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# The distinctive features of masticating dentures as demonstrated by comparative occlusion

Axel Lundström
Goteborg, Sweden

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In papers on orthodontia allusions are frequently made to the importance of studying comparative anatomy. It is argued that it is impossible to understand the anatomy of the human denture properly unless compared with other dentures. But I have never found any specific reasons for this statement. The treatises on comparative dental anatomy that I have seen have principally contained descriptions of the teeth of different classes, orders, etc, of animals. For example, we are told in one textbook that is, I believe, extensively used in the dental colleges of the United States that 'The Inguandon had remarkable teeth. Some were flat and spread out like a fan with serrated edges —the base constructed of folded laminæ of dentine and cementum, similar to the teeth of the Labyrinthodont'. Such facts are no doubt very interesting, and it may be handy on some occasions to have a book containing them, but they have no direct bearing on orthodontia. But yet I am convinced that comparative anatomy has one or two points to teach us, but they are so simple that they do not require any extensive study, and once observed they are never forgotten.

The modern orthodontist of the best training will, with his acquaintance with normal denture of man and his skill in bringing about this condition in cases presented for treatment, never have any need of comparative anatomy to convince him of the reasons for operating for the best result. But there are many other people concerned with the treatment of malocclusion, so we ought to be able to produce every possible argument in favour of our work. And is seems to me that if we can find that certain characters of the human denture are a rule also with animals in need of mastication, we can conclude that our operations must result in these characters, if it be granted that effective mastication is necessary for the health of man.

The human denture and face are so radically different from those of all other animals, even the most similar, that from an artist point of view orthodontia has nothing to learn from the study of comparative anatomy. The appearance of different animal dentures seems to me to be something that the orthodontist has no need to be acquainted with, as he never will be required to fashion the human dentures and face after an animal one. But some functions of the teeth are the same, so we expect to find a certain correlation in human and animal dentures.

It is well known that during evolution the organs of an animal are accommodated according to its wants, in such manner that if useful variations occur in a sufficient number of individuals, they have a chance of becoming fixed and in time become a specific character. It may be of interest to follow this line of evolution, as far as it concerns the teeth.

From what has been investigated concerning the ancestors of the living mammals it appears that they were less specialized, if it be permitted to use such an expression. They were probably in a better position to accommodate themselves and to thrive in a greater variety of conditions than their better equipped descendants, although they would have been easily beaten in these descendants special field. This lessened ability to become accommodated can be shown by several examples from the animal world, where certain species, having evolved some organ to perfection, yet have sooner become exterminated than their lower relations, as soon as the advantages of this excessive specialization had disappeared.

If we now examine the evolution of the masticating apparatus of mammals we will find that in the denture of those animals to whom mastication is of importance certain sections of the dental arches have become specially modified for this purpose at the expense of others which have remained unaltered, becoming more or less rudimentary, or even disappearing. The original denture gets divided into one part that is used and another that is not used. Between these two sections we may note the following differences: when teeth are present in the not-used portion of the arch, they become subject to several changes during the evolution of the species in question, of which the most important are that they do not reach occlusion, and they become smaller and get separated approximally. The teeth in the used portion, on the contrary, retain occlusion and have approximal contact. The farther the division of labour has advanced, the more apparent is the difference. The denture of the carnivore is very instructive in this respect. The felidæ are perhaps the most purely carnivorous of them all. Of their remaining 14 premolars only eight seem to be of

any use. These eight are well developed and have occlusal and approximal contact, which the ones anterior to them are without. The dog family has on each side of the upper jaw four premolars and two molars and in the lower four premolars and three molars. Of these 13 teeth no fewer than seven are too short to strike those in the opposite jaw. There are also spaces between them, while the *dens sectorius* and the remaining molars have approximal contact.

The ruminants and many other plant-eating animals have advanced far beyond this. Their masticating teeth are in close contact, which is not a point, but a considerable surface. On each side of the jaw they constitute a continuous masticating surface, divided from the anterior teeth by a wide space.

We stated that the original denture in animals requiring thorough mastication could be divided into a used and a not used section. With ruminants the former has attained a high degree of perfection and the teeth of the latter have disappeared.

We find the same conditions in the dentures of other ungulates, rodents, etc., viz., no spaces between those teeth that are used for mastication, which character is widely prevailing in different families of mammals.

These groups of mammals, who within their class must be considered as highly organized, have also their dentures well suited for that special mode of comminution of the food, that is of most use to its owners. In the portion of the denture that is most used the teeth have greater width bucco-lingually and approximal contact. We draw the conclusion from this, that for effective mastication those two characters are imperative. There are, however, several groups of mammals that have dentures so defective in just these respects, that we must subject them to a more thorough investigation to examine if their anatomy does not contradict our conclusion.

Among those mammals whose dentures are without the characters we stated as necessary for mastication we may first note the toothed whales. They have often a large number of teeth, but these are small and simple in form and are quite unsuitable for mastication. The bruta also have often a very defective denture, and some are quite without teeth. The sloths have cylindrical teeth with approximal spaces between them all. It would probably be difficult to decide if the food of these animals, poorly equipped with teeth, is more digestible than that of those we first discussed. In many cases the difference seems to be insignificant. The grampus has teeth that are quite unsuitable for mastication, but preys on the same animals as the polar bear, which has a far more efficient denture. The toothless ant-eaters and pangolins live on insects, which the insectivore also do, and the sloths browse leaves like many ruminants.

And that it is not by chance that so many genera of animals have far more perfect organs of mastication than others is easily seen from the fact the development of the salivary glands corresponds with this, so it becomes necessary to take into consideration their existence and sizes. We will then note that in proportion to the functions of the mouth being decreased so are these glands diminished in size. The piscivorous whales, who bolt their food like fishes, are without both parotis and sublingualis. But the plant-eating sirenia, who have masticating teeth, have also a large parotis. The carnivorous dasyurus has a small parotis and large sublinguals, while the herbivorous phalangista vulpine has a larger parotis than its insect and flesh-eating relations.

If we study the higher forms we will find further examples of the relative preponderance of parotis in animals requiring thorough mastication, *i.e.* vegetable feeders, while the sub-maxillary glands are larger in carnivore. Parotis is large in the horse, hog, all ruminants, but small in carnivora, and it is very small and even in some cases missing in seals. The sub-maxillaries are best developed in those which need the saliva rather as a lubricant to facilitate the passage of the food through the pharynx than as a fluid for its insalivation.

We stated that a large number of mammals were characterized by dentures quite unsuitable for mastication if, as we have assumed, for this is required broad occlusal surfaces and aprroximal contact. And, thanks to caries unhampered by any dental treatment of substituted only by work unsuitably designed, we find a very large percentage of people with dentures, that in point of efficiency remind us of those belonging to these animals, as for example those of the edentate, in which we find different graduations of poor masticating machinery down to the toothless ant-eaters and pangolins.

No doubt these dental conditions correspond to the need of their owners and it may be asked, if not the defective dentures of so many people also are sufficient. The likeness between a defective denture in man and the denture of one of these edentate proves that neither can masticate properly. But there is a great difference between them in the other digestive organs. Concerning this Owen says: ‘The leading character of the stomach in bruta is one tending to compensate for the poor masticating machinery of the mouth, indicated by Cuvier’s name of the order. It is, of course, least conspicuous in the toothed families; but even in these the musculo-tendinous structures at the pyloric portion, and the thick epithelium continued over the inner surface of that part in phyllophagous species, significantly indicates a community of type under the mask of the most complex modifications of the digestive cavity. The great expanse and subdivision by broad and permanent folds of the cardiac cavity simulates the ruminant stomach.’

We may cite some examples. The ant-eaters have the pyloric portion of the stomach so excessively thick and muscular that it can be compared with the muscular stomach of a bird. The pangolins who also are toothless have the stomach ‘divided in a thin cardiac sac with thin walls, and a thick pyloric portion. It always contains a number of stones.’

The Cape ant-eater, *orycteropus*, has teeth it is true, but their number generally gets reduced to nine on each side and has the stomach divided in a right and left position, the former of which has very thick and muscular walls. The sloth has approximal spaces between all the teeth. Its stomach is singularly complicated. It is of enormous size and divided into four compartments, somewhat analogous to the four stomachs of the ruminants.

We have yet one group of non-masticating animals to whose digestive apparatus we will give some attention. It is the whales, the stomach is complex, divided into several cavities, as in all true cetacea. To this end, the first cavity is continued in the same line with the oesophagus, having the same structure and not being divided from it by any sensible constriction; its commencement is indicated by the orifice leading into the second stomach, beyond which orifice it is continued in the form of a diluted ovate cavity. It is lined with a cuticle, or thick laminated epithelium, and its inner surface is beset with small rugæ. A number of large irregular projections surround the aperture leading to the second cavity, and are calculated to prevent the passage therein of any substances save such as are of very small size. Notwithstanding the nature of the lining membrane, the digestive processes are considerably advanced in the first cavity, which does not act simply as a reservoir. The thick epithelial lining terminates abruptly at the small orifice leading in to the second stomach. The interior of this cavity presents a series of close set, longitudinal, wavy rugæ, laterally indented into one another. The internal layer is thick, and mainly consist of unusually long gastric tubes perpendicular to the two membranes which enclose them. The membrane next to the cavity of the stomach is smooth; the one external to the fibres is a vascular and cellular tunic, and is invested by the layer of muscular fibres, continued from the preceding cavity.The third compartment is a small, round vascular cavity; it is lined with a smooth and simple villous tunic. The fourth cavity is long and narrow, and passes in a serpentine course almost like an intestine.

While comparing the digestive conditions of these animals with those of human beings with defective dentures it will not evade our attention that although the masticating capability of both is insignificant, yet the animals have compensation in other parts of the digestive apparatus which man has not. So that if other conditions are the same, people with these defective dentures are at a greater disadvantage than these animals as regards digestion.

It would be outside the province of this paper to attempt to discuss whether at this period of evolution it is necessary for man to have a masticating apparatus of the strength and efficiency of a normally developed human denture. From what has been investigated in this matter (v.Oefele), it seems that thorough mastication is a very beneficent factor in the process of digestion. And it is far safer to give all organs of the body a chance of the use which we, lacking a better expression, say they were intended for. So, granted that what I have tried to show in the foregoing, namely, that occlusal and approximal contact are necessary for effective mastication, and if our present knowledge does not justify us in assuming that this is an unnecessary function, it follows that our operations and orders for operations in the specific masticating portions of the human denture must result in approximal and occlusal contact. We are strengthened in this assumption by the fact that in those animals, where the approximal contact was missing, there was ample compensation in other parts of the digestive apparatus.

By quite different modes of reasoning, modern orthodontia has arrived at the same conclusion regarding the best possible conditions of the human denture. During earlier periods, while all orthodontic work was connected with the practice of dentistry, certain methods were common, which resulted in more or less the opposite to what seems an efficient denture. We have probably all of us seen the disastrous effects of so-called symmetrical extraction and extraction ‘for providing space’ in crowded arches is still frequently resorted to.

In the foregoing I have tried to show what I believe to be the most important that comparative anatomy can teach the orthodontist. And in spite of the interesting facts that it will reveal to the student, if examined in its various details.The instruction in this branch of science ought, in my opinion, to be limited to the points that I have spoken of in the foregoing. With the help of a collection of jaws it ought to be shown, how the dentures have from simpler forms become more and more complex, and that in those parts which are used for mastication approximal and occlusal contact is the rule. Also that where these characters are wanting the animals to have as compensation a more complicated digestive apparatus. Of course the enthusiast will find many other interesting facts, but I believe the outlines I have here briefly sketched are by far the most important and give the most useful returns to the student of orthodontia.

I must admit that I have never attended any lectures on comparative dental anatomy specially worked out for orthodontists, nor have I heard of how such courses are conducted, but from discussions on these matters both with orthodontists and dentist I have found the prevailing opinion to be that we ought to know something about the teeth of animals, but there seemed to be rather vague ideas as to what this knowledge ought to contain.