perature to 104.5 degrees. Upon removal of the dressings, which up this time had not been disturbed, a faint suspicion of pus was found oozing from beneath the skull, in the tempero-sphenoidal fossa. A small probe was carefully pushed between the inner table and dura, upward and backward along the track of this oozing, for a distance of an inch or more. The withdrawal was followed by a few drops of pus, making it evident that a pus cavity was located in the region explored. Deeming it necessary to have the patient under general anesthesia in order to thoroughly evacuate the epidural abscess, as well as to explore for other infectious foci, it was suggested that ether be administered at once, but to this he emphatically objected, saying that he preferred to die rather than submit to further operative procedures. I then decided to enlarge the fistulous opening as much as possible by hurried but forcible pressure with blunt probe, and trust to drainage for the rest. The passage of the probe, though exceedingly painful, resulted in draining the abscess cavity of, perhaps, a dram of bloody pus. A light gauze dressing was applied. Three hours later the temperature had dropped to 101 degrees, and there was a decided lessening of pain. For two weeks following this the temperature varied between 101 and 102 degrees, with an occasional chill to break the monotony, and for fully ten days longer the temperature varied between 99 and 100 degrees. The wound was dry dressed twice daily for three or four days, and then once daily for a week, at the end of which time the parts, including the middle ear, what remained of the mastoid antrum, and exposed parts of the dura mater and lateral sinus were free from discharge. The tenderness along the line of the jugular slowly disappeared, though it could be detected as long as three and a half weeks after the second operation. A moderate amount of pain on the affected side continued for fully a month, but finally disappeared altogether.

The patient, under good nursing, stimulating and tonic treatment and careful attention to all eliminative functions, slowly recovered strength, and finally returned to work about the first of October, three and a half months after his last operation, and is now running regularly between Chicago and Fort Wayne. The wound has gradually filled with granulation tissue, though an extensive scar, with marked depression of contour of the skull exists.

The case presents many interesting features, among which are:

1. The development of a well-marked sinus phlebitis, with probable thrombosis, after apparent recovery from abscess of the mastoid antrum which had been thoroughly evacuated. I attribute this to infection arising from carious bone at the bottom and inner aspect of the large cell at the apex of the mastoid process, which was probably overlooked at the time the mastoid operation was performed. This carious process, easily overlooked in the mastoid antrum owing to the small area of presentation in that cavity, undoubtedly involved the inner table at the time of the mastoid operation, and if removed at that time would have obviated the necessity of a second operation.

2. The final disappearance of this phlebitis and probable thrombus without the development of other pyemic manifestations, such as pulmonary infarcts or abscesses in other portions of the body, or a fatal termination.

3. The development of an epidural abscess somewhat remote from the site of the carious process, and not discovered nor suspected at the time of the second operation. This was probably occasioned by the burrowing of pus from the original mastoid abscess and subsequently becoming walled off by adhesive inflammation.

4. Demonstration of the necessity of thoroughness in mastoid operations, which should not only include free opening of the mastoid antrum and obliteration of pneumatic structure, but careful search for and removal of small areas of diseased or carious bone.

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TOOTH FORMS IN RELATION TO JAW MOVEMENTS.

Presented to the Section on Stomatology, at the Forty-ninth Annual Meeting of the American Medical Association, held at Denver, Colo., June 7-10, 1898.

BY ALTON H. THOMPSON, D.D.S.

TOPEKA, KAS.

The writer feels like apologizing for addressing the Section upon such a simple thing as the relation of tooth forms to the movements of the jaws, and in defense makes the excuse that there is, as you well know, such a general misapprehension and lack of appreciation of many such simple principles of the profession that reiteration is never out of place. The writer has hopes to enlist the interest of the Section in the cultivation of a better appreciation of at least one of these simple principles. It is not sufficient to say that these things are found in the text-books. The text-books are rarely studied and the living principles must be presented over and over in meetings in various forms of dress, that all kinds minds may be reached and interested and lifted up.

To be brief, therefore (in a paper which can only be suggestive), we wish to call attention first to the causes of the various forms of jaws and teeth found in the animal kingdom. In following the teachings of evolution we must understand that function is the cause of structure, and that organs are created in response to demand for performance of functions. The teeth were therefore produced for the purpose of performing a function and that function is the reduction and preparation of food for digestion. Not only were the teeth produced for this purpose primarily, but by the variations presented by different kinds of food animals came to employ, they have been infinitely modified and many various types evolved. This adaptive modification has led to the almost endless varieties of teeth and masticating apparatus found throughout the animal kingdom, all of which are adapted to the reduction of particular kinds of food. To the primary function of food reduction, there must be added the secondary offices that the teeth are often modified to perform, as tools, implements, weapons, etc.

The food-supply is one of the most potent influences in the environment of animals, and is secondary only to climatic conditions in determining the course and forms of life. The variation of the quantity or quality of the food-supply has led to the modification of all the species that have lived upon the earth. Gradual and persistent deviation has been the most potent for a change in structure, while sudden alterations in the food environment have resulted in the extinction of whole genera of mammals. The work of dif-

ferentiation and conformatory adaptation of the masticating apparatus and teeth has progressed onward through the eons until the result is an extensive and most wonderful variation. But in all the variation and complexity of structure, we observe a remarkable adaptation of means to ends, of instruments to purpose, of tools to material. The cause is the material, the tool is the result. The variations in the food-supply caused the variations in tooth forms.

The same law applies also to the evolution of the jaws and masticating apparatus, the support and environment of the teeth, which were developed by adaptive modification for the same purpose, viz., the reduction of food preparatory to digestion. The teeth being merely the armament of the jaws, it follows that they were developed with them for the same purpose. The lower jaw or mandible has been described as a lever of the third class, in which the glenoid cavity is the fulcrum, the muscular force the power and the resistance of food the weight. Since the co-efficient of muscular power is 104 pounds per square inch, it is easy to surmise that the tendency of the exertion of the great masticating muscles upon the jaws and teeth must be to react powerfully upon those structures directly subjected to the resulting strain.

The principles of construction and motion of the specialized parts devoted to mastication and the precision and force with which this function is performed in the majority of animals possessing vertic mandibular occlusion, are wonderfully illustrative of the capacity of the animal mechanism for the display of power. The modification of the forms of the teeth and their supporting mechanism is directly due to the force of occlusion and of jaw movements. These tissues, like other parts, are disposed to develop in the line of greatest resistance in order to meet the demands of use. This is what Dr. John Ryder calls "displacement due to strain." He says, further, that "many of the parts associated in the function of mastication are greatly modified and brought to their present shape by the resistance incident to its performance. . . . There are distinct kinds of mandibular movement, and each kind corresponds to one very distinct type of tooth. Thus, in the carnivora, the tubercles are laterally compressed and raised into sharp edges to form effective cutting instruments, the teeth being developed in the direction of the vertic movement of the jaws." In the opposite extreme, the herbivora, the lateral movement of the mandible causes the plication of the molar crowns in a line transversely to the direction of the strain exerted during mastication. As the excursive movements have increased in complexity there has been increase in the complexity of the enamel foldings, ridges, crests, etc. It is concluded, therefore, that the various forms of teeth and mandibular articulations have been molded into shape by the jaw movements and force of occlusion and also that they bear a direct relation to each other and exhibit associated types that are constant.

To go into some detail, we find that in the lowest and simplest form of tooth, that of the single cone, the reptilian type, it is associated with a mandibular movement that is purely vertic, mere opening and closing. This movement performs the one function of the teeth, i. e., prehension, for division and mastication of the food is unprovided for in these animals. There is wide opening of the jaws and after sharp closure a pulling motion is exercised. To resist these motions the teeth alternate above and below and are long, conic and sharp and slightly recurved to hold struggling prey. The teeth and jaws are well adapted to perform their functional duties together.

Among mammals, the two great extremes of types are the carnivora and herbivora, with some intermediate and composite types which subsist on an omnivorous diet. The carnivora, as you will recall, are possessed of a mandibular articulation which is like a simple hinge that allows of but one movement of the jaw, i. e., opening and closing, with no lateral excursion whatever. This movement requires the long canines and the long blades of the premolars to pass close to each other in the seizing and cutting of flesh, with a shear-like motion. The condyles are also shaped to resist the strong pulling motion which the curved canines are formed to effect in tearing flesh. The blades of the premolars and molars are developed vertically in the direction of greatest force, to effect the cutting of flesh. The jaw bones are short and stout and the closing muscles strongly developed to effect strong vertic force. The *Filtdœ* present this extreme modification, but there is a general departure from this type through the hyenas, dogs, bears, and other omniverous animals which employ a mixed diet. The jaw articulation becomes more open, to allow of some lateral motion of the jaws; the teeth become modified to the tubercular form to masticate vegetable food, and the grinding teeth increase in number as the function of mastication comes more into use. In the Filidæ, the true cats, there are no tubercular teeth and no mastication, but in the more omniverous carnivora there is development of number and tubercularity of the teeth, and the jaws become longer.

In the other extreme, that of the herbivora or the plant-eaters, we have in the ungulata the best example of extreme lateral excursion of the mandible. This is due to the open temporo-maxillary articulation allowing extensive movements in various directions, but not much vertic play. There is also less density and diameter of the jaw but much lengthening. By a peculiar arrangement of the dental tissues, the wear of mastication preserves a constantly rough surface for the effective trituration of resisting vegetable fibers. The lateral movement of the jaws produces lateral extension of the teeth, in obedience to the law of development in the direction of resistance and use. The pigs show the first tendency to lateral movement and have lengthened crown crests to meet this movement in masticating. The tapir presents a little more lateral movement, and the kangaroo still more, with corresponding folding of the crown crests. The rhinoceros, the horse, and their allies, have a larger jaw excursion, and the ruminants most of all. The forms of the molar crowns follow the law of displacement due to strain, and in the latter class present many very complex patterns, as in the ox, deer, sheep, etc., owing to foldings and complications of the crown crests. The movements of the jaw are lateral, anterior-posterior, and diagonal, and in consequence the crowns of the molars are extended horizontally, with resisting ridges in every direction opposed to the horizontal movements. Other herbivora, as the rodents, have complicated molar patterns also. Some, as the beaver, have molars composed of transverse plates of enamel, which are so arranged as to resist the antero-posterior mo-

tion of the jaw, which is the main movement. This is also the main motion of the proboscidæ, the elephants, mastodon, etc., which have ridges of enamel arranged transversely to resist this main masticating movement.

In regard to man, who is a simple bunodont of primitive type, there are limited antero-posterior and lateral jaw movements with slight crown crests and cusps to oppose them. Like the bears and most omnivorous animals, the crests are weak, and tubercles for mere crushing are the most marked feature of the occluding surfaces of the molars. The dentition of man is much like early types found in the eocene geologic formations, which were much generalized and from which the later more specialized forms were developed. Both his teeth and jaws are degraded if not primitive in type.

MANAGEMENT OF PULPLESS TEETH.

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Two thoughts induce us to present the following suggestions upon the subject indicated by the above title: 1, that pulpless teeth and roots are susceptible of being retained in the mouth and made serviceable and comfortable under a proper treatment, for a much longer period than is usually realized in the modes of treatment adopted; 2, faulty management is so very common that it would seem important that some effort ought to be made for a better mode of procedure in this particular of practice. It is entirely familiar to all dentists of much observation and discrimination, that by far the larger share of disease and discomfort from affected teeth occurs in cases where the pulps have been destroyed (usually the result of decay). Disease and severe pain many a time occur before devitalization of the tooth-pulp, and without some appropriate treatment, the teeth are disintegrated and destroyed.

Physiologically, teeth pulps were intended to serve a valuable purpose during the life of the organs with which they are associated. There is an important function which they should serve during this period, but unfortunately, from one cause or another, there are multitudes upon multitudes of pulpless teeth and roots. The common occasion of death of this tissue is by decay of the teeth. Subjecting the pulp to exposure, irritation, inflammation, hypertrophy, suppuration and death, this is the common result of this process. Pulps are, however, frequently devitalized in other ways. Calcific deposit in the pulp chamber or in the pulp itself, or upon the apex of the root, cutting off its vascular and nerve supply, is not an infrequent occasion of pulpless teeth. In the low state of health when the nutrient function is impaired, its tissue sometimes becomes devitalized without any apparent cause. The conservation of exposed tooth-pulp, is a mode of practice that under favorable circumstances and with proper skill is entirely practicable; in a very large percentage of exposed pulps, as they are found, it is the result of decay. The indications presented in many cases are not such as to promise much good for conservative effort and hence it occurs many times that the destruction of the pulp is a necessity, if the best results are to be attained.

The best method of accomplishing this is not always employed. Many methods have been used which we will not fully consider here. It is hardly proper to pass from these points, however, without two or three suggestions. One is that when an exposed tooth-pulp is to be devitalized and removed, its conditions should be as thoroughly understood as possible, and not only this but the peculiarities, whether normal or abnormal, should be understood. The practice of applying poisonous escharotics, as arsenious acid, for example, should always be avoided. With the appliances and facilities at the command of every dentist the use of such agents is wholly unnecessary and especially so when it is considered that most serious results follow their use in some instances, in either the immediate or remote future, and especially to those highly susceptible to the poisonous influence of arsenious acid or similar agents. Specific results in some instances occur within twenty-four hours; these results, however, may be in other cases delayed for weeks or months before manifesting any action in a very marked manner. It is better that these agents never be used for this purpose and that some methods should be employed that would not leave a sting behind. Since cocain has been used as an anesthetic, there has been no occasion for using a more violent agent, as by proper application to, or injection of the agent into the pulp it may be so anesthetized that its painless removal is an operation entirely practicable. Since the general introduction of anesthesia by cocain and the electric current (cataphoresis), it is a very simple operation to render an exposed pulp entirely oblivious to contact, when it can as easily be removed from its habitat as any other tissue of the body. This can be done by the use of the barbed broache or a sharp pulp-extractor. In the performance of this operation, the teeth should be perfectly protected by the rubber dam, from the saliva or any agent that would convey infection. The instruments employed in the operation should be absolutely aseptic and kept as nearly so as possible during the operation.

The broaches, if they are used, should be moistened during the operation with some efficient antiseptic fluid. The instruments used in cleaning out the canal should be used with the same precaution. When the pulp chamber and canal have been treated in this manner it is the best possible condition for permanent enclosure, unless there is a persistent hemorrhage or weeping of the plasm from the foramen into the canal, and that in most cases is readily arrested by some appropriate styptic or coagulent, as Lugol's solution, tannin, persulphate of iron and numerous other things that will suggest themselves to the intelligent dentist. In by far the larger portion of cases this flow will cease spontaneously in a very brief time, but if not it may be assisted as above indicated. When the pulp has been brought to this condition and thoroughly dried by a jet of warm air or by the use of a copper root-drier, it is in the best possible condition for permanent enclosure. In such cases nothing can be gained by the very common prolonged treatment preparatory to filling. The best time for closing such cases is immediately. If there is a doubt as to the entire arrest of the plasm flow through the root, it may have packed into the canal a small pledget of lint, moistened with some astringent, then fill the canal with Hill's stopping or some material that will be impervious. Twenty-four hours will be sufficient to determine whether the flow has been entirely arrested.