FIXED PARTIAL DENTURES

FUNCTIONAL OCCLUSION OF THE NATURAL TEETH OF MAN

ANGELO D'AMICO, D.D.S.*
Stockton, Calif.

THE STUDY OF THE FUNCTION of the natural teeth of man has been associated with the construction and function of dentures. However, the study has dealt mainly with mechanics in the occlusion of teeth and articulators rather than the physiologic and biologic factors involved in the function of the masticatory organ. Bonwill's introduction of an anatomic articulator in 1885 could have been the start of later serious, intensive studies of the problems of occlusion. However, Bonwill did not contribute any observations that later evolved the balanced occlusion theory.[1]

THEORY OF BALANCED OCCLUSION

The theory of balanced occlusion could have had its origin in 1890 when von Spee presented his observations on the function of the natural teeth of man.[2] He wrote, "Since therefore, a forward and backward movement of the mandible takes place in the form of circular movements, it is possible that such movements can be carried out to a greater extent without it being necessary for the rows of the opposing teeth to move away from each other. In this way, one obtains a more perfect use of the grinding movement. A separation of the grinding surfaces must then occur only when there are pronounced projecting corner teeth (cuspids) in the lower and upper jaw. In this case, these teeth overlap. But this can be eliminated by grinding.

"If the chewing surfaces of the teeth were arranged in a plane with the presence of such an articulation of the corner teeth (cuspids), then a parallel gliding of the opposing teeth on each other would not be possible and the grinding of the food would not result. In the case of constructing artificial teeth, this fact should be considered not only for improving the chewing movement, but also to avoid dislodgement of the dentures while chewing."[2]

Von Spee had more to say about the synchronization of condyle movements and occlusion of opposing teeth. He also made a favorable comparison of the *grinding* action of the human dentition with that of the ruminant in contrast to the

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*University of California Extension Division in Southern California.

masticating action of the carnivore. His comparison of the grinding action stands out as the function that appealed to the dentists of that era. His reference to the "overbite" (vertical overlap) of the cuspids was overlooked entirely. Subsequent writers on the subject of occlusion continued to expound the desirability of the lateral grinding action with all the antagonist teeth remaining in contact during all eccentric excursions of the mandible.

EVOLUTION OF NATURAL TEETH

The study of the evolution of the natural teeth of the entire primate family does not support von Spee's observations or the balanced occlusion theory. Gregory's study in paleontology depicts the organic changes that have taken place in the anatomy and formula of the natural teeth of the primates.[3] From the Eocene period through the Oligocene and into the mid-Miocene period (20 to 35 million years ago), the dental formula was reduced from $\frac{I\ 2\ C\ 1\ PM\ 4\ M\ 3}{2\quad 1\quad\ \ 4\quad\ 3}$ to $\frac{I\ 2\ C\ 1\ PM\ 2\ M\ 3}{2\quad 1\quad\ \ 2\quad\ 3}$ (Figs. 2 to 4). The number of cuspids and their position in the dental arches have remained constant. The anatomy has undergone some changes, but basically the intended function remains the same.

Cusp formation and intercuspal relations of the teeth of man are basically the same as those of the dentition of the great apes (Figs. 5 and 6). The dentition is designed for a shearing, cutting action and not the grinding action of the herbivore and ruminant. Primarily, the tooth structure is designed for a cutting, shearing action during the mastication of their natural frugivorous, insectivorous, carnivorous diet.

The great apes that still live in their natural, forested environment continue to specialize in a diet of fruits, berries, tender shoots, insects, and eggs. The apes are not flesh eaters, although in captivity they do acquire a liking for meat and a general omnivorous diet.[4] Man, in his early migrations, learned to adapt himself to the diet provided by Nature which varies according to latitudes from the arctics to the tropics.

Man became omnivorous because his struggle for survival depended on it. He learned to eat anything that changing environments produced, provided such foods did not prove to be harmful. The fact that man is omnivorous does not mean that his natural teeth possess a specialized form for an omnivorous diet. Primitive man and recent culturally retarded peoples would have shown the overlap of the cuspids that is seen in western Europeans of today and as shown in *Pithecanthropus robustus* (3 to 6 hundred thousand years ago) (Fig. 7) had they continued to specialize in a soft, nonabrasive frugivorous, insectivorous, carnivorous diet.

STUDY OF ATTRITION

The study of attrition seen in prewhite and recent Australian aborgines by Hector Jones[5] and my own study of the prewhite and present California Indians offer good evidence that the almost immediate change to the edge to edge incisal relation of the anterior teeth from the overlap relation as seen in western Europeans of today was due to environmental factors. Their primitive way of living, the

were not in functional contact. The occulsal surfaces slope lingually and follow the anteroposterior curve of Spee.

The posteroanterior aspects of the maxillary and mandibular teeth of a prewhite California Maidu Indian are seen in Figs. 14 and 15. The approximate age

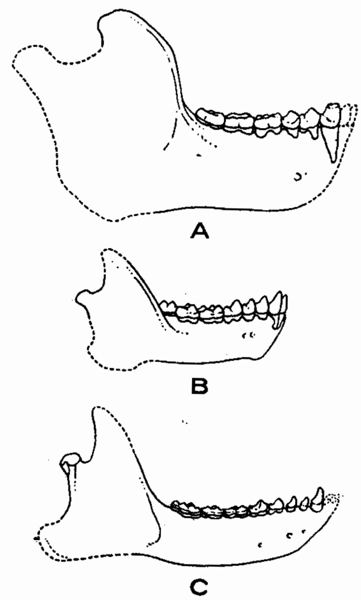


Fig. 2.—The evolution of the human mandible: *(C) Northactus osborno; (B) Parapithecus froasi,* Lower Oligocene, Fayum, Egypt; *(A) Propleopithecus haeckeli,* Lower Oligocene, Fayum, Egypt. (From Gregory, W. K.: Origin and Evolution of the Human Dentition, Baltimore, 1922, Williams & Wilkins Company.)

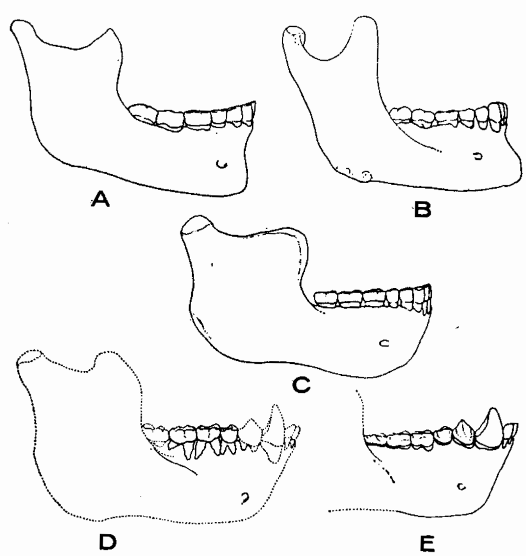


Fig. 3.—The evolution of the human mandible: *(E) Dryopithecus niocene; (D) Sivapithecus miocene; (C) Homo heidelbergensis,* lowest human type, Pleistocene, Germany; *(A) Homo sapiens* var. *australianus,* low human type; *(B)* modern man. (From Gregory, W. K.: Origin and Evolution of the Human Dentition, Baltimore, 1922, Williams & Wilkins Company.)

of this person was 20 to 22 years, about the period of full growth. The lower left third molar is missing. However, the upper third molars and lower right third molar were erupting in a manner similar to that seen today. The upper and lower molars and premolars show a gradual reversal of the occlusal plane. The extent of attrition of the lingual cusps of the upper molars and premolars, the buccal cusps of their antagonists, and the incisors and cuspids indicates an edge to edge relation of the anterior teeth.

The maxillary teeth of another prewhite California Indian in a later stage of life are seen in Figs. 16 to 18. Note that the occlusal plane is reversed, with the occlusal surfaces worn flat and at an angle to the long axes of the premolars and molars. Fatigue and periodontal lesions are present in premolar and molar areas.

The study of the progressive steps of attrition from infancy to old age shows that the normal, functional temporomandibular movement of the mandible is a

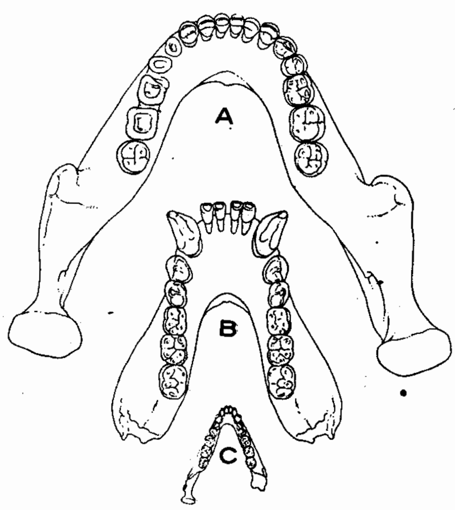


Fig. 4.—The evolution of the human mandible: *(C)* Parapithecus, supertarsoid stage; *(B) Dryopithecus fontani* (by Smith Woodward, 1914); *(A) Homo heidelbergensis.* (From Gregory, W. K.: Origin and Evolution of the Human Dentition, Baltimore, 1922, Williams & Wilkins Company.)

gliding hinge movement. The progressive reversal of the occlusal planes indicates that the functional closing movement of the mandible is backward, medial, and then vertical, into centric occlusion. If the condyles possessed a fixed center of rotation during lateral excursions, attrition would be uniform and would follow the curve of Spee or even the curvature of Monson's 8 inch sphere.

Krogman stated that "according to Todd, our temporomandibular joint is at first slightly hinged, but it is basically gliding."* If the upper cuspids had been able to assume their normal overlap relation, such extensive attrition would not have occurred. Instead, just as we see them in the great apes, the upper cuspids would guide the mandibular teeth medially and vertically, avoiding contact of the opposing teeth until centric occlusion has been attained.

*W. M. Krogman: Personal communication.

The prewhite California Indian enjoyed an omnivorous diet. Rapid attrition of the teeth was not due to the dietary items as much as to the methods of preparing and cooking the food. The use of stone and wooden mortars for grinding the food incorporated considerable amounts of abrasive substances. Leaching acorns in sand pits and heating meal in tightly woven baskets by casting heated stones into it and stirring increased the abrasive content. Cooking meat over open fires incorporated dust and carbon in it. These environmental factors were the principal causes for the rapid attrition of their natural teeth.

When western Europeans migrated to California, the Indians soon adopted their way of living. By so doing, the Indians eliminated the abrasive agents in their food and reduced the rough texture. This sudden change in culture soon eliminated the rapid attrition of their teeth and resulted in an almost immediate change in the functional relation of the natural teeth. The upper incisors and cuspids assumed the overlap relation that Nature intended.

The study of the Australian aborigines by Jones[5] coincides with the study of the California Indian. The immediate change from their primitive culture to the modern European way of life eliminated the abrasive factors which caused rapid attrition of the teeth and reduction in the vertical relation of the mandible. The result of this sudden change was the development of the overlap relation of the upper incisors and cuspids. Evolutionary or organic changes do not develop in such brief periods.

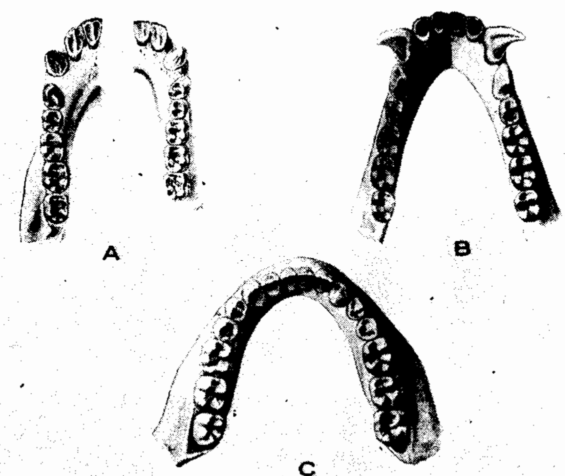
Many individuals who have made studies of primitive specimens and those from retarded cultures have accepted the edge to edge relation of the anterior teeth as a hereditary, normal, functional relation of the natural teeth. But the enamel has been abraded and impaired in such specimens. If the edge to edge relation of the anterior teeth were a hereditary, functional relation, it would be seen in man today, with unabraded, normal tooth structure.

DEVELOPMENT OF EDGE TO EDGE OCCLUSION

The development of the edge to edge occlusion resulting from attrition and reduction of the vertical relation of the mandible is illustrated in Fig. 19. Line *EK* represents the upper central incisor overlapping the lower central incisor, represented by line *IN*. Point *F* is the axis or center of rotation in the vertical closure of the mandible. Point *N* represents the symphysis of the mandible. The upper central incisors are fixed to the maxillae so that the distance of line *EK* to the axis at point *F* is constant and fixed. However, the lower central incisor is fixed to the mandible and moves in a constant arc described by the vertical rotation of the mandible at its axis at *F*. Radius *FN* is much greater than radius *FE*, as shown by comparing arc *D* to point *E*. If the length of the upper central incisor is reduced to point *G* and that of the lower central incisor to point *M*, *M* will describe arc *C* and meet point *G* at point *X*, which is anterior to the incisal edge of the upper central incisor.

The edge to edge relation of upper and lower anterior teeth could not develop if the natural teeth of the primates possessed the compensating factors of crown structure and constant eruption seen in the herbivores and ruminants. The vertical relation of the mandible would remain the same, with constant eruption of the teeth

Fig. 5



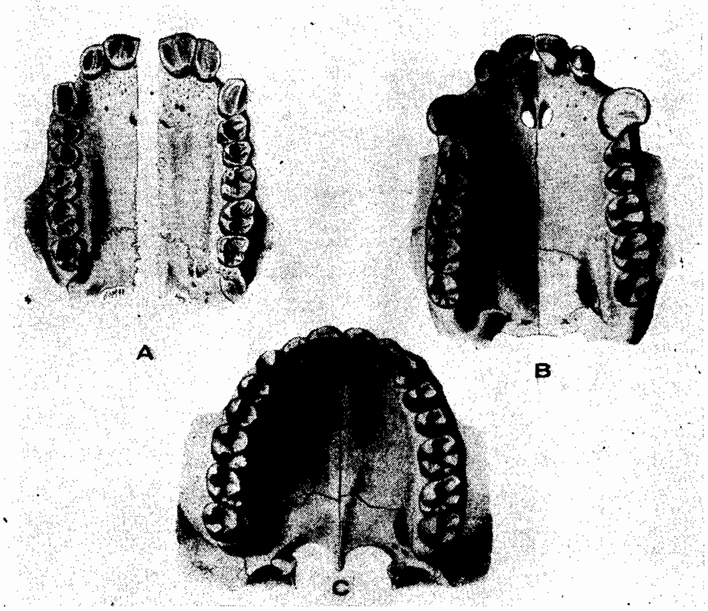


Fig. 6

Fig. 5.—*(A)* The mandible of the chimpanzee; *(B)* the mandible of the gibbon; *(C)* the mandible of man. The cusp formation and intercuspal relation are basically similar.

Fig. 6.—*(A)* The maxillary teeth of the chimpanzee; *(B)* the maxillary teeth of the gibbon; *(C)* the maxillary teeth of man. (From Gregory, W. K.: Origin and Evolution of the Human Dentition, Baltimore, 1922, Williams & Wilkins Company.)

to compensate for wear. The radii from the incisal edges of both upper and lower central incisors in relation to the fulcrum or vertical hinge axis would also remain constant. The incisal edges of the lower central incisors would continue to describe the same arc as constant eruption compensated for progressive attrition.

Clinical observation and tests on patients with an edge to edge relation of the anterior teeth because of extensive attrition of the natural teeth have shown that no forward drift of the condyles in the glenoid fossae occurs. The center of vertical rotation of the condyles at F remains constant as the vertical relation of the mandible is opened or closed. Also, there is no mesial drift of the mandibular anterior, premolar, and molar teeth.

FUNCTION OF CUSPIDS

The natural vertical and horizontal overlap relation of the upper cuspids is not strictly a mechanical block. Their function is more than a mechanical guidance of the mandible and mandibular teeth into centric occlusion. The innervation of the periodontal membrane functions in the same manner as the innervation of the tendons, ligaments, muscles, and inner ear. Shock contact of the upper cuspids by the opposing mandibular teeth during eccentric excursions causes transmission of periodontal proprioceptive impulses to the mesencephalic root of the fifth cranial nerve, which in turn alters the motor impulses transmitted to the musculature.

Fig. 7.—The skull of *Pithecanthropus robustus.* (Reconstructed by Dr. F. Weidenreuh.) (From Le Gross Clark, W. E.: History of the Primates, London, 1950, British Museum of Natural History.)

This involuntary action lessens the tension of the musculature, thus reducing the magnitude of the forces being applied.

When the natural overlap relation of the cuspids is eliminated by grinding to obtain a balanced occlusion relation of the natural teeth, one of the most vital physiologic factors possessed by any segment of the masticatory organ has been destroyed. If all the natural teeth possessed this involuntary physiologic factor to the same degree as the cuspids, the balanced occlusion theory could be applied without fear of failure of the periodontium and restorations.

Fig. 8.—The mandible of *Homo heidelbergensis.* (After Schoetensack. From Gregory, W. K.: the Origin and Evolution of the Human Dentition, Baltimore, 1922, Williams & Wilkins Company.)

RESOLUTION OF FORCES

A theoretic static relation of the opposing teeth in centric and eccentric contact is see in Figs. 20 and 21. The forces of action and reaction are supposedly in equilibrium. The diagram and resolution of the forces as shown on the lower molar also apply to the upper molar, but in the opposite direction.

The applied opposing forces exerted against the antagonist teeth when they come in contact are supplied by the musculature, mainly the masseter, temporal, and internal pterygoid muscles. The reciprocal forces of reaction are supplied by the periodontium, mainly by the alveolar process and periodontal membrane. In Fig. 20, the opposing teeth are in contact in centric occlusion. In this functional relation, the opposing applied forces *(F)* are parallel to each other and to the long axes of the teeth. The reciprocal forces *(R)* supplied by the periodontium are equal in magnitude and act in the same direction as the applied forces. The rotational effect of the moment about the fulcrum point *(A)* is nil and does not cause tipping of the opposing teeth.

Fig. 21 illustrates the direction and resolution of the opposing forces when the mandible is in eccentric relation and the opposing teeth are in contact on the balancing side. Both applied and reciprocal forces are resolved into vertical and horizontal components when the forces are applied at an angle to the long axes of the teeth. Theoretically, if the horizontal vector of the applied force (OP) in the direction of O to P were equal to the reciprocal horizontal vector (PO) in the direction of P to O and if the vertical vector of the applied force (OL) in the direction of O to L were equal to the reciprocal vertical vector (LO) in the director of L to O, all opposing components would be equal to each other. This theoretic static state of the opposing forces would not cause a tipping of opposing teeth on their long axes.

However, when the opposing teeth are in this eccentric functional relation, there is an increase of the moment or rotational arm and a reduction of the area of resistance. This functional contact is seen when the upper cuspids are either missing or when their overlap relation is insufficient to increase the vertical dimension to prevent contact of the remaining opposing teeth when mandibular teeth close into centric occlusion.

Fig. 9

Fig. 10

Fig. 9.—A posteroanterior aspect of a model of the mandibular teeth of Skhūl V. (Courtesy of T. D. McCown.)

Fig. 10.—The maxillary teeth of Skhūl V. (Courtesy of T. D. McCown.)

MECHANICS OF MASTICATION

Many variables are present in the mechanics of mastication. Some of these are hypo- or hypercalcification of the alveolar process, hypo- or hyperdevelopment of the musculature, and presence of teeth with either long or short roots. The magnitude of the applied forces supplied by the musculature can be determined with a gnathodynomometer. The length of the roots of the teeth can be determined with roentgenograms. However, no one has yet devised an instrument to make test borings of the alveolar bone to determine the magnitude of the reciprocal or resistance forces. Such a procedure is all important in construction and engineering.

To avoid fatigue of the periodontium, the applied forces should be directed parallelly to the long axes of the teeth when the opposing teeth come into functional contact. Any force applied at an angle to the long axis of a tooth, whether

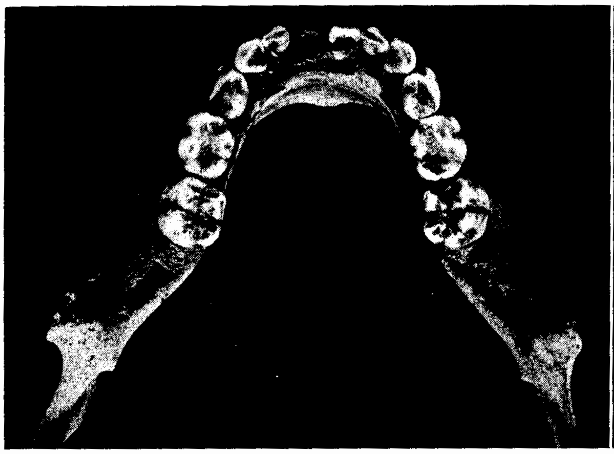


Fig. 11

Fig. 12

Fig. 11.—The mandibular teeth of a prewhite Nevada Indian child are worn flat. (Courtesy of the Anthropology Museum, University of California. Catalogue No. 12-3494.)

Fig. 12.—The maxillary teeth of a prewhite Nevada Indian child. (Courtesy of the Anthropology Museum, University of California. Catalogue No. 12-3494.)

it is applied at a 1 or an 89 degree angle, may cause trauma of the periodontium and rapid resorption of the alveolar bone. Nature has taken into account all the variable factors in the primates. Even when the least desirable combination—short roots, hypocalcification, and hypermuscular development—is present, the natural vertical and horizontal overlap of the upper cuspids prevents contacts that could develop horizontal vectors which could cause rapid fatigue of the periodontium or failure of restorations.

PRESERVATION OF NATURAL TEETH

Preservation of the natural teeth and periodontium as well as of the normal function of the entire masticatory organ of man is the goal of dental science. Deviations are the general rule in Nature rather than the exception. The ideal is rarely seen. However, to attain this goal, an ideal functional relation of the natural teeth must be ascertained before the deviations can be detected.

Fig. 13.—The first permanent molars of a prewhite Nevada Indian child slope lingually. (Courtesy of the Anthropology Museum, University of California. Catalogue No. 12-3494.)

There are five teeth on either side of both upper and lower dental arches which determine the ideal functional relation of the natural teeth of man.[7] These are the upper and lower first molars and cuspids and the lower first premolars.

Angles's "key to occlusion" governing the occlusion of the first permanent molars is quite important for growth and development of the dental arches mesiodistally. The mesiobuccal cusp of the upper first molar should occlude in the mesiobuccal groove of the lower first molar. This functional occlusion of the first permanent molars maintains the vertical and centric relation of the mandible during the eruption period of the successive teeth.

Fig. 14

Fig. 15

Fig. 14.—The maxillary teeth of a prewhite California Indian show a gradual reverse of the occlusal plane. (Courtesy of the Anthropology Museum, University of California. Catalogue No. 12-5507.)

Fig. 15.—The extent of attrition of the teeth of a prewhite California Indian indicates an edge to edge relation of the anterior teeth. (Courtesy of the Anthropology Museum, University of California. Catalogue No. 12-5507.)

During lateral excursions of the mandible, the interlocking overlap relation of the upper cuspids with the lower cuspids and lower first premolars guides the mandible into centric relation until the opposing teeth are in centric occlusion. Thus, contact of the remaining opposing teeth that could cause tipping on the long axes is avoided.

Protection of the periodontium of upper and lower incisors is equally important. With the opposing premolars and molars in centric occlusion, as the mandible moves forward, the distoincisal lingual surface and edge of the upper cuspids should glide on the mesiobuccal surface and occlusal ridge of the lower first premolars. The overlap of the upper cuspids must be sufficient to open the vertical relation to

Fig. 16

Fig. 17

Fig. 18

Fig. 16.—The occlusal plane is reversed in an old, prewhite California Indian. (Courtesy of the Anthropology Museum, University of California. Catalogue No. 6791.)

Fig. 17.—Right lateral view of Fig. 16.

Fig. 18.—Left lateral view of Fig. 16.

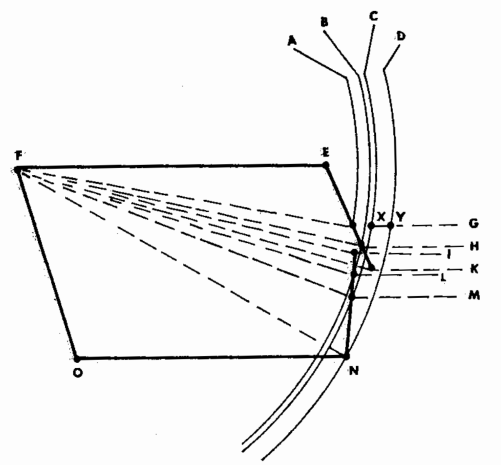


Fig. 19.—An edge to edge relation of the incisors and cuspids developed as a result of a reduction of the vertical dimension of occlusion.

prevent contact of the cusps of opposing premolars and molars. At the same time, contact of upper and lower incisors is avoided until they meet in edge to edge relation. This functional contact of the upper cuspids eliminates the possibility of development of horizontal vectors.

COMPLETE DENTURE OCCLUSION

The ideal functional relation of the natural teeth is in sharp contrast to the ideal functional occlusion of complete dentures. Complete dentures are made up of two units—one upper and one lower. A single deflective occlusal contact can dislodge one or both units during eccentric functional occlusion. Deflective occlusal contacts and cuspal interference must be eliminated for stability of both units.

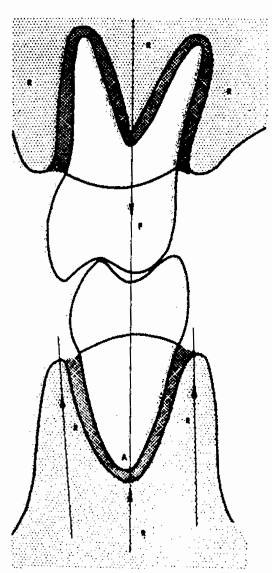


Fig. 20.—The applied forces *(F)* are parallel with long axes of the teeth when the teeth are in centric occlusion. (By A. D'Amico and J. S. Shell.)

However, the complete natural dentition of man consists of *thirty-two separate units,* each acting independently of the others. When the opposing natural premolars and molars are in centric occlusion, each opposing unit is subjected to the full magnitude of the applied forces. If the antagonist teeth still remain in contact in eccentric occlusions without the protection of the upper cuspids (opening of the vertical relation), the same holds true. Such functional contacts at an angle to the long axes of the opposing teeth can develop kinetic horizontal vectors of high magnitude.

CONDYLAR POSITION TO PREVENT TRAUMA

Prevention of trauma in the temporomandibular joint is equally as important as prevention of trauma of the periodontium. The ideal position of the condyles in the glenoid fossae when the opposing teeth are in centric occlusion is in the vertical hinge axis position. In this position, the ligaments are free of tension. This static position of the condyles when the teeth are in centric occlusion is all important in that it is the terminal and starting point of functional movements.

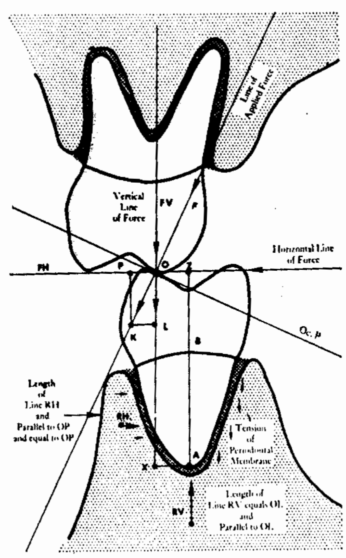


Fig. 21.—The opposing components of force are not equal when the cuspids are missing, or they do not prevent contact of opposing teeth as the teeth come into centric occlusion. The unequal force causes a tipping action on the teeth.

CORRECTION OF OCCLUSION

Correction of any deflective occlusal contacts that would cause the shifting of the condyles from this static position when the opposing teeth come into centric occlusion is the first step in corrective procedure. Diagnostic casts must be properly mounted on an adjustable articulator to determine such contacts. Deflective occlusal contacts that prevent equal distribution of the applied forces parallel to the long axes of all premolars and molars must also be removed before any correction of the vertical and horizontal overlap of the upper cuspids is undertaken.

Superimposing the upper diagnostic cast on the lower diagnostic cast does not mean that the opposing teeth make functional contact in a like manner. Neither does this static state reveal the relation of the teeth to the temporomandibular articulations. Roentgenograms reveal the extent of inflammation of the periodontal membrane and also the presence and extent of periodontal lesions. The direction and progress of alveolar bone resorption give good indications as to the direction of the horizontal vectors that may be causing such resorption. Procedures to attain the ideal functional relation of the natural teeth should never be undertaken before a thorough study of roentgenograms and properly mounted diagnostic casts.

The next step to restore the ideal functional relation of the natural dentition is the correction of the vertical and horizontal overlap of the upper cuspids. This is determined first by the vertical and horizontal overlap of the upper incisor teeth. The protrusive correction of the upper cuspids in relation to the lower cuspids and first premolars should prevent contact of the lower incisors with the upper incisors until they meet edge to edge for shearing action. Then, the horizontal overlap of the upper cuspids is corrected for lateral eccentric occlusions.

INTERLOCKING OCCLUSION

The term interlocking, when used to describe the vertical and horizontal overlap of the upper cuspids, will be misinterpreted by many dentists. They believe interlocking means that with the opposing teeth in full contact in centric occlusion, the upper cuspids will fully lock between the lower cuspids and first premolars to completely immobilize the mandible. Such is not the case. The upper cuspid should have a horizontal overlap of approximately 1 mm. to allow a slight lateral and protrusive eccentric movement when the teeth are in centric occlusion. If the upper cuspids are locked and the mandible is completely immobilized, the effectiveness of the periodontal proprioceptive impulses will be destroyed. Also, locking causes resorption of the labial cortical plate over both upper and lower cuspids and recession of the gingivae around those teeth.

Tight occlusion of incisors and cuspids that completely immobilizes the mandible when all opposing teeth are in centric occlusion often induces bruxism. With the physiologic action of the upper cuspids destroyed, the musculature can exert the full potential magnitude of its forces. Horizontal vectors developed under these conditions create havoc with the periodontium and also, in many instances, with the temporomandibular articulation. A desirable horizontal overlap of the upper incisors and cuspids is extremely important. The extent of the overlap varies with individual patients.

CONSTANT ERUPTION OF TEETH

The horizontal overlap and freedom from contact of upper and lower incisors and cuspids seem to perplex some periodontists and orthodontists. Their big question is the theory of constant eruption. Eventually, they say, constant eruption of these teeth will eliminate the horizontal overlap. Clinically, I have not found this to be true in adult patients. If the upper cuspids are in the ideal functional relation, attrition of the occlusal surfaces of premolars and molars is almost completely eliminated. If attrition of the occlusal surfaces progresses rapidly, the reduction of the occlusal vertical dimension will most assuredly reduce the horizontal overlap of the upper incisors and cuspids.

Anatomists state that the skull reaches full growth at the average age of 13 to 14 years. Full growth of the body of the maxillae and mandible is not realized until several years later; the age varies with individuals. We are also told that growth and development of the alveolar processes depends on the presence of the natural teeth. Constant eruption of the natural teeth would lead one to believe that this would cause constant growth of the alveolar processes. If this were true, a constant increase in the vertical dimension of the face would be seen.

CONCLUSIONS

The human organism passes through various biologic phases during the full life span. The organism grows and develops by the processes of cell division (mitosis), with constant replacement of worn or fatigued cells from the period of inception, through birth and infancy, and up to the stage of full maturity.

During this favorable period of life, cell growth is greater than cell resorption in alveolar bone. At this stage, periodontal lesions that result from traumatic contact of the opposing teeth are rarely seen.

Traumatic contact of the antagonist teeth accelerates the action of the osteoclasts in the alveolar bone. Failure of osteoblasts to keep pace, with fatigue, gradually results in progressive resorption of the alveolar bone. It is during this later stage of life that the acceleration of bone resorption and rapid development of periodontal lesions occur.

Proper occlusal corrections can be made during the most favorable period if deviations from the ideal functional relation of the natural teeth are detected during the early stages of life. Exceptionally favorable cell replacement of worn cells occurs as fatigue develops during this period of greatest growth and development. With proper corrections during this ideal growth period, it may be possible to reduce the percentage of extractions necessitated by failure of the periodontium from the present estimated 9 out of 10 to a much lower figure.

Photographs by Victor Duran, Life Science Photographer, University of California, Berkeley, Calif.

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540 North California St.
Stockton, Calif.