Comparative Mammalian Mastication

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Phylogenetically, man has placed himself in the order of primate and perhaps only because, anatomically, there are some apparent similarities. Morphogenetically, Homo sapiens has evolved from an earlier semblance of quadruped to biped stature. The opposed digits and increased brain capacity has given man an extension and capability that transcends his environment and, to a limited degree, control of it. Power for locomotion and food gathering, a life necessity for all animals, is no longer a vital concern to man and here he pays a physiologic price. It may be said that he has made the greater compromise with his dentition. His only need for teeth has become esthetic.

W. Warwick James[17] says, "special mention needs to be made about the teeth of civilized man. Their beauty is regarded as their chief attribute, for concern about front teeth is well-known. Removal of teeth so widely practiced today is not considered serious as artificial substitutes serve sufficiently well. In fact, the teeth of civilized man as zoological studies are probably better regarded as pathological and degenerate structures." When odontologists prepare observations and analyses of the human dentition, dilemmas abound. Bernhard Peyer[32] wrote, "When it was attempted, long ago and unsuccessfully, to arrange animals in a single ascending line according to the levels of their organization, it was obvious that the monkeys and man must be placed at the upper end of this ladder. For a presentation of the relations of the dentition, this did not work, however, because the dentition of man is in no way particularly highly advanced. It is, in fact, so little specialized that it is best discussed with that of the primates, following the still more primitive insectivores."

Occlusion is an open and shut relation between teeth and toothlike structures or their derivatives and substitutes located on opposing moving parts.[11] The functional mode of the denticles or teeth may be either grasping such as sharks and reptiles, shearing as in meat eating animals, or crushing and grinding as in vegetation eaters. The simplest tooth form is the conical tooth of reptiles or haplodont. The addition of little side cusps forms the protodont tooth which, according to Osborn, is seen as a basic triangular cuspal pattern in all fossil and extant mammalic jaws. Predatation requires the most developed and specialized teeth and jaws as in the order of carnivore. As primates evolved from carnivorous-insectivorous diets, molar cusps have tended to become less shearing and fewer in number. Evolution takes on a form of simplification and retrogression.[14] The simpler tooth forms in modern man are probably secondary acquisitions.

Mammalian digestion places certain demands on teeth. The ruminant stomach depends on considerable trituration of tough and fibrous foods to digest cellulose. Herbivorous molars have developed specialized patterns to mill and grind lower surfaces over upper surfaces. Incisors are not found in all herbivore species, and they are not necessary to pick plants and browse. Canines are usually vestigial; it has been speculated that this absence is associated with horn and antler formation. The herbivore molar is specially reinforced with vertical plates of enamel to resist wear. There is an infolding of the tooth crown enamel interlayered with cementum (Fig. 1). The cementum wears at a faster rate leaving ridges of enamel as

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Fig. 1 Herbivore molar pattern of the deer. Ridges of enamel interlayered with faster wearing cementum provide mechanically efficient grinding surfaces.

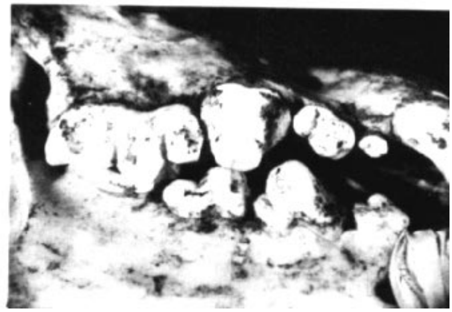

Fig. 3 The heavy, specialized premolars of the spotted hyena. This break-shear function is probably the most powerful of mammalian dentitions.

grinding flutes. Because of rapid attrition and the longer life span of some herbivores such as elephants, molar teeth are constantly formed at the posterior end of the arch and migrate anteriorly when badly abraded. Worn teeth are lost at the forward end of the arch.

The carnivore diet is primarily meat and the mode of food gathering is predatation and scavenging. The teeth of the strictly meat-eating animals are highly specialized to first kill by grasping and puncturing vital areas with long heavy canines. Secondly, the flesh of the quarry is severed and reduced by the shearing action of the two pairs of sectorial or carnassial molars (Fig. 2). In the cat family these teeth evolved from the upper fourth premolar and lower first molar. As the sides of these crowns shear past each other, the two broad, flat buccal cusps become progressively blade-like to form a complete pair of scissors. Brodie[5] analyzes the sectorial function of the carnassial teeth which he terms "the law of shear." He points out that the mediolateral shift of the mandible by the medial pterygoids and the laterally directed fibers of the masseters from the wide zygomatic arches develops a scissor-like cutting action of the carnassials, but only unilaterally. All incisors and premolars have become rudimentary while the canines have become long and heavy. The hyena is a unique exception, where large premolars have developed as bone crushers (Fig. 3), reducing long bone for the marrow.[22] Undoubtedly, the

Fig. 2 Carnassial teeth of the Canadian lynx in initial contact. Dentitions of this sort are called "secodont" (Peyer).

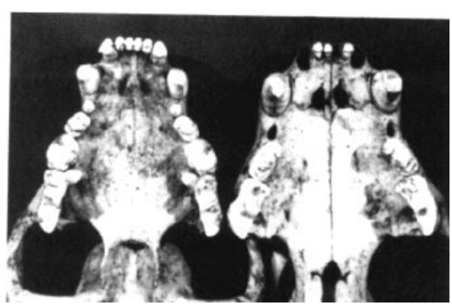

Fig. 4 Although the hyena is a smaller animal its dentition and skull (left) are more robust than the larger lion (right).

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Fig. 5 Potos flavus or honey bear. This Central and South American mammal's diet is both frugivorous and insectivorous. Note the flat molar pattern.

hyena has evolved the most powerful animal jaw in the world (Fig. 4).

The character of the food need not correspond to the designated grouping as there are omnivorous and herbivorous carnivores, such as the giant panda which feeds on bamboo exclusively. Most bears are omnivorous though classified as carnivores (Fig. 5). The aardwolf, a specie of hyena, is actually insectivorous.[40] Also insectivores, such as hedgehog, shrew and mole do not feed on insects alone but take on small animals as well. However, as the diet becomes more omnivorous, elevations on the surface of the molar crowns rise to form the trignoid and protocone which serve as mortar and pestle in crushing. The tooth patterns in early primates combine features of insectivorous and omnivorous-frugivorous types that exhibit a cogtooth occlusal relation.[11] The upper occlusal plane of most primates is arranged in a long anteroposterior convexity, while the lower is arranged along a concave curve. In this arrangement, as the jaw begins to close, the first parts to occlude are the medial posterior cusp of the lower third molar and the posterior border of the upper third molar. As the jaws close, interlocking proceeds forward like the teeth in a cog wheel. At the same time a lateral component becomes conspicuous causing the lateral elevations of the lower teeth to shear across the lingual surfaces of the outer cusps of the upper molars. This displacement takes place in an ectal-ental direction from inside outward and outside inward. This lateral movement becomes necessary as the diet requires more trituration or milling, such as in cattle and sheep.

The dentition as a whole is not static, but must be thought of as a collective name for a long series of events from tooth germs until death. In the individual there is a slowly-changing pattern of occlusal relations. In most mammals and in man there are two prolonged crises in development of the diphyodont: first, the completion of the deciduous dentition and secondly, the completion of the dental arches of the permanent dentition.[11] In man the relatively prolonged maturation from deciduous to permanent dentition allows other changes in the neuromuscular patterns to evolve in response to glenoid fossa and eminentia development.

The jaw action of most carnivores is that of mere opening and closing in a hinge-like action called ginglymic or orthal. The closer and more exact the cusps must pass each other to cut or shear, such as the carnassials, the more there must be a stable fulcrum or hinge action in the mandibular condyles and fossae. Strong retroglenoid processes inhibit posterior movement but consider-

Fig. 6 Lingual view of racoon temporomandibular joint.

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able lateral shifting must take place to maintain contact between carnassials (Fig. 6). This is evident from the powerful medial pterygoids running almost horizontally to provide for the mediolateral shift to maintain tight contact of the carnassial blades as the powerful temporals and masseters close the jaw. The wear facets on the lingual surfaces of the upper carnassials and buccal surfaces of the lower carnassials of the lion show characteristic wear while there is no contact of these surfaces on pure vertical, sagittal closure. This action of shear is not only necessary to sever meat but, equally important, to hone the cutting edges of the carnassials.

It is also evident that the canines of the lion play a stabilizing role in this lateral movement and provide a sort of anterior fulcrum for the posterior shift of the mandible. In the hyena, tooth wear is more pronounced where abrasions occupy almost the entire buccal and lingual surfaces of the carnassials. As scavengers and carrion feeders, they break and crush all but the largest bones of cattle and cape buffalo with their heavy premolars. The hyena's temporomandibular joints allow much less lateral shift of the mandible. The medial pterygoid would seem to be somewhat diminished in size and function and this is evident by the relatively reduced gonial process. Gonial area has been shown to be undeveloped and rudimentary with experimental excision of the medial pterygoid muscle.[38]

One of the most unique examples of ginglymic or hinge movement is found in the badger where the condyles are encapsulated which prevents disarticulation of the mandible (Fig. 7). Lampi[24] suggests that this firmly supported socket minimizes the effect of torque applied to the mandible by the struggling prey. Nevertheless, lateral movement is still evident.

In a study of the symphyseal joint

Fig. 7 Hinge action of the badger TMJ.

or "third joint of the canine jaw" Scapino[36] describes the function of the mandible of the dog as "The cutting edges of the carnassial blades are the first dental elements to contact. After this upper-lower molar contact, the anterior side of the lower canine in the passive jaw engages the posterior edge and cingulum of the upper third lateral incisor on the same side. This area of contact is usually marked clearly by a prominent wear facet on the canine. The canine-incisor contact completes the guiding of the jaws back into centric occlusion. At no time during masticatory stroke did the upper and lower canines contact each other. In older specimens, there was greater canine-canine contact."

The observation by Scapino is somewhat contrary to a popular belief that the canine contact is necessary and precedes or guides the closing of the mandible, particularly in carnivores. When manipulating dry skulls, canine contact is usually seen after carnassial engagement. Canines then continue to glide to full closure immobilizing the mandible anteriorly from any lateral motion. However, the posterior intercuspation seems to possess freedom of movement as the condyles shift with the canines as a pivot. Occlusal facetation seen on molars of bears and apes would give credence to this observation (Fig. 8). A fascinating example of canine function can be seen in the baboon where the

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Fig. 8 **The close interlock of the canines of the Tibetan bear.**

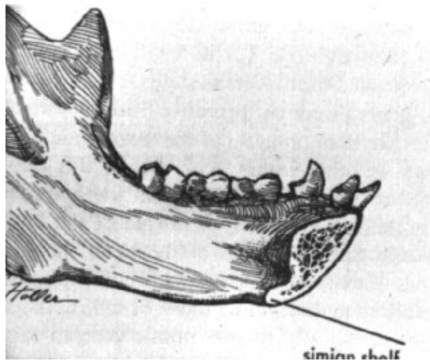

Fig. 9 **The simian shelf is a distinctive feature of many anthropoids but not seen in man.**

long slender maxillary canines shear over a specially developed lower first premolar. This abrasive action hones the upper canines to a very sharp edge while the lower canines appear to be much less functional.

DeBrul and Sicher[9] proposed the theory that the human mandible has evolved due to the total readjustment of the skull to vertical posture. To accommodate vital structures in the anterior of the neck during retrusion of the lower border of the mandible, the posterior ends diverged creating a change in angulation of the external pterygoids. When this angle increased, greater stresses were placed on the symphysis, such as pressing the ends of a wishbone. As foreshortening of the mandible proceeded through the primate order in response to upright posture and vertical positioning of the head over the vertebral column, a reinforcement of bone developed in the midline. In the apes this addition of bone to brace the inferior border of the symphysis is known as the "simian shelf" (Fig. 9). Shortening of the muzzle and further retrusion of the mandible within the hominids "everted" this addition of bone anteriorly through remodeling to form a chin or mentum osseum.

With continued reduction of the mandible the simple opening and closing movements in hinge-like fashion would also encroach on lingual structures. To compensate for pure hinge action and to maintain airway, the mandibular condyles can be drawn forward by the external pterygoid muscles. To augment this forward movement on opening, an eminence has elevated anteriorly to the articular surface of the squamosal portion of the temporal bone, guiding the mandible farther away from the cranial base. This articular eminence is a peculiarly human characteristic as noted by Gregory and Hellman.[12] They consider that the purpose of the eminentia is to allow the incisors to clear their opponents during lateral movements. This is true in man where a positive overbite is present, but not seen in other primates. Hellman[15] says that overbite is essentially a development of the last 1000 years while the articular eminence has been present since differentiation began. Possibly, the more logical explanation has been advanced by Mills;[26] he points out the angulation of the buccal teeth in man is different from other primates. Because of the wider lower arch, molar teeth need to lean lingually and, in response, the upper molars tip buccally. To facilitate cuspal contact in lateral excursion, the mandible has to tilt and, to achieve the necessary degree, the an-

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terior part of the glenoid fossa slopes downward to the root of the zygoma. The angle of the tilt occurs with rotation of the mandible about a point within the condyle of the working side to initiate the buccal phase of chewing. That is, the lower buccal cusps slide in grooves between the upper buccal cusps, and the lower lingual cusps slide between the upper lingual cusps. As a consequence, the evidence of motion and direction of the mandible can be seen in facetation patterns of the cusps.

In general there are two masticatory function phases: one phase corresponding to rotation about the condyle on the same side and the second phase corresponding to rotation about the opposite condyle. Mills[26] observed that a general pattern of facets remains remarkably constant in all widely differing members of the primate order. However, one noticeable change among monkeys is the early reduction of the lingual cusps of upper molars and the lower buccal cusps, so that contact is lost during the lingual phase of occlusion. In the human the tip of the protocone or mediolingual cusp of the upper first molar hangs below the occlusal plane. In lateral movement the mandible must tilt or lower the molars of the opposite side from the working or contacting group of molars as their buccal cusps engage and shear into the bolus of food. If the articular eminence does not rise sufficiently so that forward movement of the condyle cannot tip the mandible to disengage the cusps of the same side, then an interference occurs to the proper function of the opposite or working side. However, where canines are long and well-developed, the degree of lateral swing is not sufficient and most mandibular movement is then a vertical champing.

Brodie[5] describes this motion of the mandible as three arcs in three planes of space. With a wide lateral swing to-

Fig. 10 Interproximal attrition is a common characteristic among primitive cultures.

ward the functioning side, the posterior molars may make first contact and as the mandible closes in an anterior-posterior arc, the next pair of molars makes contact and closes in the act of shear. Concurrent with the closing arc is a mediolateral arc as cusps maintain sliding contact into fossae and the bodily rocking motion of the mandible follows a third arc as the condyles return to resting position. Therefore, it can be seen that only two teeth at a time may contact in a wave-like fashion. This observation will explain the individual movement of teeth. Hence the rubbing of interproximal surfaces, and the result we see in the well-worn dentition is the reduction of point contacts to more broad contacts by attrition (Fig. 10). Begg[3] believes that this phenomenon is a natural physiologic process in the reduction of arch length.

As we move from one primate specie to another, it may be noted that lateral movement is limited especially for some monkeys, while in baboons it is almost negligible. Hector Jones states,[18] "Comparison of anatomical specimens shows that monkeys and anthropoid apes are very different from man in movements of the masticating machinery, and the differences can all be laid at the door of the canines. These teeth practically prevent lateral movement of the mandible. Man alone of the primates has

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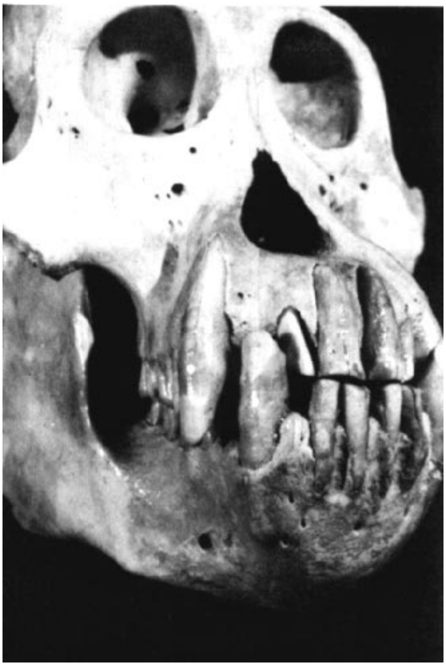

Fig. 11 The gorilla canines are large and elongated though the incisors are edge-to-edge.

learned to incorporate the shearing stress into his masticating." Jones points out the limiting influence of the canines in the gorilla (Fig. 11) and that "the buccal cusps of the maxilla and the lingual cusps of the mandible are not worn to any degree comparable with their fellows." However, our frame-by-frame analysis of gorilla mastication in motion pictures and manual manipulation of dry specimens show that there is considerable lateral movement (Fig. 12a, b, c, d). Attrition is a very active process in all buccal segments. Overjet and diastema of maxillary canines permit sufficient shift of the mandible to abrade the occlusal surfaces of the molars very similar to

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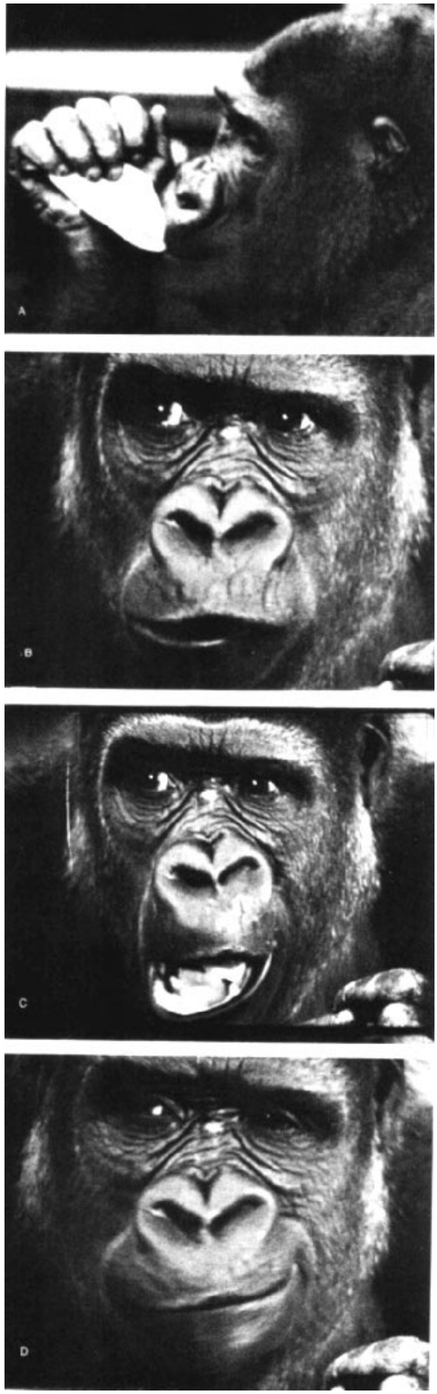

Fig. 12 Gorilla eating banana (a) shows bilateral rotation of the mandible (b, c, d). With the fibrous diet of fruits and foliage, gorillas show considerable attrition.

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Fig. 13 In spite of large canines the gorilla is capable of lateral motion.

that of Australian aborigines (Fig. 13). Protrusive movement is also quite obvious but more limited by the canines than the lateral excursion.

D'Amico in 1958 propounded a theory of canine function in the human dentition.[6] Citing Hector Jones as a premise, he claimed that the canines serve and function as stops or limiters of lateral and rotary movements of the mandible, thereby preventing excessive abrasion and angular loading of all other teeth with the ensuing trauma to supporting tissues. He states, "Attrition of the buccal cusps of the teeth of man reduces the efficiency of their intended shearing action. It does not enhance their function. Prevention of attrition is one of the functions of the canine teeth in the Orders Carnivora and Primates." His monograph and pronouncements have become known as the principle of "cuspid protected occlusion."

There is no universal pattern of function for the canines. They are either weapons of offense and defense or prehensile tools. Even though there is little evidence that the canine plays any part in mastication of food, it is a remarkably constant tooth throughout mammalian history. The mammal-like reptiles, circa 200 million years ago, had canines in the tooth formula 5-1-7-7/5-1-4-7. Mammals of 100 million years ago were 3-1-4-3/3-1-4-3 and primates beginning about 70 million years ago were 2-1-2-3/2-1-2-3.[21] Although some ungulates have lost canines in the permanent formula, in general Krogman terms the canine or Eckzahn, a veritable "Rock of Gibraltar."

Attrition or abrasion of occlusal and incisal surfaces is a physiologic and necessary process in mammals. The teeth of the herbivores are poorly adapted to grinding when first erupted because of the smooth rounded cusps on premolars and molars. Not until abrasion exposes the folded enamel ridges and grooves of cementum can calves and colts begin to manage forage and fodder. Because of various degrees of hardness a rough uneven grinding surface exists under continuous wear. Romer[35] notes that an increase in the chewing efficiency became necessary not only with reliance on gramineous and fibrous plants, but also with increase in body size. The incisors of young rats do not have deciduous precursors nor do they resemble the adult. They are bilobed and bent lingually to clamp to the mother's fur, and it is attrition that eliminates the clamping portion and changes it into the cutting chisel of the adult. Therefore, attrition is not just a loss of tooth substance but is, in many animals, a functionally important, often indispensable, stage in the development of the masticatory organs.[37]

Barrett[2] observed that the aboriginal child, at early age, is given food that requires vigorous mastication, the same food as adults. Deciduous teeth show signs of wear soon after eruption and, even before permanent eruptions the deciduous dentition has undergone marked changes by attrition, occlusally and interproximally. Attrition of permanent teeth commences as soon as they erupt and make functional contacts. The resulting wear pattern in newly acquired teeth is determined by the existing mode of occlusion. This

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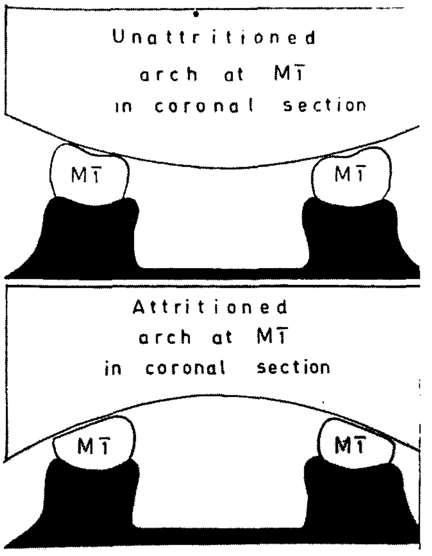

Fig. 14 Transfer of occlusal curvature from youth to advanced age or reversal of Monson curve (Murphy).

transfer to the permanent dentition is a continuous and dynamic process. The lower buccal cusps wear to a greater extent than lingual cusps and the upper molar lingual cusps to a greater extent than buccal cusps. This type of occlusal wear produces a transverse, oblique attritional plane or the so-called "reverse curve of Monson" (Fig. 14).

Murphy[29] describes attrition in the Australian aborigine by diagramming facet formation. As the lower first permanent molars erupt, the mesiobuccal cusp becomes faceted by the upper deciduous molar. When the upper first molar erupts with its occlusal surface in the Monson pitch, the mesiolingual cusp begins facetation. The incisors show abrasion at the same time as forward positioning of the lower arch takes place while cuspal interdigitation is lost. As the canines erupt, they quickly take part in occlusal function, so that there is no time lag or interlude for the deep overbite to become manifest as is so common among western children. The tough nature of kangaroo meat, which is the staple of the aborigine diet, requires much pulling and tearing with hands and jaws.[2] Also, the lesser articular eminentia, during the preadolescent years, allows considerable lateral and protrusive movement of the mandible.

Independently, Ahlgren[1] and Murphy[30] describe an elliptical pattern of mandibular opening and closing during the crushing and grinding phases of the chewing cycle. Ahlgren observed in children that there were great variations in the form of the masticatory movements, although in normal occlusions the masticatory movements were more regular and consistent. The irregularity of masticatory movements in malocclusion may be due to muscular incoordination or a disturbance in the periodontal sensory function associated with malocclusion. The deviations in the form of movements do not necessarily mean inferior masticatory function, rather, it is the mechanics, degree of energy expended, and rhythmic quality that is more important than normal occlusion.

Graf and Zander[10] studied contact patterns of intercuspal and retruded mandibular relationships by placement of intraoral radios in temporary bridges. They found that frequency and duration of occlusal contacts varied considerably between test subjects, and in some cases only fleeting contacts occurred. We have also used intraoral radios to evaluate functional contacts in our retention cases.[39] In recording protrusive sounds of the upper incisors, great variation in duration and amplitude of rubbing of incisal edges was observed. Where movements were positive and vigorous, good spikes were produced by the penwriter, and in other cases protrusive sounds were barely evident though the overbite was favorable and protrusive movement was unimpeded. Elimination of incisal irregulari-

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ties, such as mammelons, chipped or angular abrasions that force deviation of protrusive movements, produced greater amplitude and duration of contacts.

The protrusive movement demonstrates the desirability of "group function," a distribution of contacts of maxillary central incisors with all four lower incisors as antagonists. The maxillary lateral may enter into light contact but frequently, mobility occurs with interference of the lower cuspids. This is why a close or tight overjet is undesirable and often traumatic. There should be freedom for the incisors in the act of protrusion. It is apparent that incisal adjustment has been favorable when the individual demonstrates an easy protrusive movement that had previously been hesitant and jerky with uncertain contact. Continued self-polishing of the new facets also gives credence to this view.

Positioning and seating of cusps should be observed before orthodontic debanding takes place so that first order adjustments can be made. Many times it is prudent to reduce sharp pointed cusps and occlusal ridges that can be seen as potential impediments to centric seating. Occasionally, poorly carved restorations should be contoured. It is encouraging to see lateral and even protrusive movements developing spontaneously, though often unilaterally. Proof of the ability of the mandible to move or not can be tested with articulating paper. It is quite revealing to see how incapable many patients are to exert enough muscular force to make a carbon mark. However, the vigorous and dynamic chewer will already be showing some facetation on canines and premolars while still in the full-banded state. The lethargic and phlegmatic individuals have little desire to bring muscular pressure to bear on the tooth surfaces. Their coordination is so poor when trying to make mandibular movements that there will be hesitancy, often quivering, as they search for contact or to avoid contact. Ricketts[34] suggests that this ataxia or imbalance contracture can be brought on by prolonged avoidance of certain types of function.

Without elaborate electromyographic equipment we cannot diagnose muscle contracture, but palpation of the masseter will sometimes be surprising. Moss[27] demonstrates the difference in muscle activity between normal occlusion and malocclusions and how treatment and retention will bring on a more normal activity. He states that many of the imbalanced muscles can be palpated clinically. The great variability of functional habits can be seen when providing the patient with a resistant food following appliance adjustments. Carrot sticks are eagerly accepted by some while the next patient will protest taking even one small stick. Triscuits are a convenient snack to check function and to observe unilateral chewing habits. Sugarless gum is popular but provides little resistance, although it does demonstrates to the individual that one can chew immediately and not be resigned to liquids after every appliance adjustment.

Ingervall[16] suggests that "Both before, during and after othodontic treatment, functional examination is necessary to determine the indications for treatment and to assess the results of orthodontic therapy." Perry[31] believes that "It is wise at each appointment to check the open-close, right and left noncontact movements." If one will make these observations early, there will be ample opportunity to make first-order arch adjustments or recement bands before interferences are established that can only be reduced by excessive grinding.[41] When these early interferences are corrected and a greater range of

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movement can be practiced while still banded, function for some patients seems to develop spontaneously. This is particularly evident as excessive overbite is reduced in cases that exhibited no lateral components before.

We wish to encourage and develop a full range of movement and not limit it to strictly vertical loading of teeth, such as vertical champing in the deep overbite. Ramfjord states,[33] "the neuromuscular mechanism seems to have a great potential for adaptation." He also writes, "multi-directional functional movements should be encouraged by removing gross interferences restricting lateral and protrusive mandibular movements; routinely this can be accomplished without extensive grinding." Keedy found that "contact on the nonfunctioning or balancing side is not necessary and is often undesirable and, when interferences exist, common sense would naturally indicate that these interferences be removed."[19] The balancing contact most frequently seen is the buccal slope of the mesiolingual cusp of the upper first molar, followed by the same cusp of the upper second molar after it has fully erupted. Of course, the companion contact on the lower molars should be just as readily reduced particularly if it is a sharp and elevated cusp above the average occlusal plane[13] (Fig. 15). Hence the position of the lower second molar is most important and can only be controlled by banding and leveling. It would almost seem imperative that lower second molars be included in the strap-up for extraction cases, but inexplicably these teeth are commonly ignored by many orthodontists. To be sure, cementing bands on lower second molars can be difficult and may even require surgical exposure, but the earlier they can be controlled, the sooner the patient can move into functional patterns.

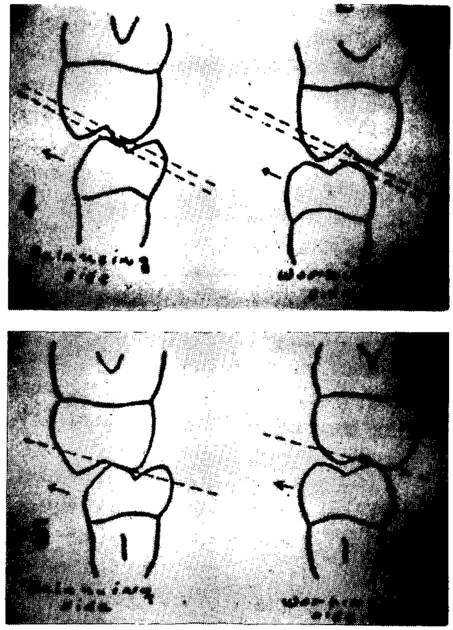

Fig. 15 Above, unattritioned lingual cusp is gross interference to working side. Early reduction of balancing cusps is indicated below. (Heimlich)

The maxillary second molar may not be banded except for crossbite and rotation. Tuberosity development is usually insufficient during treatment and continued eruption in the retention phase seems to allow self-seating of cusps. When the upper second molars have been extracted to reduce a difficult Class II situation, control of the lower second molars will be necessary until maxillary third molars erupt. Ramfjord also warns that "under no circumstances should there be established heavy contact in the posterior regions during protrusive excursions."

Ahlgren has shown that lateral components, when chewing, are natural phenomena and are well-coordinated in normal occlusions. With motion pictures of aborigines chewing roast beef, Beyron[4] studied the patterns of mandibular movements; their chewing cycle appeared to be wide, oval and bilateral. In most cycles, occlusal contact was made over part of the closing move-

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ment and occasionally over part of the opening movement. Contact gliding, 2-3 mm, from intercuspal position indicated this type of function is a normal feature in man. Ramfjord and Ash[33] would seem to agree when they note, "it is important to establish a bilateral smooth gliding movement pattern with approximately equal cuspal inclination and cutting efficiency of occlusal anatomy." Therefore, it would seem reasonable that development of grinding movements and facetation would be desirable and physiologic and not entirely all evidence of bruxism and trauma to supporting tissues as claimed by many periodontists.

Attrition is not the evidence of pathological loss of tooth substance, but a visible manifestation of maturation in vigorous and dynamic masticatory function of all mammals. On the contrary, absence of abrasion is indicative of unnatural dietary conditions. Domestication, with the provision of refined food, eliminates the hazards of food gathering and, therefore, increases the life span of mammals but at the expense of the dentition. Zoo animals, as well as domesticated pets, suffer distorted dentitions and loss of periodontal support. Only the human primate can control his diet and select food for nutrition and palatability.

However, when food became prepared through cooking, grinding and pureeing, masticatory function ceased. Ahlgren concluded that "the chewing force developed is probably the minimal stimuli necessary to avoid disuse atrophy." In making the same observations Linghorne[25] proposed an interesting suggestion for adding an abrasive to the modern diet and prescribed tobacco chewing to some of his patients. Incorporation of an abrasive factor in prepared food could be as logical as other additives. Perhaps stone-ground cereals may inadvertently be beneficial for physiologic attrition and not all food fad. Of course, this is speculation. Nevertheless, there is a responsibility after immediate debanding and during the retention phase to aid, assist and motivate our patients in developing functional patterns with which they are unfamiliar and often incapable of performing. Physical therapy is routine following other orthopedic procedures. Orthodontists also can do more for the retention patient than the simple word implies.

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