Treatment Planning with a Functional Concept

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Recently, evidence of mandibular repositioning in the treatment of Class II malocclusions was presented before the Midwestern Component of this society. This repositioning appeared to have occurred spontaneously as a result of correcting maxillary and mandibular arch forms. Occlusal interferences were removed that obviously had caused posterior mandibular deflections in much the same manner that bilateral maxillary constriction results in lateral deflection as seen in crossbite cases.

In the Class II malocclusions of both divisions, full anteroposterior correction was achieved without the aid of cervical traction therapy or the use of intermaxillary elastics. Before the conclusion is drawn that I imply that all Class II cases will respond in this manner, I hasten to add that many, and perhaps a majority, are of a structural nature and do require conventional Class II mechanical therapy. However, since there are those that demonstrate this functional adaptive factor, we feel its potential should be allowed to operate before the forces of Class II mechanics are applied in treatment.

The entire field of dentistry, today, has graduated from its humble beginnings involving the relief of dental pain and improvement of esthetics to the goal of establishing normal occlusion by means of dental restorations, prosthetic appliances, reconstructions and orthodontic treatment as the case demands. It is encouraging to again see function receiving the attention it deserves after taking a back seat to esthetics for many years. Dr. Angle's definition of "line of occlusion" has no equal in relating function to anatomical occlusion. The vagueness of that definition was clarified by Dr. Carl Storberg of Duluth, Minn., who defined normal occlusion as "that mandibulo-maxillary relationship supported by the natural or artificial dentition which permits the structures directly or indirectly, dependent upon that relationship to function in a state of equilibrium." Equilibrium may be defined as a condition in which opposing forces exactly counteract each other.

We may think of dynamic equilibrium as a condition of balance between varying, shifting and opposing forces which is characteristic of living processes. How applicable this statement is to the direct living processes with which we are concerned, namely, mandibulomaxillary relationship!

As we understand and learn more about the autonomic nervous system, endocrinology, symptoms of visceral disease, etc., it becomes obvious how different systems function in equilibrium, each system depending on the equilibrium of other systems and still, under adverse situations, systems can adjust or compensate their equilibrium to make it possible for survival until such time when stress and disease processes are eliminated.

If we are to speak of function, let us think of it with full meaning and purpose. Function should be thought of as that special, normal or proper action of any part or organ that does not affect adversely the related structures. The metabolic requirements of tissue depend on its *normal* function. Function

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can be a destructive force, can consume tissues, particularly if the function is augmented by abnormal forces. Dr. John Thompson stated these factors concisely in his article, *"Function, the Neglected Phase in Orthodontics"* when he stated, "no doubt, we have all unknowingly been guilty of converting an excellent physiological occlusion, but one that was in malocclusion, into a better anatomical occlusion to the detriment of physiological function."

Our dental colleagues are becoming ever more aware of the problems that arise in cases orthodontically treated by methods and philosophies that are mechanically rather than biologically oriented.

In early orthodontic teaching a strong emphasis was placed on function. All deviations in form were credited to malfunction. The concept of functional development prevailed not only in orthodontics but also in orthopedics, and it seems to have arisen from a misinterpretation of Wolff's law of the transformation of bone published in 1885. Wolff had experimentally deformed the bones of animals and fowls by altering the normal forces to which these bones were functionally subjected. He demonstrated that the response of the tissue was precisely that of a perfect reorientation of its structural elements to best meet the new forces. Wolff's law has never been controverted and is held as valid today. The error arose when it was accepted in the quantitative as well as the qualitative sense; Wolff mentioned only *change,* never size or degree of development. The overzealous orthopedist and orthodontist added the quantitative interpretation by holding that it was only necessary to increase the function on bone to increase its size. Since both groups were dealing with bones during their growth periods, they noted the changes in size which accompanied their ministrations and quite humanly and modestly gave themselves credit for it. Later it became obvious that the size increase, attributed to improved function, was in reality a result of growth. There were those who questioned this functional concept and asked about heredity. Has it nothing to do with the occurrence of malocclusion? How can the occurrence of mouth breathing be explained in Class I and Class III cases if it is a functional causative factor in Class II malocclusions? These and many other pointed questions were directed at the functional concept.

With the development of cephalometric techniques the orthodontist had a valuable tool for research to study growth changes serially in both size and form and our attention was directed from the functional to a structural concept. Much valuable information was gained from the many and varied studies conducted. It was inevitable that there were unfortunate as well as fortunate end results from so many diverse lines of study. According to Brodie, the most critical of these came from the findings on the constancy of the facial pattern. In some ways it was not unlike the misinterpretation of Wolff's law that had occurred earlier. In that case the mistake had been made of applying quantitative interpretation to qualitative matters. In this case too literal an interpretation arose. The statement had been made in summation of the many findings that, "from all of the evidence, it seems that the morphogenetic pattern is established at a very early age and that once attained, does not change." The interpretation given was that if the case is crowded at age seven and the morphogenetic pattern is constant, there will never be more room later. This reasoning gave rise to the serial extraction philosophy. In the quote nothing was said about size attainment, only form,

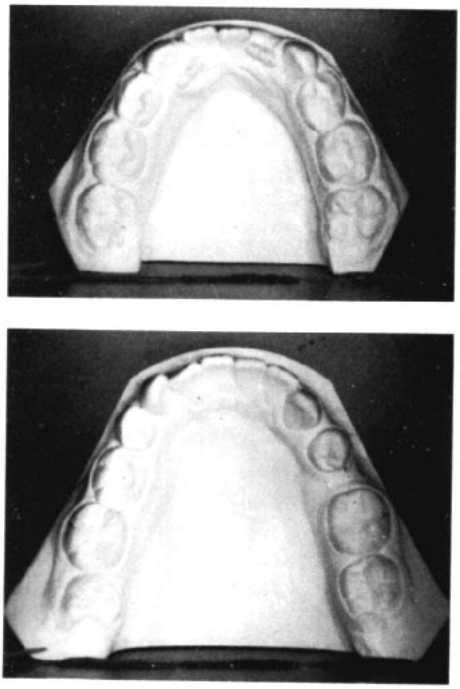

Fig. 1

yet this point was overlooked. With these findings and the misinterpretations placed on them, orthodontic attention was diverted from the functional possibilities of treatment to the morphogenetic limitations of treatmtnt. Present-day orthodontic teachings have fostered a philosophy of extraction that does not permit the student to experience the unfolding and development of the normal denture and the various phases experienced. They are too busy extracting premolars and serially extracting deciduous teeth to appreciate the possibilities of treatment. In many cases problems are created where none exist.

Figure 1 will illustrate the importance of size attainment. The model on the left was obtained from a girl, age 7 years and 3 months, the one on the right, the same girl at age 14. No deciduous teeth were extracted nor was any appliance used to effect the changes you see.

The case was and is in Class I occlusion with congenitally missing lower second premolars. Unfortunately, the eruption of the lower right first premolar resulted in the exfoliation of both first and second deciduous molars and the slight resultant shifting you observe. This is what T. Wingate Todd meant when he said, "Growth is increase in size and development is readjustment of proportion." When treatment is instituted, all teeth will be properly placed and replacements for the missing second premolars provided. While extraction procedures are tempting, I feel they would lead to the functional discrepancies of deep overbite and overclosure that would result in muscular imbalance.

It has been said that the thing that has made the game of baseball the great American pastime is the fact that it is the only sport which lends itself completely to our passion for statistical assessment. As baseball became the pastime of the average man, so has the cephalometric headplate become the orthodontist's great pastime for it, too, as a diagnostic instrument, lends itself to our passion for statistical assessment. We have our facial angles, our convexities, mandibular planes, Y-axes, interincisals and FMIA's, to name but a few.

In baseball, it is true that the averages do not always reflect every part of the game. There are shortstops who can stop the ball only with their elbows and their fielding averages are very good because they never get close enough to the ball to make an error. Another shortstop may look pretty bad on paper but be the most functional player in the league. I fear, also, that our statistics do not reflect all aspects of our patient. The one whose type places him well away from averages may also have the best function in our practice. To appraise the value of the

shortstop, you may have to go out and watch him play once in a while. Likewise, our patient's function should be allowed to guide our plan rather than mechanical methods based on preconceived notions of the meanings of averages.

At the present time it is customary to refer to malocclusions as functional or structural in nature, in addition to the customary Class I, II, or III classification. Such an analysis has some diagnostic and treatment implications as they affect the prognosis. I am in agreement with Dr. Thompson whose comparison is as follows: "A structural malocclusion requires a long period of treatment which is often dependent on growth and should be treated during the circumpubertal growth period. On the other hand, a functional malocclusion requires a short period of treatment, at as early an age as is possible. The earlier treated, the more simple is the method. A structural malocclusion does not become more severe with growth but only more apparent, while a functional malocclusion becomes propressively more severe, and the later it is treated, the more difficult it is to correct. A structural malocclusion is characterized by lack of mandibular displacement while mandibular displacement is characteristic of functional malocclusions. If such displacement is anterior, normal joint function can exist, if lateral or posterior, the displacement results in abnormal joint function either unilateral or bilateral." As well as the joint function mentioned by Dr. Thompson, I feel we should even more strongly be concerned with the system of antagonistic muscle balance.

In current literature it is generally accepted that the temporomandibular joint is a stress-bearing structure and that the primary purpose of the joint is to serve as a fulcrum around which the muscles of mastication may function. In any muscle system there must be a mechanical fulcrum to permit physiologic reciprocative function. The muscle system associated with the mandible is one in which the reciprocating muscles generally oppose one another and function in opposite directions. In the absence of fulcral influence, mandibular function is possible; however, it becomes a clumsy up-and-down manipulation and is limited by the neuromusculature capabilities of the individual.

One of the factors capable of impairing normal function of the temporomandibular joint as a fulcral influence is genetic variability of the dentition. The musculature is quite capable of compromising normal joint relationships to accommodate this variability. Such muscle activity results in alteration of the normally-functioning joint to integrate with the developing dentition and thus impairs fulcral influence in the mandible. These factors usually result in abnormal, abusive forces being exerted on the teeth and their supporting structures. In a sense, the teeth become secondary fulcra. The functional demand on these teeth frequently exceeds their physiologic capabilities and a defensive proprioceptive feedback is established which can result in muscle confusion and, eventually, spasms and discomfort. Impaired fulcral influence in the mandible is one of the major etiological factors in periodontal disease as well as muscle pain. In other words, the aberrations of tooth relationships result in attempts of the musculature to compensate the normal joint relationship forcing this articulation to bear greater stress than nature intended. The degree of severity and the time of occurrence will naturally be a variable dependent on the individual's constitution and the ability of the tissues to adapt.

During the past several years I have

had the opportunity of working with a group vitally interested in the functional aspects of dentistry. These men deal generally with the older individual whose denture has been mutilated by the ravages of time, neglect and abuse, functioning with other systems in imbalance rather than equilibrium. I would like to share with you some of these experiences, hoping you will benefit as I have with a better appreciation of the importance of dental function as it relates to the complexity of the total person.

Interest in this subject stems from a study done on the use of mouth guards at the University of Notre Dame by Drs. John M. Stenger, Edward A. Lawton, James Ricketts and myself. This study reported in the American Dental Association Journal in September of 1964 suggested a synergistic relation between the mandible, hyoid bone and cervical vertebrae.

Our approach to the subject was the study of individuals prone to concussion and neck injury and evaluating why a mouth guard eliminated many problems encountered. Time does not permit a detailed review of the findings reported but I would like to repeat one paragraph from the article. It is as follows: "A reduction in the number of neck injuries was an unexpected result of wearing the mouth guards. Neck injuries had increased since the use of the face bar had become mandatory. During the 1962 season at Notre Dame, six or seven players had chronic neck problems and four of them wore cervical collars. Cervical traction, and here I mean the orthopedic type, was routine therapy for these players. An automatic traction device was ordered by the athletic department and delivered during the summer of 1963 to augment the manual one in use. Fortunately, because of the mouth guards worn by the players prone to neck injuries, the new machine, ordered in anticipation of more injuries, has never been unpacked. Furthermore, not a single Notre Dame player who faithfully wore his mouth guard during the 1963 season found it necessary to wear a cervical collar."

From the results it was decided that additional posterior support from the mouth guard stabilized the cervical vertebrae and hyoid bone as well as the maxillomandibular relationship and made the player less prone to neck injury and concussion. A cephalometric study on the patients reported in the article was done. Two lateral films, one with the patient in occlusion and one with the patient biting on his mouth guard, were employed. Details of the technique can be found in the article.

Having been thus stimulated, I asked my colleagues to send me some of their patients, treated by the use of an occlusal splint, who had been relieved of physical symptoms by establishing balanced dental relationships in that manner. By cephalometric evaluation of one of these patients, I hope to show you some clinical verification of the biological facts set forth in this discussion and hope that such verification will help restore function to its rightful place in diagnostic thinking. I feel the study provides some definite evidence of postural muscle changes as indicated by positional change in the vertebrae in cases presenting clinical symptomatology.

On this patient, three lateral head films were taken in sequence with the patient remaining in position in the headholder between exposures: the first taken in occlusion, the second occluding on the splint, and the third in wide-open position. It should come as no surprise to you that the first patient I received as a result of this request was a Notre Dame football player, a patient completely lacking in posterior support.

P. D. came to the University of Notre Dame in 1963 as one of the most highly touted freshman prospects ever recruited by the university. His freshman performance was superb. Early in the 1964 season, he suffered a spinal injury that decreased his efficiency to a point where he couldn't make the squad. We were particularly interested in his case because, while a mouth guard could be made to protect his teeth, it could not be built with sufficient bulk to provide the posterior support believed so necessary from the earlier study, due to the absence of any posterior occlusion. Because of the bulk of the mandible and the power of the musculature, we were interested in finding if providing posterior support would enhance his physical abilities.

It had been suggested to the medical staff, in his presence on numerous occasions, that if partial dentures could be provided over which to wear a mouth guard, the proper support might be achieved. The university would do nothing regarding such replacements since he had lost all of these teeth prior to his entry. You will recall an earlier statement concerning the equilibrium of the various systems and how, under adverse situations, they can adjust and compensate until a breaking point is reached. I feel this explains why a patient is often slow developing such symptoms. Remember, his freshman performance was superb. He became so concerned about his inability to perform that he sought dental care on his own. Through the procedure of check bites and splint use over a period of months, his rest position was determined, and in spring practice in 1965 he was wearing a mouth guard made over a splint. After this had proved its value, the partial dentures were made.

In this case posterior support was the goal and was provided. P. D.'s record during the succeeding years also speaks well for the service provided. He has won All-American honors on many of the teams selected and is now playing professional football.

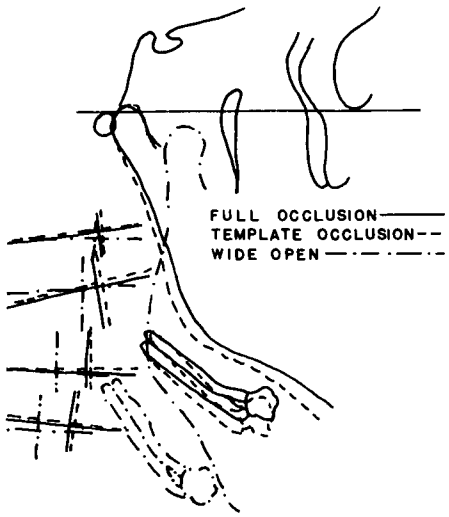

Fig. 2

Now, lest I be misunderstood, we were not interested in this individual because of his athletic prowess but because his neglected dental mechanism provides an extreme example for the understanding of the importance of muscle balance, so important to the equilibrium of the entire system.

It was my privilege to acquire headplates of P. D. in the early fall of 1965, and in Figure 2 we see the postural change of the vertebrae in occlusion, with the splint in place, and wide open. It is most interesting to note that from the position of comfort occluding on the splint (dashed line) to full occlusion without the splint (solid line) that the cervical vertebrae move in a posterior direction indicating a contraction of the postcervical muscles to counterbalance stress in the anterior chain of muscles in full closure. It is the same contraction but of lesser magnitude as seen when a wide open posture of the mandible is assumed. In a wide-open

posture, (dash-dot line) a stress in the anterior chain is obvious.

In preparation of the composite figure to study the positional change of the vertebrae, it was difficult to trace the same outline of an individual vertebra on successive cephalometric films. To facilitate a study of these changes, an outline of each vertebra was made on separate pieces of tracing paper and a vertical and a horizontal line were drawn within this outline. It then becomes easy to place this outline over the same vertebrae on successive films and transfer the vertical and horizontal lines to the tracing being prepared. When the two, three or four tracings are placed together, oriented on cranial landmarks and cranial outlines, it is possible to see not only anteroposterior positional changes but also rotational changes without the confusion of the curvature and irregularities of the vertebral outlines.

At this point I began to question myself and wonder if perhaps a symptom-free individual would demonstrate the same postural movement from rest to closure that I had observed in these treated patients. In a series of three films, one in occlusion, one at rest and one wide open on symptom-free individuals, I found the slight expected change in hyoid and mandible positions from rest to closure but no changes in the vertebrae.

Further study of individuals who had been relieved of debilitating symptoms by use of a mandibular splint revealed similar results to those seen in P. D., that is, postural changes of the cervical vertebrae from a position of occlusal comfort on the splint to full occlusion with the splint removed. These postural changes were not always in the same anteroposterior direction, but the fact that changes occurred is important, I feel, for any changes indicate stress.

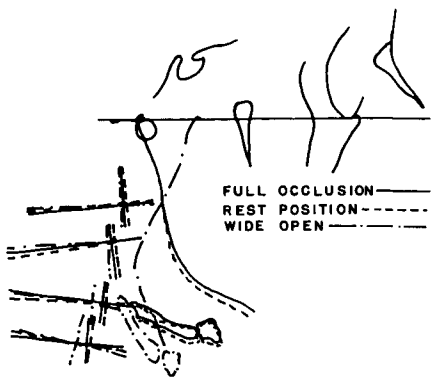

Fig. 3

In Figure 3 are the tracings of a fourteen year-old girl referred by her dentist and pediatrician. She had sought medical attention from the pediatrician because of neck pains, frequent headaches in the temporal region, a stiffness of her jaw on the right side and a daily fever occurring usually in the afternoon, sometimes as high as 101 degrees. Following a physical examination in October 1966, the pediatrician gave a presumptive diagnosis of rheumatoid arthritis.

Oral examination revealed a Class II, Div. 2 subdivision, left malocclusion with a completely blocked-out, unerupted lower left second premolar. The pediatrician had asked for a dental check because of the appearance of the lower right first molar and the possibility that a periapical involvement here might be the cause of her trouble.

Further questioning of the patient revealed she had moved to South Bend in early September and that on July 15th, her dentist in her former home town had placed an upper Hawley type appliance to "straighten her teeth" by reducing the protrusion of the front teeth. As our examination attests, that protrusion was reduced and, as a consequence of the dental interferences created, a rather bizarre set of symptoms developed.

You see from rest position (dashed line) to closure (solid line) the same direction of vertebral movement as in the other case having clinical symptoms. The dentist placed an occlusal splint on November 4th, and I questioned him for building it so high and suggested he might be encroaching on the freeway space. He assured me that from the rest position mounting of the work models, determined by plaster cores, the case was closed three to four mm to this relationship and could not be closed farther without meeting interference from the upper right central. Therefore, there should be no encroachment on the freeway space.

There is no single treatment of these problems and I am not proposing "opening the bite." This is not the purpose of the splint. Its use is to rid the denture of interferences that result in impaired fulcral influence of the temporomandibular joint. This may be achieved in many cases by occlusal equilibration. In such a case as this, equilibration of the incisors was impossible because of the necessity of removal of excessive tooth structure. The only answer is biologically oriented orthodontic treatment or full dentures.

I saw the patient again on December 10th, and she reported that she had had immediate relief of all symptoms when the splint was placed. She further said that she had gone to school one morning and had forgotten to replace it after brushing her teeth and, by afternoon, was experiencing a headache and neck pain which was relieved when she returned home and replaced the splint.

Here are the tracings of the cephalometric films obtained December 10, 1966 (Figure 4). The vertebrae are represented as dashed lines from the two films, rest position and occlusion on the splint. The positions of the mandible and hyoid bone are shown as a dotted line from the splint occlusion

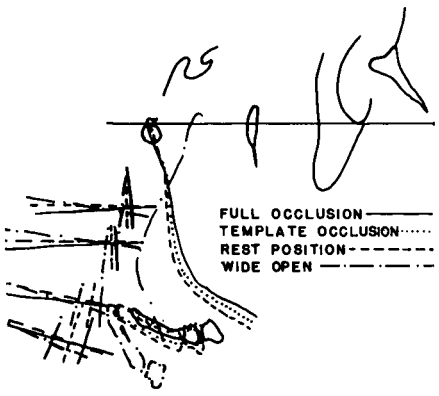

Fig. 4

film. There is movement of the hyoid bone and mandible but no vertebral movement from rest to template occlusion. Again, the solid line represents full occlusion without the splint. It is interesting to note that now the vertebrae have moved forward. Again, the direction is not significant but the fact of instability shows that bombardment of the cervical ganglion sets up stress as demonstrated by movement of these vertebrae. The dot-dash line represents wide open. The concluding paragraph of the physician's next letter read: "Examination November 22nd, 1966 was normal. The girl had no fever or pain, off aspirin. There was no evidence of rheumatoid arthritis or rheumatic fever".

Since the original presentation of this material, this girl has been orthodontically treated to establish normal functional relationships. No teeth were extracted. The space for the lower left second premolar was opened and the tooth positioned. She has been symptom free during treatment and the six months following. Figure 5 shows the cephalometric appraisal after treatment. The dashed line in the vertebral area represents rest and full closure. There is no change in vertebral position. The mandible and hyoid bone are seen as dashed lines at rest and solid lines in

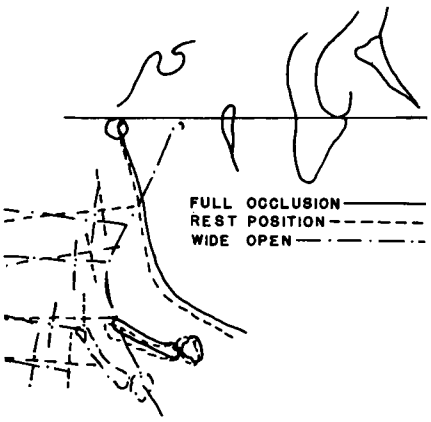

Fig. 5

occlusion. The dot-dash lines show the wide open position.

This discussion has not given any concrete means by which to implement function into orthodontic treatment as the title might imply but, through the examples shown, I hope that we become more mindful of the far-reaching effects, good or bad, that orthodontic treatment can have on the total person. Let the goal of all orthodontic treatment be, as in all phases of the medical arts, the restoration and maintenance of normal function.

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