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The Canine Teeth—
Normal Functional Relation of the Natural Teeth of Man (continued)

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Mechanics Of Mastication: Resolution Of Opposing Forces

Now that we have examined evidence in physical Anthropology which casts a cloud over present accepted theories, let us concern ourselves with evidence in the science of physics. The accepted theory of normal occlusion likewise presents problems in mechanics for which nature has not made provisions to compensate in the periodontium. During the act of mastication the teeth and their supporting structures are subjected to certain forces. The main force in bringing the mandibular teeth in contact with the maxillary is supplied by the Temporal and Masseter muscles. This applied force is in the vertical direction and parallel with the long axis of the teeth, that is, if the mandible is closed vertically and not at an angle. In this favorable vertical direction, the contact of the opposing teeth developes two equal forces opposing each other (action and reaction). When the two opposing forces are parallel with the long axis of the teeth, each force equalizes the other and results in a static state. The entire periodontium supporting the opposing teeth then represents the resistance force to the opposing or applied force. With both forces in equilibrium and in a static state, the only movement of the opposing teeth would be in a vertical direction. This is the line of force that the supporting hard and soft tissues can withstand most favorably.

As we observed during the early stages of evolution, man (noting the terrific development of the ramus) developed powerful Temporal and Masseter muscles. However, the study of function and its effect on the occlusal surfaces of the premolars and molars, and incisal edges of incisors and canines (attrition) would also indicate that primitive man also possessed well developed Internal and External Pterygoid muscles for the horizontal and forward movement of the mandible. Man today still has the tendency to move the mandible in a horizontal direction, and if the horizontal movement is not limited and controlled by the canines, the result will be the development of kinetic forces which will cause a rotational movement of the teeth affected toward areas of lesser resistance.

In sketches shown in figure 58 and 59 I have tried to interpret the action and reaction of the applied forces, when the opposing teeth are in centric and in a static state and also in eccentric, the position accepted as being normal by those advocating the balanced occlusion theory. For easier interpretation of the action and reaction of the forces involved, the writer has confined his diagrams to the lower molar. However, the diagrams and resolution of the forces as shown on the lower also apply to the upper molar but in an opposite direction.

In Figure 58 the applied force F of the upper tooth is opposed by an equal force F as applied by the opposing lower tooth. The forces are equal and parallel with the long axis of the teeth. Consequently, the reciprocal or resistance forces R act along the same line. The rotational effect of the moment about the fulcrum point A would be nil, theoretically speaking. However, there are certain variables which we must take into consideration. The maximum magnitude of the applied force of the musculature represented by line F is not always equal to the reciprocal or resistance force of the alveolus and periodontal membrane as represented by the areas R. In some individuals we may have hyper-muscular development and at the same time we may have hypo-calcification, and vice versa. In the diagram just described we see a static state of the forces involved which would not result in development of kinetic forces causing a rotational movement of the teeth. In this relationship, the variables in the magnitude of either the applied or reciprocal or resistance forces would be of little significance, and damage to the supporting tissues would be reduced to a minimum.

In Figure 59, the diagram illustrates the direction of the forces involved and their resolution when the mandible is in eccentric position on the "balancing side" with the opposing teeth in functional contact. The lingual cusp of the upper molar is in contact with the transverse ridge of the buccal cusp of the lower molar at a point near the apex of the cusp. The solid line B is the axis of the tooth and the point A the fulcrum. The applied force F at the contact point of the opposing tooth is directed at an angle

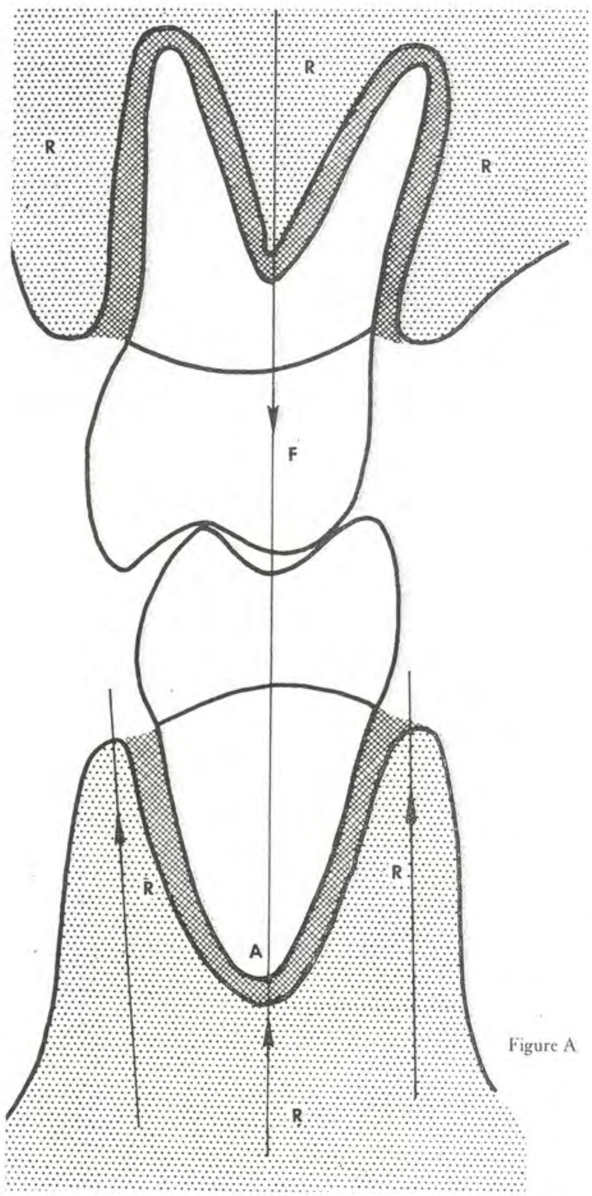

Figure 58. Sketch of upper and lower first molars in centric occlusion illustrating resolution of applied and reciprocal forces.

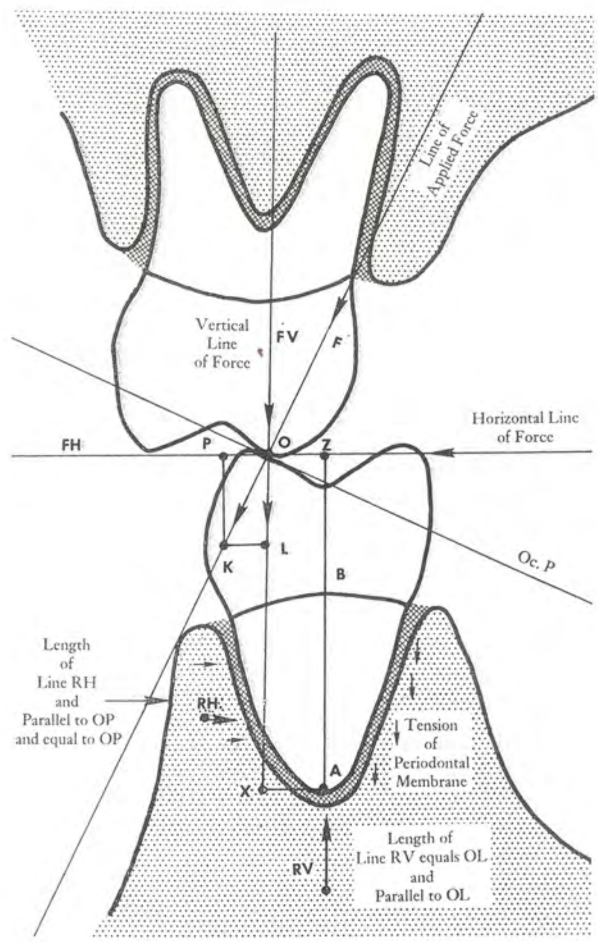

Figure 59. Sketch of upper and lower molars in eccentric occlusion in "balanced" contact, illustrating the resolution of applied and reciprocal forces. Result of collaboration by John S. Shell and Angelo D'Amico.

to the long axis of the lower tooth and at right angle to the occluding plane Oc. P.

To resolve and compare the resisting force caused by the applied force, the forces are resolved into vertical and horizontal components. The vertical direction of the applied force F is noted by the line Fv and its horizontal direction is designated by the line Fh. The component of the resistance force to the horizontal component Fh is designated by the alveolar area on the buccal side of the root by the horizontal arrow Rh. In theory we show it as acting on one point but actually it is spread over the entire area as shown by the smaller arrows. This also applies to the vertical arrow at the apex of the root Rv and the smaller arrows. To prevent rotational movement of the tooth at the fulcrum point A, the opposing forces must be equal. Assuming the applied force F to have a magnitude equal to line OK, it may be resolved into a horizontal force FH equal to OP in the direction of O to P and the vertical force Fv equal to OL in the direction of O to L.

In equilibrium, the total resultant forces RH in a horizontal direction in the line OP must be equal to PO in the opposite direction. If the force RH is smaller than PO, then there will be movement until they are equalized. The same applies to RV. If OL equals RV in the line OX but in reverse direction no motion will occur. But if OL is greater than RV motion must take place. By the laws of static OL equals the resultant of RV in the line OX and PO equals the resultant of RH in the line OP. If these equations are not equal motion must result.

In the diagram we note that the rotation or moment set up by the applied force F around the fulcrum A is much greater than the moment (solid line B) where the rotational moment ZA is zero when the teeth were in centric and all opposing forces were equal. In this diagram (figure 59) we see that a counter clockwise moment will be set up by the applied Force F which is equal to the component force OL times the length XA plus the force PO times the length ZA. This, in turn, is resisted by a clockwise moment equal to the horizontal component resistance force RH times ZA plus the vertical component resistance force RV times OZ. Also, it is resisted in part on the lingual side of the root by the tension of the peridental membrane designated by the smaller arrows pointing apically. The total moment caused by the applied force F would be resolved as being the moment arm B times the force OP plus the moment arm XA times the force OL.

In theory, if all the components of the applied forces were equal to all the components of the resistance forces as shown in the diagram, a rotational movement of the teeth would not occur. However, this theoretical static state of forces does not occur during functional contact of the opposing teeth, because whenever the applied forces are at an angle to the long axis of the teeth we see an increase in the moment or rotational force and at the same time there is a reduction of the resistance areas or resistance forces. Intermittent and frequent application of the applied force at an angle to the long axis of the teeth will, in time, cause molecular fatigue of the alveolar process, and detachment of the peridental membrane. In time progressive resorption of the osseous structure can result in exfoliation of the tooth or teeth affected.

The horizontal component of the applied force must not be construed to mean that it is the result of lateral motion of the mandible alone when the opposing teeth come into functional contact. When points and or surfaces of opposing teeth come into contact, the horizontal component of the applied force may act in any direction (other than the vertical) as seen in the spokes of a wheel. The magnitude of the kinetic force developed by the horizontal component depends on the magnitude of the applied force, plus the moment or rotational arm which may vary between 1° to an 89° angle.

Molecular fatigue of the investing tissues resulting from the kinetic force developed by the horizontal component of the applied force is well illustrated in the adult California Indian specimen shown in figures 33 and 34. In the mandible, note the slope of the incisal edges of the anteriors. They are at a greater angle to the long axis of the teeth than the flat surfaces of the premolars and molars. Even though the incisal surfaces are approximately one-sixth in surface area of that of the flat occlusal surfaces of the molars, the kinetic force, developed by the horizontal vector of the applied force, has caused a rotational movement of these teeth, resulting in fatigue and resorption of the alveolar process directly in line with the direction of the horizontal component. The same result is seen in the upper anterior region.

In the lower first molar region where we see the plane of the occlusal surface sloping buccally and at a slight angle to the long axis of the teeth, we see the early stages of fatigue of the alveolar process in the lingual area. Flat occlusal surfaces of other teeth present, which are at right angle to the long axis of the teeth do not show fatigue of the aveolar process to the extent that the others do. This is due to the fact that the opposing applied forces are parallel with each other and to the long axis of the teeth.

The extent and location of fatigue of the alveolar process as seen in this specimen should be concrete proof that a flat surface does not, in itself, produce trauma. It can only produce trauma if and when the horizontal vector of the applied force is of sufficient magnitude to produce a kinetic force, which in turn can cause a rotational movement of the tooth at its fulcrum.

Reverting again to the diagram in Figure 59, we see also the cause for detachment of abutments and restorations in fixed partial restorations and also the cause for fatigue of the alveolar process around the roots of the teeth supporting removable partial restorations. Again it is the horizontal vector with the resulting development of a kinetic force causing the rotational movement of the restoration or the abutment teeth.

Many operators have tried to prevent detachment of abutment restorations by resorting to the use of stress-breaking attachments to allow individual functional movement of the abutment teeth. These work well *if*, and only when the applied force is directed with the long axis of the abutment teeth. The precision fit of most attachments is such that they cannot compensate the rotational force, so, the implied purpose of such attachments is nullified. If the rotational force is of great magnitude, the detachment of the abutments will occur regardless. Complex resistance and retension forms of the abutment preparations and use of pins or dowels may prevent detachment. However, in such cases, the resorption of the alveolar process surrounding the abutment teeth is hastened, so that again, not only the restoration is jeopardized, but also the abutment teeth themselves.

In the construction of removable partials the same principle is applicable. If the operator achieves a balancing and working bite by eliminating the interlocking relation and function of the canines, the results are more disastrous than those we see in fixed restorations. The abutment teeth clasped not only are subjected to the increased rotational force but also to a mesio-distal torque. The combination of the two forces hastens tremendously the resorption and deterioration of all the investing tissues. The result? More extractions, more extensive restorations and the premature full denture restorations.

In recent years a great deal of attention has been given to the phase of "equilibration." However, here again the old principle of balanced occlusion during lateral excursions of the mandible remains as the goal. The attempt is made again to revert to the functional relation of the teeth as seen in primitive man and the herbivor. The elimination of a premature contact does not equalize the applied force to the remaining teeth in the arch, but rather increases the rotational force at the apex of the roots of all the posteriors. The premature contacts to be avoided should be those that prevent the mandible from closing in its hinge axis into centric occlusion. These are the prematurities that will result in the resorption of the osseous structure in the embrasures of the roots of the affected teeth. When such prematurities exist and the mandible is unable to close into centric occlusion in its hinge axis, the end result will be not only the deterioration of the investing tissues but also an acquired indolent method of mastication.

To obtain a "balanced occlusion," all teeth in contact on the "working side" and premolars and molars in contact on the "balancing side," naturally means that the operator should grind away the canines, eliminate their normal overbite and interlocking relation, and convert man's teeth to function as those of the ruminants instead of their intended natural function of the primate. When we do this we destroy the natural "stressbreaker" which nature has provided, i.e., the canines. Their interlocking position is primarily to guide the mandible into a gliding hinge movement when closing into centric position, so that the full magnitude of the applied force of mastication is directed with the long axis of the teeth, and such applied force is met by a resistance force equal in magnitude. When the canines are in normal interlocking position, the lateral and forward movement is limited so that when an attempt is made to move the mandible laterally and or forward ,there is an involuntary reaction when the opposing canines come in contact. The reaction is an immediate break in the tension of the Temporal and Masseter muscles, thus reducing the magnitude of the applied force. Regardless of how hard the individual tries to tense these muscles, as long as the canines are in contact, it is impossible for these muscles to assume full tension. The length of the roots of the canines and the anatomical structure of the supporting alveolar process give testimony to nature's intention as to the function intended. What may appear as trauma as they come in contact is not trauma at all, because when contact is made, muscular tension is involuntarily reduced, thus reducing the magnitude of the applied force.

Since the second revision of this manuscript in 1955, a splendid paper describing the foregoing neuromuscular reaction was published by Robert E. Moyers, professor of Dentistry at the University of Michigan. (19) Although the article was primarily intended to explain the establishment of centric relation of the mandible, it also explains the periodontal reflex action when the opposing teeth are in contact in eccentric relation. The following quotation explains the reactions in both centric and eccentric relation:

"Only the postural (rest) position is consistently observed prior to the eruption of the teeth. Sillman spoke about the development of an "occlusal sense" as the erupting primary teeth first met their antagonists of the opposite jaw. This "occlusal sense" is the formation of the neuromuscular reflex establishing centric relation. Centric relation has been spoken of as if it were a morphologic trait like big ears or blue eyes. But since it is not present at birth, it must come later, either through learning or the acquirement of neuromuscular features not present at birth. The postural (rest) position is easily recorded in the neonate, (newborn) but repeated efforts to locate centric relation met with failure until the age at which the primary occlusion was established. As the teeth occlude, afferent impulses of touch and pressure are transmitted through the mesencephalic root of the fifth cranial nerve to the brain where they may alter and affect the motor impulses being transmitted to the muscles controlling the position of the mandible. After the teeth have erupted, the muscles learn one position of occlusion providing a maximum of occlusal contact and minimum of torque or lateral stress and strain on the roots of the teeth. This is the beginning of centric relation. The muscles alone could not establish so precise a mandibular position, while they are contracting. But the intercuspation of the teeth makes it possible for the brain to learn quickly this new mandibular position. Centric relation is established during the early stages of the primary dentition when occlusal anomalies are at a minimum. At the beginning, centric relation and centric occlusion are identical. *Centric relation is the first established neuromuscular reflex concerning mandibular position when the teeth are in occlusion.* The centric relation reflex is controlled not only by the stretch receptors in the muscles of mastication, but by the receptor organs in the periodontal membranes as well. The periodontal receptors demand a high degree of localization of mandibular positioning. It seems important that the postural position is maintained by the myostatic reflex alone, while the centric relation involves both muscles and the periodontal membranes for its maintenance. Centric relation involves more neuromuscular activity, since the mandible must be held in elevation above the postural position in a position permitting occlusal harmony.

"The anteroposterior limits of centric relation are defined first, since the primary incisors erupt first and restrict mandibular movements in this one direction only. *Later, the teeth in the lateral segments of the dental arch inhibit mediolateral positioning, and thus help localize the limits of centric relation in this other direction.* The vertical limits of centric relation are never so precisely defined. The least displacement of the mandible, anteroposteriorly or mediolaterally, immediately sets off a shower of afferent impulses which elicits a motoneuron stabilizing the mandible in these two directions. Greater mandibular displacement is necessary vertically for a similar response to occur. Opening changes in vertical position of the mandible cause only the firing of stretch receptors and do not, of course, cause stimulation of the periodontal receptors. *Direct biting pressure in line with the long axis of the teeth has little effect, but the slightest angular vector of force against a tooth elicits a response from the periodontal propioceptors. This helps explain the more precise limits of centric relation anteroposteriorly and mediolaterally. It also explains why we have somewhat more latitude in changing vertical dimension than in shifting the mandible horizontally.*"

One cannot disagree with Moyer's explanation of neuromuscular reflexes nor can we disagree with his deductions as to how centric relation of the mandible was first established. However, the study of the effects of function in the deciduous dentition of the primitive and the early establishment of the edge-to-edge bite, does not support his contention that inter cuspal interference of the teeth on the lateral sides of the dental arches limit the medio-lateral movement of the mandible. The rapid attrition of the cusps of the deciduous molars (before the eruption of the deciduous canines) definitely indicates that cuspal interference did not permit the transmission of periodontal impulses to the musculature so as to reduce their tension, thereby reducing the magnitude of the applied force. Such rapid attrition of the cusps of the deciduous molars is due to two factors, the incorporation of highly abrasive agents in the diet and an applied force of high magnitude.

The transmission of periodontal impulses to the musculature in mediolateral or protrusive movements of the mandible in either the deciduous or permanent dentition does not occur to any great degree until the upper canines have erupted sufficiently to assume their interlocking position. Such a functional relation does permit the periodontal propioceptor impulses of the canines to be transmitted to the muscular receptors to permit them to assume a postural (or rest) position when attempts are made to move the mandible in eccentric relation with the opposing teeth in contact. The writer is quite sure that if Moyer would recheck the cases used in his experiments, he will see that the canines were the teeth which transmitted the periodontal impulses to the musculature during eccentric movements of the mandible. This criticism is not intended to belittle Moyer's work and findings. Quite the contrary, the writer believes that he has performed one of the finest research projects related to the subject of occlusion.

"The Ideal Functional Relation Of The Natural Teeth Of Man"

In the practice of dentistry we use the term normal a great deal. The writer admits that he too is guilty of using this term a great deal in this manuscript, but only for the purpose of continuity, so that members of the dental profession can more readily follow the development of a concept. As stated before, it is a concept intended to prove that "balanced occlusion" of the natural dentition does not exist and has never existed in man. When we speak of normal function, normal occlusion, normal relation, etc., we do so in a restricted sense. We limit the function of the natural teeth for the mastication of food only. We frown upon their use for any other purpose.

In the study of the behavior of man, prehistoric and historic, we note that he has used them for many purposes. He has used them as tools in fabricating clothing and weapons; for prehensile purposes, and as weapons in combat, for offense and defense. He also could have used them for reproduction purposes to fight off rivals or to subdue a mate. All of these functions were normal for man during the early stages of his evolution in his struggle for survival. Even today, in many remote areas of our world, we find many groups or tribes living in an arrested stage of evolution still using their teeth in a like manner. In our present way of living, we term such functions to be abnormal. So, what we may consider to be normal or abnormal is strictly relative to the stage of evolution in which we live.

The heading of this chapter is self-explanatory. We wish to establish a definite functional relation of the natural teeth of man which not only correlates the physiological and biological factors, but must also conform with the physical laws governing the principals of the mechanics involved during the act of mastication. It is a realistic ideal relationship designed to prevent the fatigue of the supporting tissues of the natural teeth and to safeguard the usefulness and function of any artificial restorations we may contrive. In this respect we could use the term "normal" as well as the term "ideal."

All the physical evidence reviewed thus far definitely portrays nature's intention as to how the masticatory apparatus of man should function. The morphology of the teeth of man is a modification of the teeth seen in all primates, primarily designed for the mastication of an frugivorous, insectivorous (or carnivorous) diet. All primates present prominent canine teeth modified in size according to specie. The overbite and interlocking relation of the upper canines is the natural articulation of those teeth and common to all primates, including man. Their main function during mastication is to guide the mandible into centric relation in a medial-vertical direction, so as to prevent the contact of the remaining opposing teeth until they meet in centric occlusion.

The upper canine teeth also guide the mandible during protrusive movements. With the opposing teeth in contact in centric occlusion, as the mandible moves forward, the disto-incisal edge of the upper canine glides on the mesio-buccal-occlusal ridge of the lower first premolar. The overbite of the upper canines must be sufficient to open the vertical relation enough to prevent contact of the cusps of the opposing premolars and molars during the forward movement of the mandible, and at the same time prevent the contact of the opposing incisors until their incisal edges meet edge-to-edge. This functional relation of the upper canines with the lower canines and first premolars eliminates the possibility of applying horizontal vectors to either upper or lower incisors, premolars and molars during any eccentric movements of the mandible. Thus, by eliminating horizontal vectors, fatigue of the periodontium supporting the incisors, premolars and molars is reduced to a minimum.

Clinical evidence of the effectiveness of the periodontal propioceptor impulses of the canine teeth can be observed by studying the sequence of the loss of the natural teeth during adult stages of life. Invariably, in the upper arch, the canine teeth are the last to be extracted; in the lower arch, almost consistantly it is the canines and first premolars, these usually being the very last to be lost. If Moyer's deductions are true that the incisors, premolars and molars possess the periodontal propioceptor impulses in the same degree possessed by the canines, the theory of balanced occlusion could be practised and applied without fear of causing fatigue of the periodontium supporting those teeth. Clinical study and observation of fatigue and failure does not support such deductions.

Evidence has been presented to show that the temporo-mandibular movement of the mandible is a gliding hinge movement. Prof. Krogman's personal notation when reviewing the previous manuscript stated that: "According to Todd our temporo-mandibular joint is at first slightly hinged, but it is basically gliding." The study of the progressive steps of attrition definitely supports Krogman's statement. Also, as to the hinge movement, resolution of the edge-to-edge bite does support the theory that there is a fixed center of rotation or "hinge axis" in the vertical closure of the mandible.

The study of origin and evolution of the natural teeth of man and the effects of function does not support the theory that there exists a fixed center of rotation during the lateral excursions of the mandible. Evidence presented thus far indicates that the canine teeth are the guide teeth during eccentric excursions of the mandible. Another of Krogman's personal notations on this function of the canine teeth is as follows: "I have long felt that were Angle trained in Paleontology, he would have keyed the first molar for mesio-distal relationships, and the cuspid for the medio-lateral. Today 99 per cent of orthodontic interpretation is based on lateral X-Rays in a telescoped medial sagital plane, with mesio-distal relationships a prime focus."

After reviewing the text of the previous manuscript on the canine teeth, Dr. George M. Hollenback of Encino, Calif., had this to say: "This whole thing somewhat substantiates the position that I took in 1928 that the condyle path theory would not hold water, and that balanced occlusion, if it ever did exist, was certainly non-existent in this area. I feel that the architecture of both the mandible and maxilla show very clearly that the canines were intended to be the guiding factor when closure is made. The labial plate over the upper canine is very thick and composed mostly of cortical bone. The tooth itself, as you have pointed out, is very large and strong, and deeply embedded in the maxillary bone. The whole architecture indicates that the tooth was designed to absorb a great deal of lateral stress. Dropping back to the bicuspids and the molars, again speaking of the maxilla, the buccal plate of these teeth as we know is very thin and fragile. If the Great Creator had intended that man have a balanced occlusion (which would subject these teeth to great lateral stress) a very great mistake was made. Incidentally, the Creator did not make very many mistakes, so it is my humble opinion as it has been for a long time, that the condyle path theory and the theory of balanced occlusion will pass from the picture, and perhaps ten years from now most all of us will look back on the whole thing as being more or less a mistake."

The foregoing personal notations and comments by an outstanding physical anthropologist, Krogman, and by Hollenback, who has never ceased contributing to dental science, lends support to all the physical evidence disproving the theory of "balanced" occlusion. Likewise, they do tend to confirm the concept of the intended natural function of the canine teeth.

The term "interlocking" describing the interlocking relation of the canine teeth will certainly be mis-interpreted by many members of the dental profession. Many will believe it to mean that with the opposing teeth in full contact in centric occlusion, the upper canine tooth will fully lock between the lower canine and premolar so as to completely immobilize the mandible. Such is not the case. The upper canine should have an over-jet of approximately one mm. to allow a slight lateral eccentric movement even though the teeth are in full centric occlusion. If they are locked and the mandible is completely immobilized, the effectiveness of the periodontal impulses will be destroyed; also, it will cause the resorption of the labial cortical plate over both upper and lower canines and recession of the gingiva in those areas. The overbite of the upper canine is determined by both the over-jet *and* overbite of the incisors.

We see then that there are actually five teeth on either side of both upper and lower dental arches which determine the ideal functional articulation of the natural teeth. The upper and lower first molars, upper and lower canines and the lower first premolar. First, in the articulation of the first molars we see Angle's "key" to occlusion i.e., the mesio-buccal cusp of the upper first molar articulating in the mesio-buccal groove of the lower first molar. This is important not only for growth and development, but also to maintain the vertical relation of mandible to maxillae. Second, we have the primate interlocking relation of the upper canine tooth between the lower canine and first premolar tooth. This is the most important articulation of any of the natural teeth in that it guides the mandible and mandibular teeth into functional centric occlusion, and also serves to prevent the development of horizontal vectors on any of the incisors, premolars and molars. The foregoing describes in detail the ideal functional articulation of the natural teeth of man which we have been seeking and for which we should strive. It conforms to the natural laws governing the normal function of the entire masticatory apparatus, the physiological and biological as well as the physical laws governing the forces involved in its mechanics.

One important thing we learn in the study of the behavior of man is that in nature, aberrations are the rule and not the exception. (Fingerprints are an example. No two are alike). This definitely holds true when we study the masticatory apparatus of man. We see deviations in the morphology of the teeth, in their alignment and position in the dental arch, and in the growth and development of maxillae and mandible. The prime objective of dental science should be the correction of any deviations which tend to prevent normal development and function of the masticatory apparatus. If the average dentist, possessing average knowledge and skill, can visualize the ideal

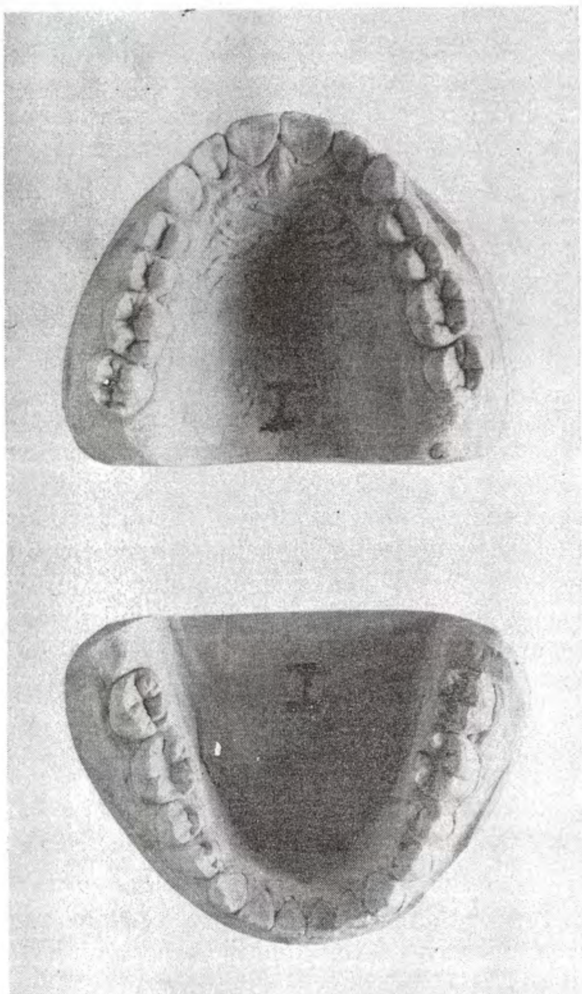

Figure 60. Occlusial aspect of upper and lower models of natural dentition of an adolescent of today, male, age 16, (German descent).

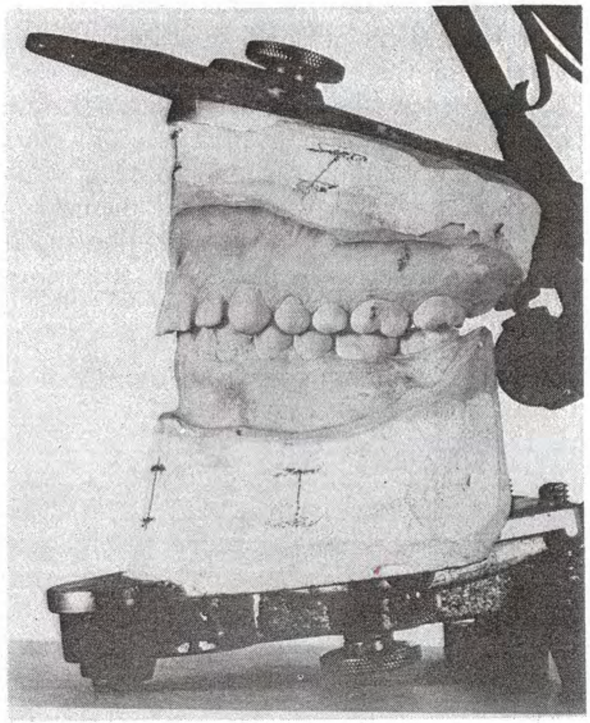

Figure 61. Upper and lower models of specimen illustrated in Figure 60 mounted in centric occlusion.

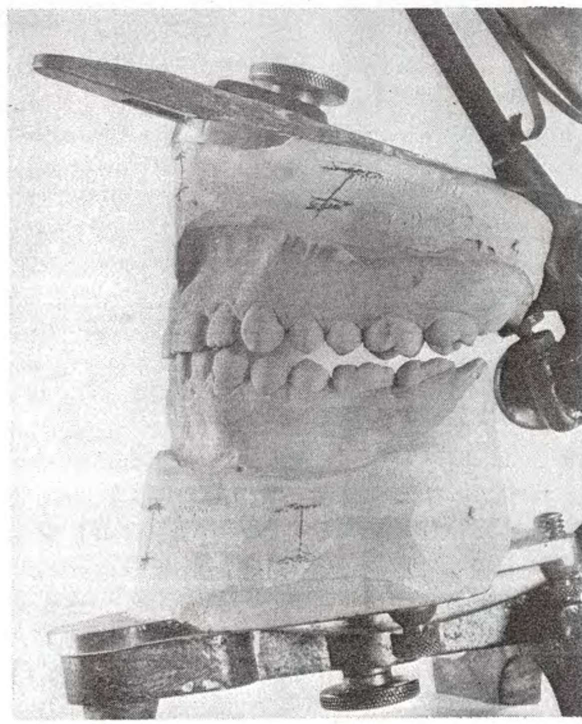

Figure 62. "Balancing" side of specimen illustrated in Figures 60 and 61.

functional relation of the natural teeth, it would go without saying that he will certainly be able to make note of serious deviations and proceed to make the proper corrections.

In order to help the reader visualize the ideal functional relation, the writer would like to cite three cases selected from his general practice, each in a definite stage of man's life cycle, which illustrate the fulfillment of all the requirements that have been set forth.

In Figure 60, we see a vertical view of the upper and lower arches of an adolescent, male, age 16, (European of German descent). This is not the result of orthodontic treatment. None of the three cases chosen and illustrated received orthodontic treatment. All are natural dentitions. The vertical view illustrates the absence of attrition of the occlusal surfaces and the normal relation of the gingiva. Figure 61 is the lateral view in centric. Note the interlocking canine and intercuspal relation of premolars and molars, and the normal relationship of the first molars. Note also a slight diastema between lateral incisors and canine and normal relationship of gingiva. Figure 62 is the view of the "balancing" side with opposite canines in cusp to cusp contact. Note that not one surface or cusp of premolars and molars is in contact, quite the opposite of what we have been taught to see. Figure 63 lateral view of the "working" side. Here again we note the lack of contact of the premolars and molars when cusps of the canines are in contact. Due to lack of attrition of the cusps of the canines at this age, the space between the upper and lower premolars and molars is somewhat greater in the two views showing the "balancing" and "working" sides than seen in the next two adult cases.

Figure 64 is a view of the occlusal and incisal surfaces of the natural dentition of an adult female, age 36, of Italian ancestry. Third molars have been extracted. As in the first case, this is natural development and not the result of orthodontic treatment. Note also the wide diastema between

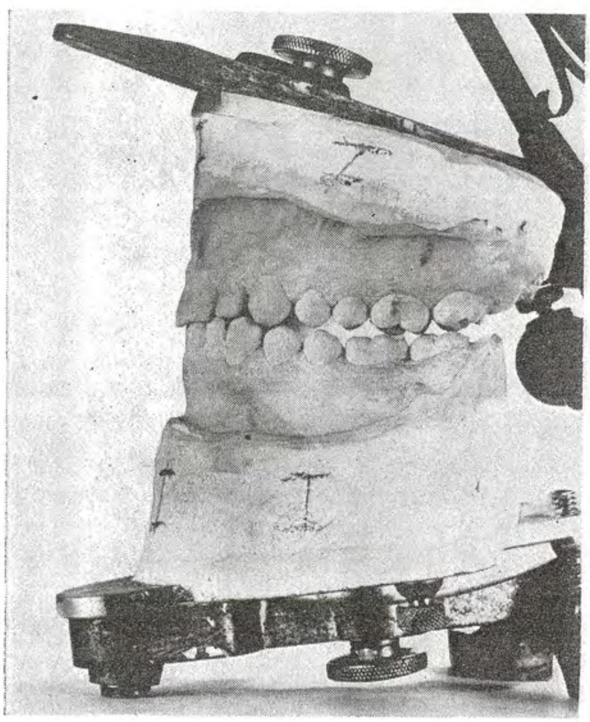

Figure 63. "Working" side of same specimen illustrated in Figures 60, 61 and 62.

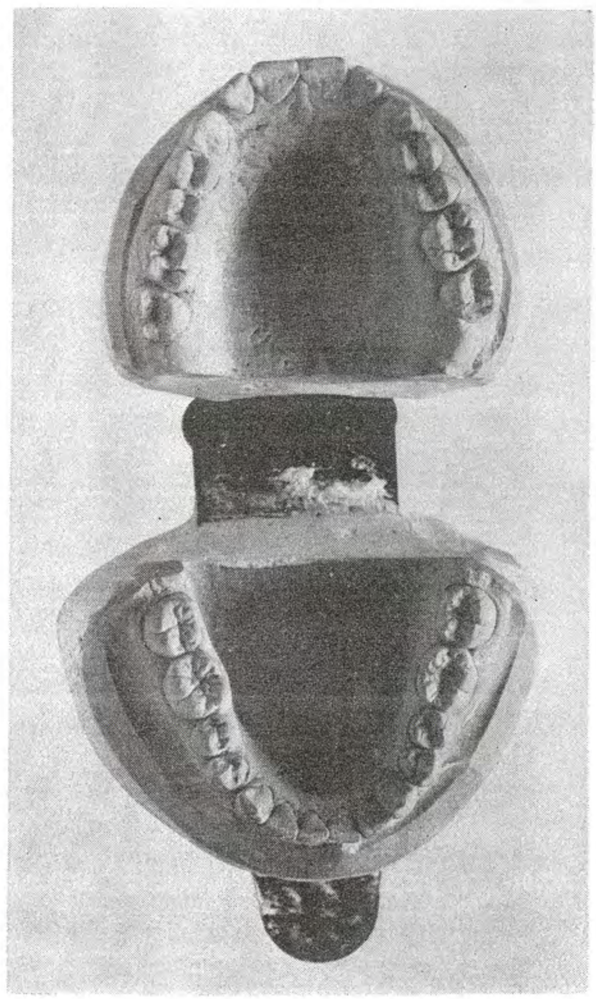

Figure 64. Occlusal aspect of models of dentition of present day adult female, age 36. (Italian descent).

upper lateral incisors and canines, and lack of attrition of the premolars and molars; also, the relation of the gingiva. Slight attrition of the cusps of the upper canines can also be noted.

The next view (Figure 65) is that of the right side in centric. The canine and premolars are in normal intercuspal relation. The upper first and second molars are fractionally off, however, the entire periodontium is physiologically normal. The slight attrition of the mesial slope of the cusp of the upper canine shows up more distinctly in this view that in the previous vertical exposure.

The next view (Figure 66) is the left lateral with canines and incisors in contact showing the "working" bite of the premolars and molars. Here again as in the first case, the cusps of the upper and lower premolars and molars are definitely not in contact in spite of the attrition of the canines. Note well the relation and attachment of the gingiva.

Figure 67 shows the same left side in "balancing" position. The angle at which this view was taken and a few shadows do not do justice to the actual relation. However, it clearly shows a lack of contact of the lingual cusps of the upper premolars and molars with the transverse ridges of the

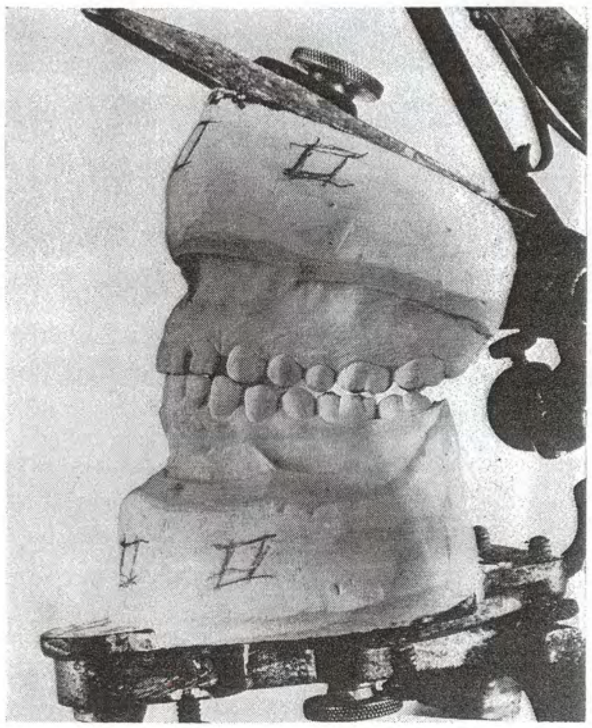

Figure 66. "Working" side of specimen illustrated in Figures 64 and 65. Female, age 36.

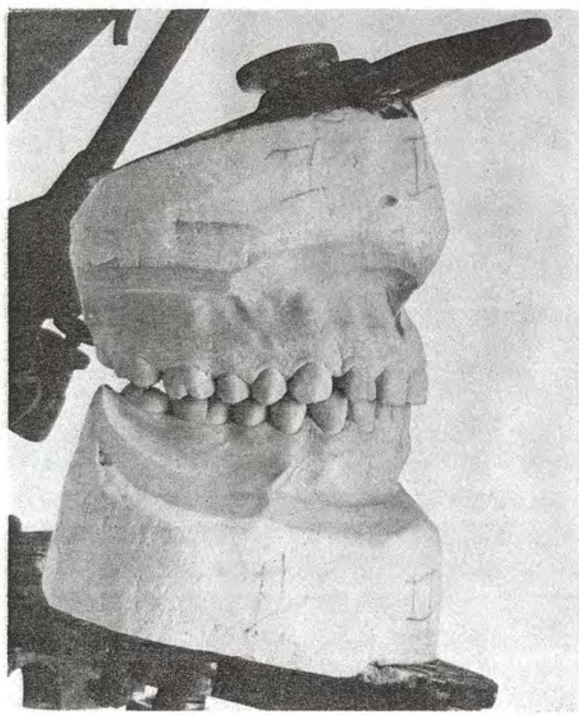

Figure 65. Upper and lower models of specimen illustrated in Figure 64 mounted in centric occlusion. Female, age 36.

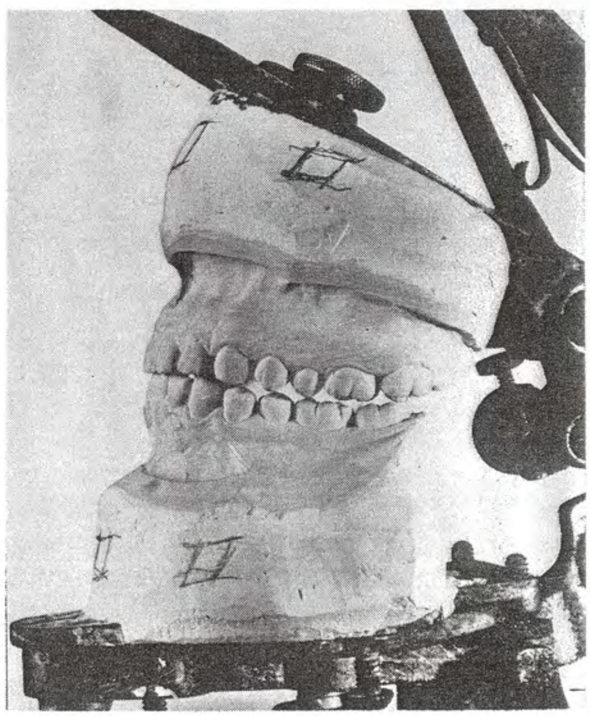

Figure 67. "Balancing" side of specimen illustrated in Figures 64, 65 and 66. Female, age 36.

buccal cusps of the lowers. Actually, there is a greater space existing between them than the photograph demonstrates. In this case, at the age of 36, the entire periodontium is still normal physiologically.

The third case of this series is that of a female of English-Dutch descent, age 54. The first view (Figure 68) again is a vertical view of the occlusal and incisal surfaces of upper and lower casts. Third molars have been extracted. Note attrition of incisors and canines. Several restorations have been placed in lower molars; however, upper molars and premolars still free of such restorations show only slight attrition of the occlusal surfaces.

The next view (Figure 69) same case, shows centric position. Note intercuspal relation of premolars and molars, the interlocking position of the canine and attrition of its mesial incisal edge. At the age of 54, the gingiva and entire periodontium is still physiologically normal.

In the lateral view of the "working" side (Figure 70) we again note the absence of contact of the buccal cusps of the premolars and molars in spite of the fact that the canines have undergone considerable attrition. Again in this view, the angle at which the view was taken does not show the actual clearance existing between the cusps.

The lateral view of the "balancing" side of the same case (Figure 71) shows definitely a lack of contact of the lingual cusps of the upper molars and premolars with the buccal cusps of the lowers, and this in spite of advanced attrition of the canines.

In all three of the preceding cases, the functional relationship is identical, all possessing an interlocking relation of the canines. During lateral excursions of the mandible, none of the cusps or inclined planes of the opposing premolars and molars make contact until the mandible has returned to centric relation with dentition in centric occlusion. In such a functional relation none of the applied force of the Temporal and Masseter muscles can be directed at an angle to the long axis of the teeth. The full magnitude of the applied force is resisted by the opposing teeth when occlusion in centric has been reached, its direction be-

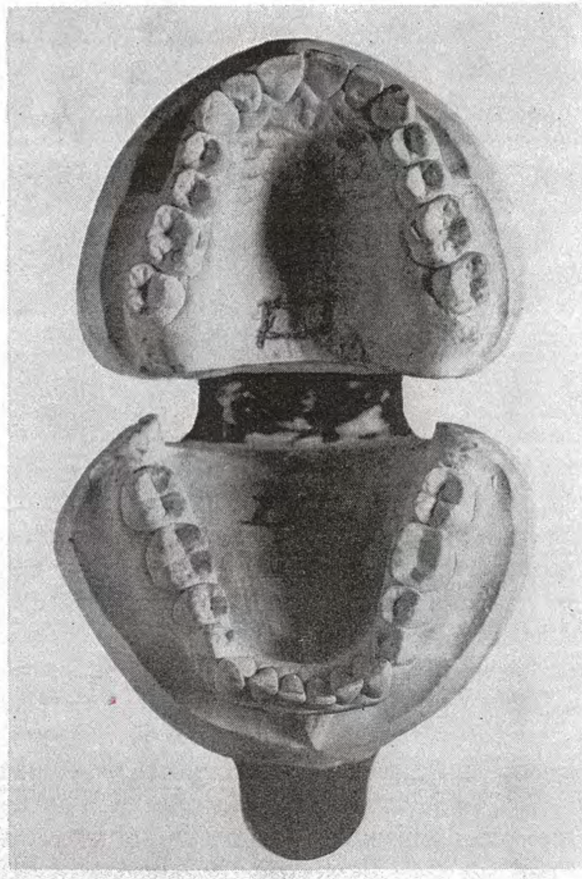

Figure 68. Occlusal aspect of upper and lower models of dentition of adult present day female, age 54. (English-Dutch descent).

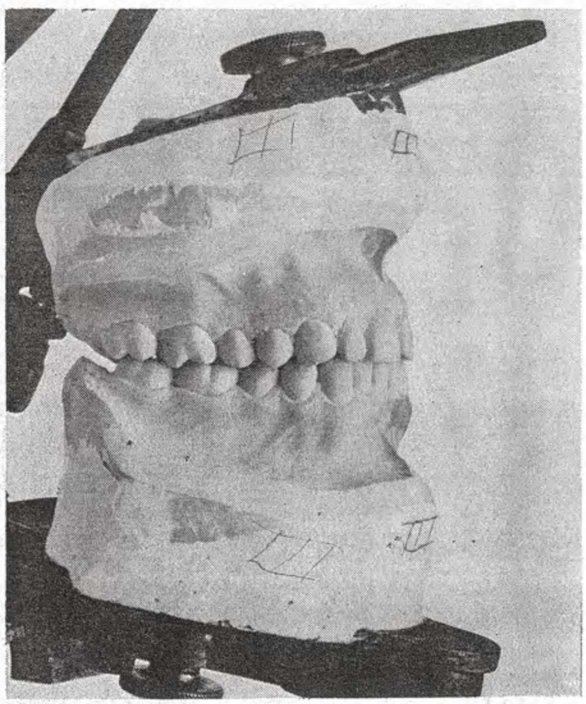

Figure 69. Upper and lower models illustrated in Figure 68 mounted in centric occlusion. Female, age 54.

ing with the long axis of the teeth and resisted by the entire alveoli and peridental membrane, thus reducing the possibility of molecular fatigue of the hard and soft investing tissues to a minimum. (All of these studies and photographs were made in 1953.)

The object in illustrating these three cases is to point out the progressive stages of attrition of the cuspids at various stages of life. This is something we see every day in general practice. Progressive abrasion of the cuspids permits the remaining teeth to remain in contact in a wider range during eccentric movements of the mandible, thereby increasing the possibility of developing horizontal vectors. If this condition remains undetected the usual result will be the spreading or fanning out of the upper incisors and resorption of the alveolar process around the lower incisor teeth. Also we will see resorption of the buccal and lingual plates around the premolars and molars. The general practitioner will agree that this condition is quite general in adult stages of life. Restoring the abraded areas of the cuspids to their original dimension so as to eliminate the possibility of developing horizontal vectors will not only be of great aid in periodontic therapy, but it will

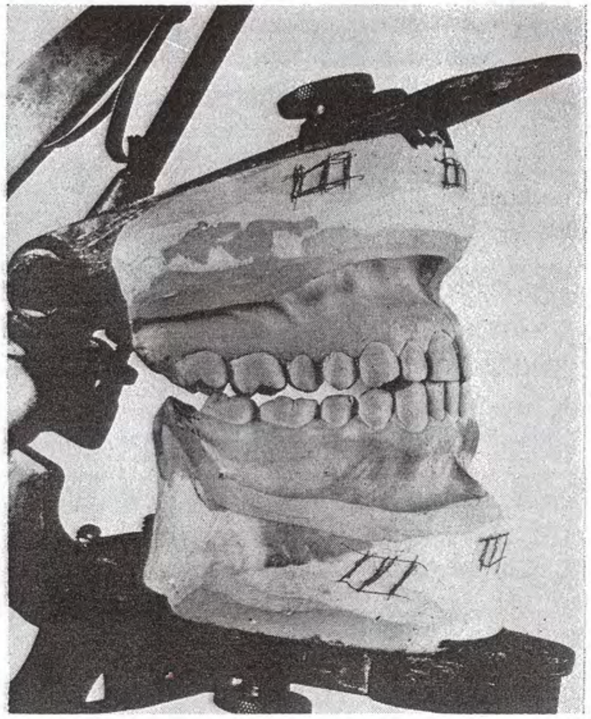

Figure 71. "Balancing" side of specimen illustrated in Figures 68, 69 and 70. Female, age 54.

Figure 70. "Working" side of specimen illustrated in Figures 68 and 69. Female, age 54.

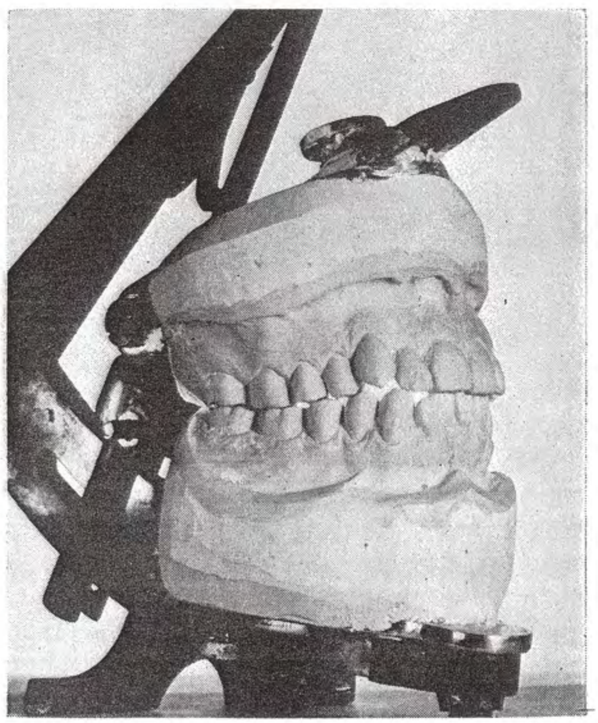

Figure 72. Upper and lower models of dentition of a male, age 24, mounted in centric occlusion. (Eight years after receiving orthodontic therapy).

also prevent further fatigue of the entire periodontium. This procedure is far more desirable than the spot grinding of cusps and transverse ridges as advocated by the supporters of the "balanced" occlusion theory practising the equillibration method.

When we note the normal physiologic state of the periodontium of the 54 year old case, it is not difficult to predict that the 36 and 16 year old patients will enjoy the same oral health for an equal length of time, barring accidents, ravages of caries or some unforeseen physical ailment. The functional relation of the canine teeth in the preceding cases has safeguarded the normal physiologic state of the periodontium. Rather than being exceptional cases and rare, the writer has found it to be the general rule. It is the desired relationship implied by such men as A. LeRoy Johnson, Milo Hellman, Samuel Hemley and others of the orthodontic profession, inasmuch as the functional relationship of the opposing teeth permits the entire periodontium to remain physiologically normal.

All the literature reviewed on normal functional relation of the natural teeth from the orthodontic point of view, fails to reveal that any one of the writers took notice of the interlocking relation of the canines. Even Hellman failed to do so, although he had close ties with William Gregory and his associates at the American Museum of Natural History. It is quite possible that, having practised the specialty of Orthodontia throughout his professional career, Hellman sought the answer in the study of evolutionary changes that have taken place in the facial bones, mandible and braincase of man. The writer is of the opinion that Hellman believed that a good knowledge of such evolutionary changes would be of great importance in anticipating the direction of growth and development of maxillae and mandible and that it would be of great aid in directing the movement and position of the natural teeth. There is no doubt that such knowledge is invaluable, however, that alone is not sufficient to retain the teeth in their re-aligned position. The "drifting" of re-aligned teeth will occur if the applied horizontal vectors are not eliminated, and this can only be done by aligning the canines in the normal interlocking position.

An example of failure in orthodontic

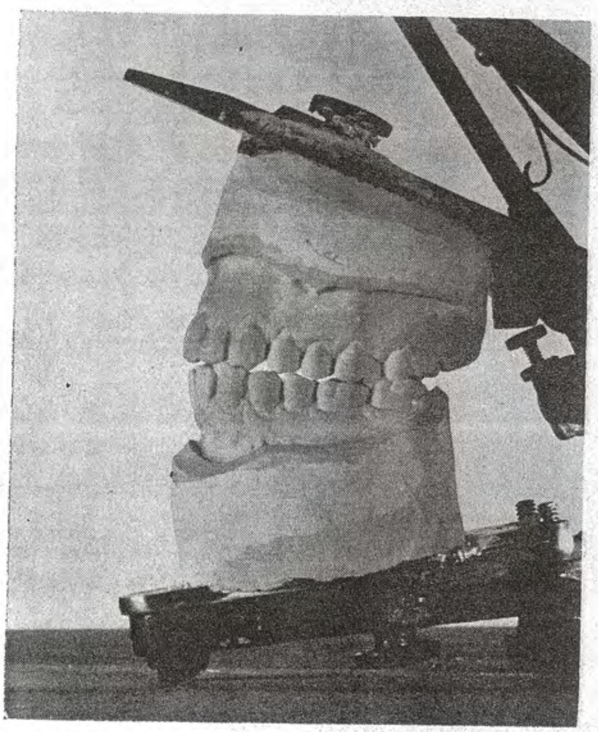

Figure 73. "Working" side of specimen illustrated in Figure 72. Male, age 24.

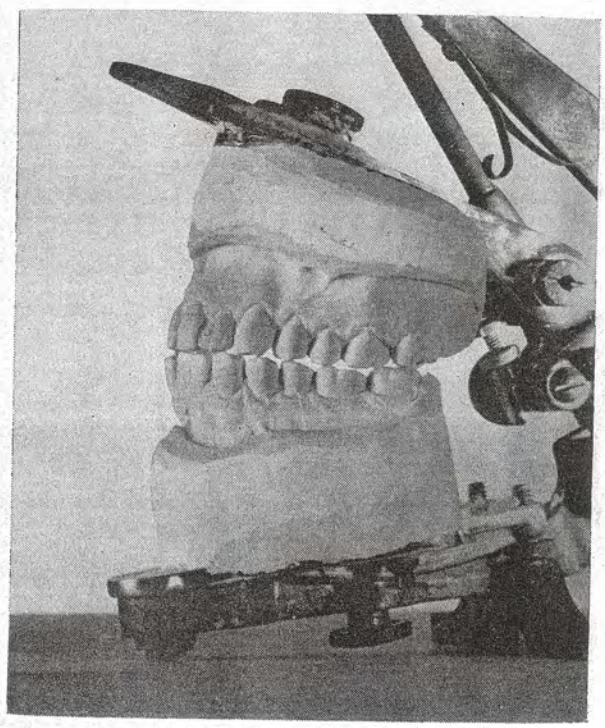

Figure 74. "Balancing" side of specimen illustrated in Figures 72 and 73, male, age 24.

treatment is well depicted in the next series of photographs. It is that of a 24-year-old male. Retainers were removed at the age of sixteen. The first view (Figure 72) shows upper and lower casts in centric position. Note the upper right canine waving in the breeze. The first and second molars are in normal relation. The upper first premolar shows considerable attrition of the buccal cusp; the lower first premolar shows slight recession of the gingiva, indicating that it is being forced lingually by the horizontal component of the applied force.

The next view is that of the left side in "working" position (Figure 73). Failure to interlock the canines has caused excessive attrition of their cusps and eliminated their normal function. As a result of this failure, contact of the cusps of upper and lower premolars when in working position has allowed the full application of the horizontal component force, causing a slight recession of the gingiva around the first premolars and canines. The next view (Figure 74) is of the same side in "balancing" position. The lingual cusp of the upper second molar is in contact with the inclined plane of the disto-buccal cusp of the lower second molar. First molars and premolars are free.

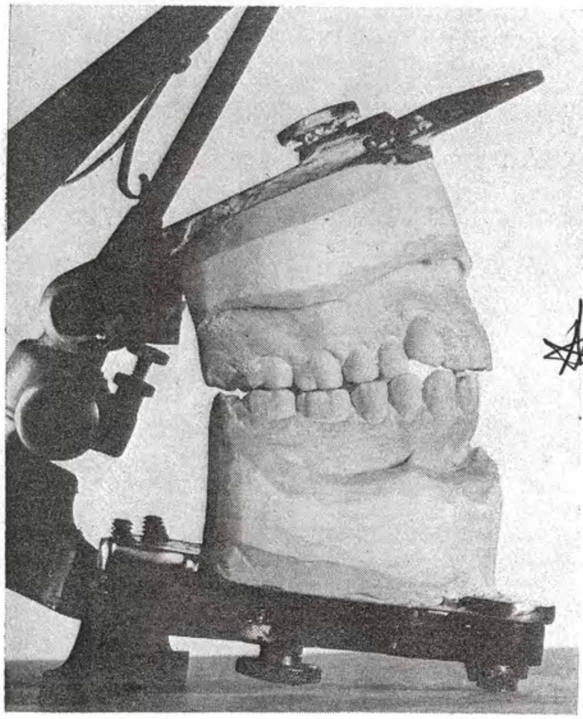

Figure 75. Right side in "working" position, same specimen as illustrated in Figures 72, 73 and 74. Male, age 24.

The right side in "working" position (Figure 75) shows a cusp to cusp contact of the upper and lower premolars. The canines and incisors fail to make contact. In studying this case, it is not difficult to come to the conclusion that the orthodontist was striving to align the posteriors so that they would function according to the theory that normal functional relation throughout all excursions of mastication should permit all cusps and ridges of the occlusal surfaces of the premolars and molars of one jaw to glide smoothly against those of the opposing jaw. In trying to reach this goal, he naturally bypassed the canines. Even if he had aligned the posteriors in their normal intercuspal relation, (which he most likely did), failure to interlock the canines permitted the horizontal component of the applied force to be applied to the premolars causing them to drift out of alignment.

Selection of this case to demonstrate failure of orthodontic treatment was for a specific purpose. *The mal-position of the canines* is so obvious that the general dental practitioner will have no difficulty in appraising results when he refers orthodontic cases for treatment. He should also bear in mind that such failures will be back to haunt him for many years to come. The orthodontist is relieved of all responsibility when retainers are removed. From then on, maintaining and prolonging the normal physiologic state of the teeth and periodontium becomes the responsibility of the general practitioner.

(Concluded in July Issue)

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The Canine Teeth—

Normal Functional Relation of the Natural Teeth of Man (concluded)

ANGELO D'AMICO, D. D. S.

"Summary And Personal Notes"

It was the writer's good fortune to have enjoyed a very close friendship with one of the very great teachers of dentistry, Dr. Forrest H. Orton, during my student days, and for many years later up to the time of his demise. During one of our many personal discussions the term "dental restoration" was brought up. Just what do we mean by the term "dental restoration"? This was his definition for it: "A "dental restoration" may be described to be any artificial substitute which restores the lost part of a tooth, an entire tooth, or any number of teeth. The substitute, however, must accurately restore the lost part or parts, and also must restore *normal function* of the same." This definition is comprehensive and to the point, i.e., that we cannot call an artificial substitute a restoration, unless it restores *normal function.* The term normal means natural, pertaining to nature. The natural teeth of man or any substitute we may contrive should function according to nature's intention.

Dental literature on the subject of occlusion needs reclassification. The writer reviewed many very old and many recent articles (probably two hundred or more) and noted that the general theme was the same. The theory as applied in full denture prosthesis is being applied to the natural teeth, although neither have anything in common, with one exception, i.e., registration of centric relation of the mandible. The axis or center of rotation of the mandible in the vertical direction is constant. Function of artificial full dentures is not unlike the function of the teeth of the herbivor. Elimination of cuspal interference which means elimination of the cuspids as guide teeth in any eccentric movement of the mandible is desirable. When we apply this principle to the function of the natural teeth of man, we are ignoring nature's intentions. When we ignore or eliminate the overbite and interlocking position of the cuspids we are inviting failure, whether it involves orthodontic, restorative or periodontal therapy.

An article on failure of fixed partial restorations and failure of the natural teeth by Rieser (20) is quite revealing. According to Rieser: "Persons who have had the benefit of adequate dental care from childhood could conceivably lose ten teeth to periodontal disease, for every one lost to caries. From this we must deduce that filling teeth does not cause periodontal disease, but merely saves them until such time as the slow insidious ravages of such disease become apparent. It then follows, in construction of fixed restorations, that the real problem in eliminating failures is the preservation of the bone support of the teeth." (To prevent failure of fixed restorations, Rieser advocates splinting or use of double or triple abutments whenever they are deemed necessary. No reference to the canine teeth.)

The quotation (by Rieser) is a candid admission that the dental profession is still faced with a definite problem, i.e., failure of restorations and failure of the periodontium. As yet, neither mechanical skill nor the application of the "balanced occlusion" theory have solved our problem.

Briefly, the physical evidence presented in this manuscript casts a doubt that the "balanced occlusion" functional relation of the teeth of man or any other member of the primate family has ever existed. The writer believes that the evidence presented thus far warrants the following conclusions:

1. The morphology of the natural teeth of man is designed for the mastication of a frugivorous, insectivorous (carnivorous) diet.

2. The temporo-mandibular movement is a gliding-hinge movement, mostly gliding.

3. The evidence does confirm the concept that the temporo-mandibular articulation does have a constant center of rotation during the vertical opening and closure of the mandible. (Resolution of the edge-to-edge bite).

4. The canine teeth have always been constant in number, position and alignment in the dental arches. Also in general morphology.

5. The canine teeth serve to guide the mandible during eccentric movements when the opposing teeth come into functional contact.

6. The position of the condyles in the glenoid fossa is the result of tooth contact and not the guide.

7. Angle's "key to occlusion," the articulation of the first permanent molars, is a major factor in growth and development.

8. The upper canine teeth, when in functional contact with the lower canines and first premolars, determine both lateral and protrusive movements of the mandible. Also, this functional relation opens the vertical relation thus preventing any force to be applied to the opposing incisors, premolars and molars which would be at an angle to their long axis.

9. The canine teeth also have a unique function. They are extremely sensitive organs. When their opponents come in contact during attempted eccentric movements of the mandible they transmit in a greater degree than any other teeth the desirable periodontal propioceptor impulses to the muscles of mastication, reducing muscular tension and thereby reducing the magnitude of the applied force. This is the all important function we seek to reduce or prevent failure of restoration and periodontium.

The object of dental science and dental practice should be to preserve the natural teeth and prolong their normal function in the same ratio as medical science has prolonged the average span of man's life. Anything less means that we have failed in meeting our obligation to mankind. Perhaps we have ignored man for his teeth.

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51st Annual Meeting of the S. C. Dental Alumni Association Begins Second Half-Century of Progress

The new International Room of the Beverly-Hilton Hotel will be the scene of the 51st Annual Meeting of the U.S.C. Dental Alumni Association, October 24, 1958. The International Room is large enough to house the entire meeting in various sections of the room—the clinics, exhibits, hobbies, the luncheon, and even the essayist will be under the same roof.

Gordon Fitzgerald, D.D.S., Professor of Oral Roentgenology, University of California Dental School, will be the featured speaker. Speaking on a timely subject, "Problems of radioactivity—in regard to the patient, the office staff, and the doctor," Dr. Fitzgerald will talk on the hazards and protection necessary in the average dental office. In the afternoon session, Dr. Fitzgerald will discuss, "Interpretation of Oral Radiographs." Fitzgerald, nationally known for the radiographic technique bearing his name, has been a great favorite in Southern California, having given many courses for southland dentists in the University of California Extension Division.

General Chairman Harold Holt has scheduled an exciting program for the all day meeting, which is expected to attract 1200 alumni and guests. The meeting opens with an 8 A.M. Coffee Hour; has an excellent luncheon program, at which Dr. Norman Topping, the newly appointed President of U.S.C., has been invited to speak; and the day winds up with a complimentary buffet and poolside no-host cocktail party. There will be table and projected clinics; an expanded hobby show and a scientific exhibit program second to none. The Exhibits will include those of the U.S.C. Tumor Board, the U.S.C. School of Pharmacy, the American Cancer Society, and the American Heart Society, all of which will offer valuable and practical information to the general dentist.

Non-alumni are cordially invited to the meeting. Save the date! October 24, 1958.

Harold Holt, D.D.S.
General Chairman
Warren E. Thornburgh, D.D.S.
Publicity Chairman