the gums is naturally uncovered bathed with saliva, and subject to friction; it is desirable, therefore, that it should be left free eight hours out of the twenty-four; and, if some part must be covered even during the night-time, let that be as small as possible.

It will be inquired, at what time of life, and under what circumstances, recourse should be had to artificial teeth, how much may reasonably be expected of them, and how long they will last? Artificial teeth should be adopted whenever the want of teeth is felt, whenever articulation becomes imperfect, or when mastication can no longer be performed by molar teeth. I say molar teeth, because some persons, when the grinders are lost, masticate with the incisor teeth, in which case the incisors are soon worn down, or the upper ones are driven outwards and loosened by the lower front teeth; and thus, by being forced into use for a purpose for which they are not fitted, are prematurely destroyed.

If the wearer be a person of average perseverance and average conformation of mouth, he may expect to have articulation perfectly restored, and mastication of ordinary food rendered effective, by using well-designed and well-made artificial teeth.

Then, as regards the durability of artificial teeth. This will vary with individuals, the variation depending on the state of the saliva, the care with which they are cleaned and kept and used, and upon the material used in their construction; also in a great degree on the manner in which they are made, whether ill or well. A well-made set will last out two ill-made sets. One or two teeth on a gold base will last an indefinite time—ten, fifteen, or twenty years, or they may require renewal in two years, depending on the state of the adjoining natural teeth.

Some people will wear a complete set ten years without renewal, while others wear them down in eighteen months. From three to four years is a fair average wear.

And now, gentlemen, the course is ended. The allotted time is exhausted, and I fear, too, your patience. The lectures have not been such as I could have wished them, neither as to the matter or the manner. I have, however, done my best to lay before you the principles that should guide your practice; and, if I have been so far successful as to make myself intelligible, and to excite in you the desire to investigate for yourselves the various subjects embraced in these lectures, my end has been attained.

The lectures were composed expressly for the instruction of beginners—not for those already conversant with the subjects treated of. Should they come under the notice of any who are already educated in the profession, I must request them to remember for whom and for what purpose they were written—not for those who have already learned, but for those who have yet to learn.

I may, perhaps, in addressing you, have made use of the facts of others, and, it may be, even of their words, without acknowledgment. If so, I have great occasion for regret—regret both on account of my own ignorance, and regret for the neglect and injustice I have committed. It must not, however, be forgotten, that, in an address to beginners, the less our discourse is burdened with quotations, and the quotation of authorities, the better. And under this I must, if necessary, take shelter.

APPENDIX.

THE following tables exhibit in detail that which in a condensed form has been already described at page 139; hence the remarks that preface and accompany the abstract must be read in connection with these, the full tables.

TABLE No. I.—Showing the relative liability at different ages of the CENTRAL INCISORS to conditions rendering their removal necessary; the relative frequency of each of these conditions; their relative frequency in Males and Females, and in the Upper and Lower Jaws.

	Teeth removed.					The Dental Tissues diseased.							The Dental Tissues natural.					
Ages.	Total number.	Males.	Females.	Upper jaw.	Lower jaw.	Caries commenced on the masticating surface.	On the anterior side.	On the posterior side.	On the labial surface.	On the lingual surface.	Reduced by caries to stumps.	Necrosis.	Inflammation of the dental periosteum.	Loose from absorption of the gums and alveoli.	Out of line from want of space in the jaw.	Fractured by mechanical violence.	Forced outwards into the lip by the antagonist teeth.	
Under 15	11	6	5	10	...	...	...	...	...	...	1	...	...	...	...	9	...	Upper jaw.
	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	1	...	Lower jaw.
Between 15 and 20	6	2	4	4	...	...	...	...	...	1	2	...	...	...	...	1	...	Upper jaw.
	...	...	...	...	2	...	...	...	...	...	...	...	...	...	2	...	...	Lower jaw.
20 „ 25	4	1	3	4	...	...	...	1	...	...	3	...	...	...	...	...	...	Upper jaw.
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Lower jaw.
25 „ 30	6	2	4	5	...	...	...	1	...	...	2	...	...	2	...	...	...	Upper jaw.
	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	Lower jaw.
30 „ 40	9	7	2	8	...	...	1	1	1	...	3	1	...	1	...	...	...	Upper jaw.
	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	Lower jaw.
40 „ 50	18	8	10	9	...	...	...	...	...	...	2	...	...	7	...	...	...	Upper jaw.
	...	...	...	...	9	...	...	...	...	...	2	1	...	6	...	...	...	Lower jaw.
50 „ 60	12	6	6	11	...	...	...	...	...	...	3	1	...	6	...	...	1	Upper jaw.
	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	Lower jaw.
Upwards of 60	5	3	2	1	...	...	...	...	...	...	...	...	...	1	...	...	...	Upper jaw.
	...	...	...	...	4	...	...	...	...	...	...	...	...	4	...	...	...	Lower jaw.
The age not registered.	1	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	Upper jaw.
	...		...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	Lower jaw.
	72	35	37	53	19		1	3	1	1	18	3	1	30	2	11	1	

TABLE No. II.—Showing the relative liability at different ages of the LATERAL INCISORS to conditions rendering their removal necessary; the relative frequency of each of these conditions; their relative frequency in Males and Females, and in the Upper and Lower Jaws.

	Teeth removed.					The Dental Tissues diseased.							The Dental Tissues natural.							
Ages.	Total number.	Males.	Females.	Upper jaw.	Lower jaw.	Caries commenced on the masticating surface.	On the anterior side.	On the posterior side.	On the labial surface.	On the lingual surface.	Reduced by caries to stumps.	Necrosis.	Inflammation of the dental periosteum.	Loose from absorption of the gums and alveoli.	Out of line from want of space in the jaw.	Removed to make room for the canines.	Fractured by mechanical violence.	Supposed to occasion or aggravate neuralgia of the face.	The causes of removal not registered.	
Under 15	19	7	12	15	...	...	1	...	...	...	1	...	...	...	8	4	1	...	...	Upper jaw.
	...	...	...	...	4	...	...	...	...	...	..	...	...	...	3	1	...	...	...	Lower jaw.
Between 15 and 20	17	11	6	12	...	...	3	2	...	...	1	1	1	1	2	...	1	...	...	Upper jaw.
	...	...	...	...	5	...	1	...	...	...	...	...	...	1	2	1	...	...	...	Lower jaw.
20 „ 25	11	4	7	11	...	...	2	2	1	2	4	...	...	...	...	...	...	...	...	Upper jaw.
	...	...	...	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Lower jaw.
25 „ 30	8	4	4	7	...	...	...	2	...	...	3	1	1	...	...	...	...	...	...	Upper jaw.
	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1	Lower jaw.
30 „ 40	14	7	7	14	...	1	2	...	...	2	4	1	...	3	...	...	...	...	1	Upper jaw.
	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	...	...	...	...	Lower jaw.
40 „ 50	22	10	12	20	...	...	...	1	1	...	11	...	...	5	...	...	...	...	2	Upper jaw.
	...	...	...	...	2	...	...	...	...	...	1	...	...	1	...	...	...	...	...	Lower jaw.
50 „ 60	13	7	6	7	...	...	...	1	...	...	3	1	...	2	...	...	...	...	...	Upper jaw.
	...	...	...	...	6	...	1	...	...	...	...	...	...	5	...	...	..	...	...	Lower jaw.
Upwards of 60	12	4	8	5	...	...	...	...	...	...	1	...	...	4	...	...	...	...	...	Upper jaw.
	...	...	...	...	7	...	...	1	...	...	...	...	...	5	...	...	...	1	...	Lower jaw.
The age not registered.	1	1	...	1	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	Upper jaw.
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Lower jaw.
	117	55	62	92	25	1	10	9	2	4	29	4	2	27	16	6	2	1	4	

TABLE No. III.—Showing the relative liability at different ages of the CANINES to conditions rendering their removal necessary; the relative frequency of each of these conditions; their relative frequency in Males and Females, and in the Upper and Lower Jaws.

Ages.	TEETH REMOVED.					The Dental Tissues diseased.								The Dental Tissues natural.					
	Total number.	Males.	Females.	Upper jaw.	Lower jaw.	Caries commenced on the masticating surface.	On the anterior side.	On the posterior side.	On the labial surface.	On the lingual surface.	Reduced by caries to stumps.	Necrosis.	Exostosis.	Inflammation of the dental periosteum.	Loose from absorption of the gums and alveoli.	Out of line from want of space in the jaw.	Fractured by mechanical violence.	The causes of removal not registered.	
Under 15	13	7	6	11	...	...	...	...	...	...	1	...	...	...	...	10	...	...	Upper jaw.
	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	2	...	...	Lower jaw.
Between 15 and 20	12	5	7	12	...	...	...	2	1	...	2	...	...	...	...	3	...	4	Upper jaw.
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Lower jaw.
20 " 25	4	3	1	3	...	...	1	...	...	...	...	...	...	...	...	2	...	...	Upper jaw.
	...	...	...	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	Lower jaw.
25 " 30	4	2	2	2	...	...	...	1	...	...	1	...	...	...	...	...	...	...	Upper jaw.
	...	...	...	...	2	...	...	1	...	...	...	...	...	...	1	...	...	...	Lower jaw.
30 " 40	12	4	8	9	...	...	1	2	...	...	4	...	...	...	2	...	...	...	Upper jaw.
	...	...	...	...	3	...	...	...	...	...	...	...	...	1	2	...	...	...	Lower jaw.
40 " 50	19	8	11	12	...	...	...	2	...	1	4	...	...	...	5	...	...	...	Upper jaw.
	...	...	...	...	7	...	...	...	...	1	1	...	...	...	5	...	...	...	Lower jaw.
50 " 60	5	1	4	3	...	...	...	...	...	...	1	...	...	...	2	...	...	...	Upper jaw.
	...	...	...	...	2	...	...	...	...	...	...	...	...	...	2	...	...	...	Lower jaw.
Upwards of 60	8	2	6	5	...	1	...	...	...	...	1	...	...	...	3	...	...	...	Upper jaw.
	...	...	...	...	3	...	...	...	...	...	...	...	...	...	3	...	...	...	Lower jaw.
The age not registered.	1	...	1	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	Upper jaw.
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Lower jaw.
	78	32	46	58	20	1	2	9	1	2	15			2	25	17		4	

TABLE No. IV.—Showing the relative liability at different ages of the FIRST BICUSPIDES to conditions rendering their removal necessary; the relative frequency of each of these conditions; their relative frequency in Males and Females, and in the Upper and Lower Jaws.

Teeth removed.						The Dental Tissues diseased.								The Dental Tissues natural.					
Ages.	Total number.	Males.	Females.	Upper jaw.	Lower jaw.	Caries commenced on the masticating surface.	On the anterior surface.	On the posterior surface.	On the buccal surface.	On the lingual surface.	Reduced by caries to stumps.	Necrosis.	Exostosis.	Inflammation of the dental periosteum.	Loose from absorption of the gums and alveoli.	Neuralgia in the face.	For space for the canines, &c.	The causes of removal not registered.	
Under 15	37	14	23	29	...	...	1	7	...	...	1	1	...	...	1 [a]	...	15	3	Upper jaw.
	...	...	...	...	8	2	2	1	1	...	1	...	...	...	...	...	...	1	Lower jaw.
Between 15 and 20	63	33	30	52	...	1	5	34	1	2	7	1	...	...	...	...	1	...	Upper jaw.
	...	...	...	...	11	...	2	6	...	...	2	...	...	...	...	...	1	...	Lower jaw.
20 „ 25	55	25	30	45	...	1	4	19	...	...	19	...	...	1	...	...	...	1	Upper jaw.
	...	...	...	...	10	...	1	5	...	...	4	...	...	...	...	...	...	...	Lower jaw.
25 „ 30	28	14	14	22	...	...	3	12	...	1	6	...	...	...	...	...	...	...	Upper jaw.
	...	...	...	...	6	...	1	1	...	1	3	...	...	...	...	...	...	...	Lower jaw.
30 „ 40	40	23	17	30	...	...	11	4	1	1	8	...	...	1	1	...	...	3	Upper jaw.
	...	...	...	...	10	...	...	4	...	1	3	...	...	...	2	...	...	...	Lower jaw.
40 „ 50	24	12	12	16	...	...	1	1	1	...	7	...	...	1	5	...	...	...	Upper jaw.
	...	...	...	...	8	...	1	2	...	...	1	...	...	...	4	...	...	...	Lower jaw.
50 „ 60	8	5	3	4	...	...	...	...	...	...	1	1	...	...	2	...	...	...	Upper jaw.
	...	...	...	...	4	...	...	1	...	...	1	...	...	...	2	...	...	...	Lower jaw.
Upwards of 60	13	5	8	5	...	...	1	...	...	...	1	...	...	...	3	...	...	...	Upper jaw.
	...	...	...	...	8	...	...	...	...	...	2	...	...	...	5	1	...	...	Lower jaw.
The age not registered.	5	4	1	4	...	...	1	...	...	...	2	...	...	...	...	...	1	...	Upper jaw.
	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	Lower jaw.
	273	135	138	207	66	5	34	97	4	6	69	3		3	25	1	18	8	

[a] This tooth was imperfect, having no fang; development had been arrested when the crown was formed.

TABLE No. V.—Showing the relative liability at different ages of the SECOND BICUSPIDES to conditions rendering their removal necessary; the relative frequency of each of these conditions; their relative frequency in Males and Females, and in the Upper and Lower Jaws.

	TEETH REMOVED.					The Dental Tissues diseased.								The Dental Tissues natural.							
Ages.	Total number.	Males.	Females.	Upper jaw.	Lower jaw.	Caries commenced on the masticating surface.	On the anterior surface.	On the posterior surface.	On the buccal surface.	On the lingual surface.	Reduced by caries to stumps.	Necrosis.	Exostosis.	Inflammation of dental periosteum.	Loose from absorption of the gums and alveoli.	Fractured.	Pain in teeth without detectable disease.	Neuralgic pain in the face.	For space for the canines, &c.	The causes of removal not registered.	
Under...... 15	47	29	18	30	...	5	4	13	...	1	3	...	...	...	1	...	...	...	1	2	Upper jaw.
	...	...	...	...	17	3	...	8	...	1	2	1	...	...	1	...	...	...	...	1	Lower jaw.
Between 15 and 20	107	58	49	78	...	3	21	31	...	3	13	2	...	1	...	1	...	...	...	3	Upper jaw.
	...	...	...	...	29	2	9	8	1	...	9	...	...	...	...	...	...	...	...	...	Lower jaw.
20 „ 25	85	33	52	56	...	1	10	21	...	1	19	1	...	1	...	...	...	...	...	2	Upper jaw.
	...	...	...	...	29	1	7	10	...	...	8	...	...	1	...	...	...	...	...	2	Lower jaw.
25 „ 30	52	25	27	37	...	1	9	8	...	1	16	...	...	...	...	...	1	...	...	1	Upper jaw.
	...	...	...	...	15	2	4	4	...	...	4	...	...	...	...	...	1	...	...	...	Lower jaw.
30 „ 40	65	31	31	35	...	3	4	11	1	...	14	...	...	1	1	...	...	...	...	...	Upper jaw.
	...	...	...	...	30	...	8	10	...	3	7	...	...	...	2	...	...	...	...	...	Lower jaw.
40 „ 50	34	20	14	20	...	...	1	3	...	1	5	...	...	...	10	...	...	...	...	...	Upper jaw.
	...	...	...	...	14	...	4	3	1	1	1	...	1	...	3	...	...	...	...	...	Lower jaw.
50 „ 60	21	12	9	9	...	...	...	...	1	...	3	...	...	...	5	...	...	...	...	...	Upper jaw.
	...	...	...	...	12	...	...	1	1	...	3	...	...	...	7	...	...	...	...	...	Lower jaw.
Upwards of 60	18	11	7	9	...	...	...	2	1	...	...	...	...	...	6	...	...	...	...	...	Upper jaw.
	...	...	...	...	9	1	...	...	1	...	1	...	...	...	4	...	...	2	...	...	Lower jaw.
The age not registered.	5	4	1	5	...	...	2	...	...	...	2	...	...	...	...	...	...	...	1	...	Upper jaw.
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Lower jaw.
	434	226	208	279	155	22	83	133	7	12	110	4	1	4	40	1	2	2	2	11	

TABLE No. VI.—Showing the relative liability at different ages of the FIRST MOLARS to conditions rendering their removal necessary; the relative frequency of each of these conditions; their relative frequency in Males and Females, and in the Upper and Lower Jaws.

Ages.	Teeth removed. Total number.	Males.	Females.	Upper Jaw.	Lower Jaw.	The Dental Tissues diseased. Caries commenced on the masticating surface.	On the anterior surface.	On the posterior surface.	On the buccal surface.	On the lingual surface.	Reduced by caries to stumps.	Necrosis.	Exostosis.	Stump deeply embedded in granulations from the pulp.	The Dental Tissues natural. Inflammation of dental periosteum.	Loose from absorption of the gums and alveoli.	Fractured.	Pain in teeth without detectable disease.	Neuralgic pain in the face.	For space.	The causes of removal not registered.	
Under 15	375	192	183	120	...	74	25	6	4	2	7	...	...	...	...	...	...	...	...	...	2	Upper jaw.
	...	...	...	...	255	174	30	14	8	6	19	...	...	...	...	...	...	...	...	...	4	Lower jaw.
Between 15 and 20	306	160	140	124	...	27	54	24	1	2	12	...	...	...	...	...	...	...	...	...	4	Upper jaw.
	...	...	...	...	182	72	41	27	11	9	17	1	...	...	1	...	...	...	...	1	2	Lower jaw.
20 „ 25	181	95	86	95	...	19	37	16	...	1	17	...	...	...	...	1	...	1	...	...	3	Upper jaw.
	...	...	...	...	86	14	21	19	7	...	18	...	...	1	...	...	...	1	...	...	5	Lower jaw.
25 „ 30	95	46	49	49	...	8	9	9	2	2	17	...	...	...	1	...	...	1	...	...	...	Upper jaw.
	...	...	...	...	46	6	16	9	3	2	9	...	...	...	...	...	...	1	...	...	...	Lower jaw.
30 „ 40	88	48	40	46	...	2	9	9	...	4	18	1	...	...	1	1	...	...	...	...	1	Upper jaw.
	...	...	...	...	42	3	7	9	7	4	8	...	...	...	...	1	...	1	...	...	2	Lower jaw.
40 „ 50	49	21	28	28	...	...	4	6	1	2	4	1	...	...	1	8	...	1	...	...	...	Upper jaw.
	...	...	...	...	21	1	5	6	1	2	3	...	...	...	...	3	...	...	...	...	...	Lower jaw.
50 „ 60	20	13	7	13	...	1	2	...	1	...	1	...	...	...	...	8	...	...	...	...	...	Upper jaw.
	...	...	...	...	7	...	3	1	...	...	2	...	...	...	...	1	...	...	...	...	...	Lower jaw.
Upwards of 60	10	5	5	5	...	...	...	...	...	...	...	...	...	...	1	4	...	...	...	...	...	Upper jaw.
	...	...	...	...	5	...	...	...	1	...	...	...	...	...	...	3	...	...	...	...	1	Lower jaw.
	1124	586	538	480	644	401	263	155	47	36	152	3		1	5	30		6		1	24	

TABLE No. VII.—Showing the relative liability at different ages of the SECOND MOLARS to conditions rendering their removal necessary; the relative frequency of each of these conditions; their relative frequency in Males and Females, and in the Upper and Lower Jaws.

	TEETH REMOVED.					The Dental Tissues diseased.								The Dental Tissues natural.						
Ages.	Total number.	Males.	Females.	Upper jaw	Lower jaw.	Caries commenced on the masticating surface.	On the anterior surface.	On the posterior surface.	On the buccal surface.	On the lingual surface.	Reduced by caries to stumps.	Necrosis.	Exostosis.	Inflammation of the dental periosteum.	Loose from absorption of the gums and alveoli.	Pain in teeth, without detectable disease.	Stumps deeply embedded in granulations from the pulp.	Fractured.	The causes of removal not registered.	
Under 15	44	25	19	9	...	6	1	1	...	1	...	...	...	...	...	...	...	...	...	Upper jaw.
	...	..	...	...	35	20	...	2	1	3	5	1	...	...	...	1	...	...	2	Lower jaw.
Between 15 and 20	152	74	78	44	...	16	7	5	7	1	7	...	...	1	...	...	...	...	...	Upper jaw.
	...	...	...	...	108	70	4	8	15	6	5	..	...	...	...	..	...	...	...	Lower jaw.
20 „ 25	129	63	66	50	...	13	11	6	3	1	10	...	...	2	. .	1	...	...	3	Upper jaw.
	...	...	...	...	79	37	8	12	7	...	13	...	...	...	...	1	1	...	...	Lower jaw.
25 „ 30	94	44	50	35	...	7	5	11	2	2	7	...	...	...	...	...	...	...	1	Upper jaw.
	...	...	...	...	59	22	5	7	8	1	14	...	...	...	...	...	...	...	2	Lower jaw.
30 „ 40	93	58	35	55	...	2	10	16	4	1	17	...	...	1	4	...	...	...	...	Upper jaw.
	...	...	...	...	38	8	5	9	5	...	7	...	...	2	...	...	...	1	1	Lower jaw.
40 „ 50	52	35	17	24	...	2	...	4	1	2	4	1	...	...	10	...	...	...	...	Upper jaw.
	...	...	...	...	28	4	2	4	7	1	4	...	...	...	6	...	...	...	...	Lower jaw.
50 „ 60	50	36	14	21	...	1	1	2	...	...	...	2	...	1	14	...	...	...	...	Upper jaw.
	...	...	...	...	29	3	1	3	7	...	3	...	...	...	11	...	...	...	1	Lower jaw.
Upwards of 60	20	13	7	9	...	...	...	1	...	...	1	...	...	...	7	...	..	...	...	Upper jaw.
	...	...	...	...	11	1	1	1	1	...	2	1	...	...	4	...	...	...	. .	Lower jaw.
The age not registered.	3	2	1	2	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	Upper jaw.
	...	...	...	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	Lower jaw.
	637	350	287	249	388	213	62	93	68	19	99	5		7	56	3	1	1	10	

TABLE No. VIII.—Showing the relative liability at different ages of the THIRD MOLARS to conditions rendering their removal necessary; the relative frequency of each of these conditions; their relative frequency in Males and Females, and in the Upper and Lower Jaws.

Ages.	TEETH REMOVED.					The Dental Tissues diseased.								The Dental Tissues natural.						The causes of removal not registered.	
	Total number.	Males.	Females.	Upper jaw.	Lower jaw.	Caries commenced on the masticating surface.	On the anterior surface.	On the posterior surface.	On the buccal surface.	On the lingual surface.	Reduced by caries to stumps.	Necrosis.	Exostosis.	Inflammation of the dental periosteum.	Loose from absorption of the gums and alveoli.	Pain in teeth without detectable disease.	Neuralgic pain in the face.	Fracture of jaw, teeth loose.	Mal-placed, and producing pain.		
Under 15	1	...	1	...	...	...	...	...	...	...	...	..	...	...	...	...	...	...	...	...	Upper jaw.
	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Lower jaw.
Between 15 and 20	18	12	6	7	...	1	...	...	5	...	1	...	...	...	...	...	...	...	...	...	Upper jaw.
	...	...	...	...	11	6	...	...	3	...	1	...	...	...	1	...	...	...	...	...	Lower jaw.
20 „ 25	51	22	29	16	...	7	3	...	2	...	4	...	...	...	...	...	...	...	...	...	Upper jaw.
	...	...	...	...	35	17	1	2	3	1	7	...	...	2	...	...	...	...	...	2	Lower jaw.
25 „ 30	62	28	34	23	...	5	7	1	5	...	4	...	...	1	...	...	...	...	...	...	Upper jaw.
	...	...	...	...	39	15	4	1	8	1	5	...	...	...	1	...	...	1	1	2	Lower jaw.
30 „ 40	69	35	34	24	...	7	4	1	3	...	3	...	...	2	2	...	...	...	1	1	Upper jaw.
	...	...	...	...	45	11	3	4	14	1	5	...	...	1	2	...	...	1	1	2	Lower jaw.
40 „ 50	42	26	16	21	...	2	2	1	1	...	4	...	...	...	9	1	...	...	...	1	Upper jaw.
	...	...	...	..	21	3	3	...	5	...	3	...	...	1	4	...	1	...	...	1	Lower jaw.
50 „ 60	15	11	4	5	...	1	...	...	...	...	1	...	...	...	3	...	...	...	...	...	Upper jaw.
	...	...	...	...	10	1	1	1	1	...	...	...	...	...	6	...	.	...	...	...	Lower jaw.
Upwards of 60	7	5	2	1	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	Upper jaw.
	...	...	...	...	6	1	...	...	1	...	...	...	...	...	4	...	...	...	...	...	Lower jaw.
	265	139	126	97	168	78	28	11	51	3	38	...	...	7	33	1	1	2	3	9	

TABLE No. IX.—Showing the relative frequency of the conditions that occasioned the loss of teeth in the cases registered.

Kinds of Teeth.	Total number removed.	Caries.	Necrosis.	Exostosis.	Periostitis.	Absorption of the alveoli.	Insufficient size of jaw.	Mechanical injuries.	Pain in the teeth.	Neuralgia in the face.	Stumps imbedded in granulations.	The cause not registered.
Central incisors. .	72	24	3	...	1	30	2	12	...	...	...	...
Lateral incisors. .	117	55	4	...	2	27	22	2	...	1	...	4
Canines	78	30	...	...	2	25	17	...	...	...	...	4
First bicuspides. .	273	215	3	...	3	25	18	...	...	1	...	8
Second bicuspides	434	367	4	1	4	40	2	1	2	2	...	11
First molars......	1124	1054	3	...	5	30	1	...	6	...	1	24
Second molars ...	637	554	5	...	7	56	...	1	3	...	1	10
Third molars......	265	209	...	...	7	33	...	2	1	1	...	9
	3000	2508	22	1	31	266	65	18	12	5	2	70

TABLE No. X.—Showing the relative number of each Tooth taken from the right and left sides of the Upper Jaw between the several ages expressed in the first column.

Ages.	Teeth from the Upper Jaw.															
	Central Incisors.		Lateral Incisors.		Canines.		First Bicuspides.		Second Bicuspides.		First Molars.		Second Molars.		Third Molars.	
	Right side of the mouth.	Left side of the mouth.	Right side of the mouth.	Left side of the mouth.	Right side of the mouth.	Left side of the mouth.	Right side of the mouth.	Left side of the mouth.	Right side of the mouth.	Left side of the mouth.	Right side of the mouth.	Left side of the mouth.	Right side of the mouth.	Left side of the mouth.	Right side of the mouth.	Left side of the mouth.
Under 15	5	5	8	7	4	7	14	15	16	14	53	67	3	6	...	...
Between 15 and 20	2	2	8	4	5	7	30	22	40	38	65	59	18	26	4	3
20 „ 25	3	1	6	5	3	...	25	20	26	30	53	42	32	18	10	6
25 „ 30	3	2	3	4	1	1	8	14	21	16	26	23	22	13	8	15
30 „ 40	2	6	10	4	7	2	17	13	16	19	25	21	31	24	12	12
40 „ 50	6	3	10	10	4	8	9	7	11	9	8	20	14	10	7	14
50 „ 60	6	5	3	4	1	3	...	4	5	4	3	10	9	12	2	3
Upwards of 60	...	1	2	3	1	4	3	2	5	4	4	1	3	6	1	...
The age not registered.	...	1	1	...	...	...	3	1	4	1	...	...	1	1	...	...
	27	26	51	41	26	32	109	98	144	135	237	243	133	116	44	53

Teeth extracted from the right side of the mouth, 771; from the left, 744.

TABLE No. XI.—Showing the relative number of each Tooth taken from the right and left sides of the Lower Jaw between the several ages expressed in the first column.

Ages.	Teeth from the Lower Jaw.															
	Central Incisors.		Lateral Incisors.		Canines.		First Bicuspides.		Second Bicuspides.		First Molars.		Second Molars.		Third Molars.	
	Right side of the mouth.	Left side of the mouth.	Right side of the mouth.	Left side of the mouth.	Right side of the mouth.	Left side of the mouth.	Right side of the mouth.	Left side of the mouth.	Right side of the mouth.	Left side of the mouth.	Right side of the mouth.	Left side of the mouth.	Right side of the mouth.	Left side of the mouth.	Right side of the mouth.	Left side of the mouth.
Under 15	...	1	2	2	1	1	5	3	12	5	124	131	19	16	...	1
Between 15 and 20	2	...	2	3	...	...	4	7	9	20	107	75	66	42	8	3
20 „ 25	...	...	...	...	1	...	4	6	20	9	45	41	36	43	16	19
25 „ 30	1	...	1	...	2	...	2	4	5	10	23	23	32	27	19	20
30 „ 40	1	...	...	...	...	3	3	7	11	19	28	14	21	17	22	23
40 „ 50	6	3	...	2	4	3	2	6	6	8	11	10	16	12	13	8
50 „ 60	...	1	3	3	1	1	3	1	6	6	2	5	16	13	6	4
Upwards of 60	3	1	2	5	3	...	5	3	4	5	2	3	6	5	4	2
The age not registered.	...	...	...	...	...	...	1	...	...	...	...	...	...	1	...	...
	13	6	10	15	12	8	29	37	73	82	342	302	212	176	88	80

Teeth extracted from the right side of the mouth, 778; from the left, 707.

TABLE XII.—Showing the relative number of Teeth taken from Males and Females between the several ages expressed in the first column.

Ages.	Teeth removed from Males and Females.															
	Central Incisors.		Lateral Incisors.		Canines.		First Bicuspides.		Second Bicuspides.		First Molars.		Second Molars.		Third Molars.	
	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.
Under 15	6	5	7	12	7	6	14	23	29	18	192	183	25	19	...	1
Between 15 and 20	2	4	11	6	5	7	33	30	58	49	166	140	74	78	12	6
20 „ 25	1	3	4	7	3	1	25	30	33	52	95	86	63	66	22	29
25 „ 30	2	4	4	4	2	2	14	14	25	27	46	49	44	50	28	34
30 „ 40	7	2	7	7	4	8	23	17	34	31	48	40	58	35	35	34
40 „ 50	8	10	10	12	8	11	12	12	20	14	21	28	35	17	26	16
50 „ 60	6	6	7	6	1	4	5	3	12	9	13	7	36	14	11	4
Upwards of 60	3	2	4	8	2	6	5	8	11	7	5	5	13	7	5	2
The age not registered.	...	1	1	...	...	1	4	1	4	1	...	...	2	1	...	...
	35	37	55	62	32	46	135	138	226	208	586	538	350	287	139	126

REMARKS[a]

IN EXPLANATION OF THE

REPUBLICATION OF MY PAPER ON THE CONSTRUCTION AND APPLICATION OF FORCEPS FOR EXTRACTING TEETH.

I HAVE found it necessary, for self-defence, to reprint the following paper from the MEDICAL GAZETTE of June 4, 1841, because a work has recently appeared, which is but a repetition of the matter related in that communication, repeated, however, without acknowledgment. The work is entitled, "Observations on the Extraction of Teeth, by J. Chitty Clendon," dated January, 1843, and from 15, Conduit Street, Hanover Square. Published by S. Highley, 32, Fleet Street.

The purpose of the writer of this book has been to describe a pre sumed new form of tooth forceps, the idea of the construction of which he would have the world believe originated with himself; and, in furtherance of the latter object, he makes the following statement; "Accident at length introduced to my notice an individual[b] who readily carried out, and, it is due to him to acknowledge, improved upon my suggestions."[c]

Now the gentleman has, in the quoted passage, fallen into a most extraordinary mistake, for which I am quite unable to account.

The succeeding part of this preface to my reprinted paper will be occupied in showing that Mr. Clendon applied to my instrument maker, Mr. Evrard, of Charles Street, Middlesex Hospital; that he there saw the forceps which I had constructed; that he was told repeatedly (as Mr. Evrard assures me) by whom they were proposed; that he ordered similar instruments to be made for himself; and,

[a] These remarks formed the preface to a reprint of my paper on forceps, and are again printed to substantiate the facts stated at page 321.

[b] "The person to whom I allude is Mr. Evrard, a Surgical Instrument Maker, near the Middlesex Hospital."

[c] CLENDON *on the Extraction of Teeth*, p. 34.

moreover, that after finding patterns ready to his hands in the shop of my instrument maker, and after being told by whom they were designed, he has chosen to describe these forceps, copied from my patterns, as instruments of his own invention.

In January, 1840, during my residence at the Middlesex Hospital as house-surgeon, I thought of having tooth forceps made upon the described plan, namely, to fit accurately to the surface of the tooth for the extraction of which they were designed.

In this and the following month my plan was carried into effect by Mr. Evrard, who, from that time, has kept sets of these instruments in his shop, which have from time to time been purchased both by dentists and surgeons.

During the same year, sets were ordered for the use of both Middlesex Hospital and King's College Hospital.

In 1841, on the 4th of June, I published, in the Medical Gazette, a description of these forceps, illustrated with woodcuts. Mr. Clendon for the first time applied to Mr. Evrard on the 17th of December, 1841, nearly two years after the introduction of these instruments, and more than six months after the publication of my paper. Subsequently Mr. Clendon ordered several pairs of forceps, which were not made after his suggestions, with improvements by Mr. Evrard, but were made after the instruments Mr. Evrard had made for me; a fact proved by Mr. Clendon's engravings.

When the forceps, which he has since assumed to be his own, were shown to Mr. Clendon, he was told by whom they were proposed, and was also told that they had been described and figured; yet with this knowledge he has chosen to take upon himself the credit of the design, as is but *too* fully proved by a reference to his book, or even to the passage of which I have made an extract.

It now only remains for me to show that Mr. Chitty Clendon has described instruments identical with mine; and that he has done so, no second opinion can be held, if his book be compared with my paper from the Gazette, when it will be seen that the matter of the letter-press in each is to the same purpose, and that the figures are expressive of precisely the same instruments; except that in my communication I thought it unnecessary to give figures of those forceps required for the extraction of single-fanged teeth, whereas Mr. Clendon has of them given engravings.

That no mistakes or misconceptions through the various dates may arise, I give the following extract with which Mr. Evrard has favoured me, as taken from his order book:—

Thursday, April 6th, 1843.
35, Charles Street, Middlesex Hospital.

SIR,

Agreeable to your demand, I send you a correct copy from my order book of the various orders for tooth forceps I have received from you and other gentlemen from 1840 unto the present day.

I remain, Sir,
Your very obedient servant,
J. EVRARD.

As witness to the above statement, Mr. Evrard's shopman,
C. LOCKER.

To J. TOMES, Esq.,
41, Mortimer Street, Cavendish Square.

Orders received from Mr. TOMES for Tooth Forceps.

1840.	
Jan. 20th.	A pair of large double jointed forceps fitted to the molar teeth of the lower jaw.
	A pair of forceps adjusted to the molar teeth of one side of the upper jaw.
Jan. 30th.	A pair of forceps adjusted to molar teeth of the upper jaw.
Feb. 8th.	A pair of forceps adjusted to the front teeth.
Feb. 17th.	Do., adjusted to molar of lower jaw.
	Do., Do., small size.
	Do., Do., pair for children.
May 4th.	A set of adjusted tooth forceps, for a friend of Mr. Tomes.
July 9th.	Seven pairs of adjusted tooth forceps.
	One pair for children.
	Two pairs for molars of the upper jaw.
	One pair for molars of the lower jaw.
	One pair for bicuspid teeth.
	One pair for incisors.
Aug. 22nd.	A set of adjusted tooth forceps, for King's College Hospital.
Oct. 22nd.	A set of adjusted tooth forceps, for Middlesex Hospital.

*** Mr. Evrard has given me an account of many more orders received by him for these forceps, but I think I have already given more than will be sufficient to establish my priority.

Orders received from Mr. CLENDON, of Conduit Street, for Adjusted Tooth Forceps.

1841.	
Dec. 17th.	A pair of adjusted forceps for central incisors.
	A pair for lateral incisors.

1842.	
Jan. 5th.	Two pairs of adjusted forceps.
April	Three pairs Do. Do.
June	Do. Do. Do.
Oct. 6th.	Two elevators.
Oct. 7th.	Pair of curved, for cuspidati of the lower jaw.
Dec. 8th.	Two pairs of adjusted forceps for molars of the upper jaw
1843.	
Jan. 20th.	Two pairs of adjusted forceps for molars of the upper jaw.
March 18th.	Two pairs of adjusted forceps for molars of the upper jaw.
	One pair for molars of the lower jaw.

As a consideration of the foregoing facts will not, in Mr. Clendon's opinion I presume, lead to the conclusion that he has, in his publication, departed from that strict line of honourable conduct which forms so prominent a feature in the actions of every right thinking man, I need offer no apology for giving them publicity.

In conclusion I may state, that at the time the forceps were made and brought into use, and when the paper explanatory of them was written, although I did not think the subject unimportant, yet to me it did not seem worthy of being made the matter of a separate volume. For although instruments of similar construction were not to be found in the shops of surgical instrument-makers, or in the hands of general practitioners, it was more than probable that many who practised dental surgery possessed instruments, if not of similar construction, yet of a form which, in their hands, answered fully the required purpose. Neither should I have republished my paper at this time, and in the present form, had not the above quoted work, with its assumed originality, been issued from the press. This, however, left me no choice.

J. TOMES,
41, Mortimer Street, Cavendish Square.

April 16th, 1843.

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