ORIGINAL COMMUNICATIONS.

On Certain Conditions *of the* Dental Tissues. By John Tomes, F.R.S., Surgeon-Dentist to the Middlesex Hospital.

The temporary teeth, when about to be replaced by the permanent set, lose their fangs by gradual absorption of their substance. The crown, when thus left, having but little hold upon the gum, soon falls out. The manner in which the absorption of the dental tissues is effected has been described in a paper published in the "Philosophical Transactions," in 1853. The subject is there mentioned in connection with the absorption of bone.

Having latterly had occasion to devote considerable attention to the phenomena attending the casting off of the deciduous teeth, several conditions relative to absorption have come under my notice, which, as applied to teeth, had, I think, hitherto escaped observation. It may, however, be here stated, that the more recent examinations have not led to any modification of the opinions upon the subject of absorption advanced in the paper alluded to, but have served rather to confirm the statement there made. Absorption may commence upon any part of the fangs of a tooth, and at several points at the same time. By the gradual extension of this process, both in depth and superficially, the root of the tooth is wasted, till, at last, nothing is left but the crown, and even this part is often so much hollowed out, that, excepting the enamel, but little of the tooth remains. The *cementum* is first attacked, then the *dentine* disappears, and the enamel at those points where the *dentine* has been entirely removed suffers from the same action. But whichever of the three tissues is attacked, we see the same characteristic surface as that shown by bone when undergoing a similar action, namely, a surface full of deep indentations, as though they had been made by a sharp piercing instrument, having a semicircular extremity. These minute holes or depressions proceed in various directions, several advancing from contrary points towards the same spot, not unfrequently isolate pieces of *dentine*. If a section be taken through the substance of a tooth, so as to cut the wasting part at a right angle, we shall find the surface acted upon to have an irregular festooned outline, so characteristic, that when once seen it cannot fail to be again recognised.

It has been stated that, closely applied to the surface, a cellular mass will be found, and that this is but slightly adherent, the wasting and growing surfaces readily parting, unless the two are held together by the irregularities on the surface of the former. It will sometimes happen that the cellular mass penetrates into the *dentine* through a small opening, and there dilates, in which case its withdrawal becomes impossible. This condition is now and then found on sections prepared for the microscope, when we have an opportunity of examining the two tissues *in situ*. Indeed we shall find a few cells adherent to the surface of the *dentine* where less deep burrowing has occurred. The cells themselves do not present any peculiarity by which they could be readily recognised, if separated from the part undergoing removal. They are small granular cells, of a more or less spherical form. If a tooth which has lost its fang be carefully removed, we shall find remaining in its place a growing *papilla*, corresponding exactly in size and form to the surface from which it has been separated; and this separation may often be effected with so little injury to the absorbent organ, that no blood appears upon its surface after the operation, although the organ is highly vascular and readily torn.* The superficial extent of the papilla will be equal to that part of the tooth undergoing waste, but the extent, as regards depth, is slight, for, as the root of the tooth disappears, the socket is contracted by the deposition of bone, which forms at the base of the absorbent organ as rapidly as the cellular surface encroaches upon the tooth. The cases in which we find an exception to this condition are those in which the permanent has advanced close to the fangs of the temporary tooth, when the crypt containing the one communicates with the socket of the other, the rate of growth of the permanent having been greater than the absorption of the deciduous organ; but even in these cases we may generally observe some part in which the contraction of the socket is coincident with the absorption of the occupant fang. From the following quotation, it does not appear that Mr. Bell observed these conditions:—

"It has been already stated, that the permanent teeth during their formation are crowded together in the jaw, by being placed in a smaller arch than they would occupy if regularly placed side by side. As the latter, however, is their destined situation, we find that as soon as they are advanced to a certain point of their formation, and can no longer be contained within the *alveoli*, absorption takes place in the anterior parietes

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

of the cavities, by which means the teeth are allowed to come in some measure forward. In consequence of this absorption it often happens, that not only the socket of the corresponding temporary tooth, but that of the tooth on each side is also opened to the permanent one. Absorption now commences in the root of the temporary tooth, generally on that part nearest its successor, and thus goes on by degrees as the latter advances, until the root is completely removed, the crown at length falls off, leaving room for the permanent tooth to supply its place."

Mr. Bell, however, rejects the idea that mere pressure of the one tooth against the other has anything to do with the absorption of the first set; an opinion that he would probably have expressed even more strongly, had he observed the shallow but perfect sockets which are formed when the temporary teeth are shed before their successors are ready to appear. This, however, must be a very common condition, as I have in my own collection several specimens illustrating the point.

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

But there is still a disposition on the part of many who are intrusted with the treatment of teeth, to attribute the absorption of the roots of the one tooth to pressure occasioned by the growth of its successor, and the development of the permanent may have something to do with the shedding of the other. But this does not offer a satisfactory explanation of all the circumstances attending the absorption of the fangs of teeth. In the first place we sometimes meet with cases in which the fangs of permanent teeth are as completely absorbed as those of the temporary organs. Then, again, the fangs of temporary teeth, which have no successors, are also absorbed. These circumstances, taken with the hitherto overlooked fact, that with the waste of the temporary tooth we have pretty generally a corresponding development of bone within the socket to be removed before the permanent tooth appears through the gum, render the pressure theory somewhat unsatisfactory. Another condition may be adduced, tending also against that opinion, namely, that temporary teeth occasionally maintain their place to the exclusion

of the permanent ones, which are then kept within the substance of the jaw, or appear in some unusual position.

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

Before the laws which regulate the absorption of the fangs of teeth can be fully recognised, a more perfect knowledge of the condition attending the process must be acquired. Recent examinations have enabled me to add the following additional facts bearing upon this subject to those already known. The process of absorption once commenced, it appears to have been assumed that the same action would be continued, with more or less rapidity, until the tooth falls out; or if not continual, is suspended only. Such, however, is not constantly the case. Not only is the action of absorption suspended, but one of development takes its place. We find the excavated surface of the *dentine cementum* and enamel covered with *cementum*, the latter following all the irregularities of the former tissues, and closely united to them. In cases where this development is going on, or being set up is maintained, the teeth afford considerable resistance when their removal is attempted. In those instances where the first teeth have remained, and tend to the displacement of the second set, this deposit of *cementum* will be found to exist in considerable quantity.

The development of bone upon the surface which had formerly been the seat of absorption, by no means indicates that the tooth will not again be subject to destructive action. On the contrary, specimens in my collection show that the bone deposited under the above circumstances may itself become the subject of absorption, that this process may be again suspended and development be renewed, that the absorption may again take the place of development; in fact, that wasting and reparation may alternate until by the preponderance of the former the tooth is shed. In sections of teeth showing this peculiar condition of development, we may find upon the growing bone numerous osteal cells, with here and there a lacunal cell. A bone *lacuna*, situated within a semicircular indentation in the *dentine*, gives the appearance of a lacunal cell, and a *lacuna* similarly situated in the *cementum* (a circumstance of common occurrence), has possibly been

supposed by Mr. J. Salter to be what has been described in the paper before referred to as a lacunal cell.*

The part of a tooth which has the greatest power of resisting absorption, is that in immediate contact with the pulp. We find examples in which a thin shell of *dentine* surrounds that organ, while that around it has been in great part taken away. This is, however, eventually removed, and the pulp itself changes its character, and becomes an absorbent organ, or makes way for that which is. In a fortunate selection we may find sections showing in one part *dentine* which has been but recently formed, with its modular outline and contiguous cells, capable of developing *dentine;* in another part absorption in active progress; and in a third the deposition of bone on the surface of the wasted *dentine.* In no instance, however, have I seen *dentine* deposited upon the surface of that which has been diminished by absorption.

It would appear that the dentinal pulp, although its function may be changed into that of absorption, or its place be taken by an absorbent organ, and this, again, changed to one for the development of bone, is incapable of resuming under any recognised circumstances its primary function of dentinal development. In other words, that a portion of *dentine* when removed by absorption, cannot be replaced;† while in bone, or *cementum*, the removal of a lost portion is of frequent occurrence. Sections taken from the teeth of adults seldom fail to exhibit points where the *cementum* has been removed and again added; and very commonly the absorption has at points extended a short distance into the *dentine*, and the lost parts made good with *cementum.* This condition may be observed in perfectly sound teeth; but in unsound ones, where the *cementum* exceeds the normal amount, the removal and renewal of tissue is still more marked. If the section be so made as to give a view of the surface of the pulp cavity, we shall probably find evidence of the pulp after the full develop-

* Transactions of the Pathological Society, vol. vi., p. 169.

† Since the manuscript was sent to the Editors of this Journal, I have seen a paper published in the last number of the Guy's Hospital Reports, by Mr. J. Salter, 'On Intrinsic Calcification of the Permanent Tooth-pulp.' Mr. Salter describes a section taken from a carious temporary molar, which was removed from the mouth of a person aged 18 years. The author states, that the "pulp was found converted into a mass of crusta petrosa and dentine confounded together." The drawing is beautifully executed, and shows, by the usual indications, that the pulp-cavity has been enlarged by absorption of its parietes. Judging from a view of the engraving only, it would appear that the tissue in contact with the wasted dentine is cementum only, while the newly-developed dentine is limited to the inner portion of the mass. If this view be correct, the specimen would have served for the illustration of the present paper.

ment of the tooth, having resumed its full formative powers, and produced new, or secondary *dentine*, the action having been excited either by the wearing away of the tooth or by the presence of caries. If the irritation be continued until it extends down the fang as far as its extremity, and signs of inflammation show themselves, the aperture of the fang will become enlarged by absorption, and after awhile the enlargement is continued to a considerable distance up the root of the tooth. The canal may be again contracted by the formation of *dentine*, or by the development of *cementum;* and I have seen one or two instances in which the greater part of the pulp cavity in permanent teeth has been lined with *cementum*. This condition of tissues is very common in teeth that have been long the subject of caries, but I believe it is not confined to carious teeth. I have several specimen of temporary teeth, in which the lower part of the root has suffered from absorption, and then has become the seat of deposition of *cementum*, leaving only a small canal in the centre. High up the root small patches of *dentine* have been removed, some of which only have been made good with *cementum*, while the contiguous parts have retained their usual condition.

It will be seen that the foregoing facts bear upon the opinions advanced by Mr. De Morgan and myself, in the paper on the structure and development of bone, before cited; that we have indications in teeth, as in bone, of alternations, of removal, and deposition of tissue. In the young subject, the development of bone tissue is in excess of absorption, allowing the bones to increase in size; that in middle life the two powers, under ordinary circumstances, balance each other, and the bones preserve their adult dimensions; while in old age the absorbent action appears to preponderate. Conditions pretty nearly parallel occur in the dental tissues after the temporary tooth has been fully formed; portions of *cementum* are removed, and with it, in some cases, a little *dentine;* the lost parts are replaced by *cementum*, and the tooth is again perfect. When the time approaches for shedding the teeth, the two actions alternate; but the absorption being in excess of the development, the tissues disappear, and the tooth is shed. After the formation of the permanent teeth we have occasional alternatives of the two actions; but they are balanced, and neither increase or diminution of size is observed. But as age comes on, it often happens that absorption is in excess, the fangs diminished in size, the teeth become loose, and fall out.

Observations on the Structure of the Enamel.

Without going fully into the structure and development of the enamel, and into the citations of the opinions published upon the subject, I wish to take this opportunity of recording certain observations which I have made upon that structure. The transverse striation of the enamel fibres has been frequently remarked, but the cause of these markings has not been determined. If sections from a number of teeth be examined, it will be found that the striæ are much more strongly pronounced in some specimens than in others, and most especially so in those in which parts of the tissue have a brown colour when seen by transmitted light.

The markings crossing the direction of the fibres are of two descriptions. The one arranged in contour lines, and situated at irregular distances from each other, uncertain in number and extent, and sometimes altogether absent. The other kind minute and regular, extending from fibre to fibre, and strongly resembling the transverse markings in voluntary muscle. In the present instance my remarks will be confined to the latter kind of markings.

In unhealthy subjects the permanent teeth, when they appear through the gums, are not unfrequently destitute of the brilliant white colour common to the finely-developed organs of a healthy child; on the contrary, they have an opaque yellow colour. If such teeth be selected for examination, we shall find that the sockets, when reduced sufficiently thin to be seen by transmitted light, present in the enamel a confused opaque appearance; but if a tolerably high power be used (such as the quarter or eighth object-glass) in conjunction with a strong light, the dark appearance will resolve itself into a series of lines; the one set marking the course of the fibres, the other taking the direction of the transverse *striæ*. The two sets of lines crossing each other at right angles leave interspaces approaching a square form. These interspaces are fitted with granular masses, having the appearance of cells. By treating the section carefully with dilute hydrochloric acid, these appearances become more distinct, and we then have series of parallel fibres composed of distinct sheaths, each containing a line of granular cells or meshes arranged in a single series, presenting a strong resemblance to the ultimate fibrilea of muscles. That such is the true structure of enamel is, I think, satisfactorily proved by specimens in my collections, some of which show the cells or granular masses; whilst others show the sheath, with the contents removed. Other specimens, again, show the enamel fibres in

the very young subject, deprived of their salts, detached from each other, and floating about in the fluid in which the section is preserved.

The figures illustrating these forms were drawn from specimens which retain the conditions figured. The appearances described do not admit of dispute; but the interpretation of their origin may perhaps be differently given by observers who do not agree upon the manner in which the enamel is developed. I do not propose to enter upon the question of development; but shall for the present leave the subject, after stating the varying conditions of enamel as it is found in human teeth.

In well-formed teeth, although the cell-like markings in the enamel are not by any means as distinct as in teeth in the condition I have described; yet having first examined the latter, but little difficulty will be experienced in recognising here and there faint indications of a similar structure, especially if the light be well managed. The more perfect the development of the tooth, the more transparent and free from markings will be the enamel, when seen as a microscopic object; and the less perfect the more distant will be the columns of granular cell-fibres.

Examples may readily be found in which the union between the enamel fibres is so defective that the tissue readily breaks down; a condition rendering it very difficult to grind it sufficiently thin for microscopic examination. When obtained, however, such specimens are very instructive, as they show distinctly the individual fibres and their contents, which in the most highly-developed tissue are so perfectly fused together, that the strongly-marked distinction of parts, which is so obvious in the one, is almost entirely lost in the other.

From what has been stated it will be seen that my view of the structure of enamel is as follows:—

The enamel fibres are composed of a sheath containing a series of cells or masses; that in perfectly-developed enamel, the cells or masses and sheaths are so blended that but slight distinction of parts remains, but that in less perfectly developed tissue the component parts remain visible.

(*To be continued.*)