The Mandibular Incisor -- Its Role in Facial Esthetics

WENDELL L. WYLIE, D.D.S., M.S.
San Francisco, California

For nearly two decades, largely through the writings and teachings of Dr. Charles H. Tweed, the position and axial inclination of the mandibular incisor has been regarded as a factor of primary importance in the attainment of the kind of facial profile which Dr. Tweed admires. His early writings deplored orthodontic treatment which allowed the dental arches to migrate forward, and the mandibular incisors served as a convenient reference point in the description of what he considered good and bad treatment, good and bad facial form. At first no attempt was made to express his concepts in quantitative terms, but over the years there has been a progression towards more precise definition of incisor position. At first sectioned models were shown, accompanied by face photographs. Next came the measurement of the axial inclination of the mandibular incisor to the mandibular plane, and this concept was soon enlarged to include the relation of the mandibular plane to the Frankfort horizontal.

In recent years Dr. Tweed has thought to correlate mandibular incisor position with variations in the Frankfort mandibular plane angle until he now defines in very precise language what he considers to be the proper relationship of the mandibular incisor to the Frankfort horizontal. The present end result of this trend is the advocacy of a single measurement from the cephalometric film, a system of cephalometric appraisal which, by comparison, makes all other methods seem quite complicated.

This paper might never have been written, but for the fact that Dr. Tweed published one of his own in a recent issue of the Angle Orthodontist[1]. Many orthodontists are going to read that paper with mixed emotions. They will detect that the basic premise of the article is open to question, but there is also the danger that they will come so quickly to that conclusion that they fail to see much that is good in the paper. The real benefit to be derived from the paper comes only through careful study of the facial photographs and of the tracings. The perusal of his article was, for me, in a sense, the renewal of an acquaintance with old friends, or at least the study of familiar photographs. This statement requires some explanation.

For a number of years Dr. Ernest L. Johnson and I have collaborated in analyzing the esthetic problem in terms of the dimensions of the human face, as is made possible by the Broadbent cephalometer. We have observed that when orthodontists are left to their own devices in choosing faces they like, most of them will single out those where the Frankfort mandibular plane angle is low, and that they will designate as poor the cases is which this angle is steep. We have reported in the literature[2] that the steep Frankfort mandibular plane angle may be attributed to an excess of alveolar process at the profile, or to a short mandibular ramus, or to a relatively high placement of the glenoid fossa in the skull. However accurately documented these observations may be, they are a little like the generalization that Scandinavians are tall

people. One can accept this as a fact and still not be dumbfounded upon meeting a Norwegian who happens to be short. Generalizations based on averages add to our information, but the clinician deals with individuals. Orthodontists preoccupied with the clinical problem rather than with research must avoid excessive reliance upon average values, and this warning certainly applies to Dr. Tweed's recent paper. Research workers dealing with clinical problems must therefore eventually center their attention on individual cases, and deal with changes which may be observed in individuals.

Because Dr. Johnson is an exceptionally able orthodontist, we had at our disposal a large number of well treated cases with complete cephalometric records, in whom we could study quantitatively the results of orthodontic treatment. This led us logically into what we have called "the study of net change". In other words, we did not simply limit our attention to the mean value of some measurement before treatment and after treatment; instead, we measured for the sole purpose of seeing how much change occurred. With such a method it does not matter whether you measure the angulation of the lower incisor to the mandibular border, or to the line gnathion-gonion, or its relation to the Frankfort horizontal plane, or to any other plane of reference. The amount of change and its direction are the matters of moment.

We were seeking to find the factors most responsible for the production of a straight profie. It was not our purpose to challenge Dr. Tweed in his advocacy of the facial changes he seeks. On the contrary, we proposed that for the sake of learning more about it, we assume that this is a beneficial change and that we learn how best to accomplish it. It goes without saying that net changes in the angulation of the lower incisor attracted our particular attention.

When all the data were at hand, derived from Dr. Johnson's treated cases, they suggested that all these years orthodontists have been attaching exaggerated importance to the angulation of the lower incisor, so far as it is concerned in orthodontic diagnosis and treatment planning. It was then that we found ourselves in the midst of a dilemma: had we discovered in Dr. Johnson's material that the uprighting of the lower incisor was crucial to straightening the soft tissue profile, it would have been a routine matter to report it. Since our findings were essentially the opposite, we suspected that Dr. Tweed might not readily accept these findings, based as they were on someone else's material. In the light of subsequent developments this may have been unduly apprehensive, but nevertheless we wrote to Dr. Tweed. We acquainted him with the nature of our findings and requested that he send some before and after headfilms of his own cases. We promptly received clinical records which included before and after films and facial photographs for 29 consecutively treated cases. These were accompanied by descriptions of the mode of treatment and other essential information. Some individuals might be reluctant, with that kind of forewarning, to comply with such a request. Dr. Tweed's cooperation was admirable, but not surprising to us who know him so well.

The advantages of such ready access to this clinical material has gone far beyond the opportunity to check our results against his. They make it possible to demonstrate the results of orthodontic treatment, evaluated cephalometrically, where the treatment is performed by one whose results show a substantial amount of tooth movement. They have also added a great deal to my conviction that we do not know nearly enough about what happens as a result of our everyday ministrations.

Unfortunately, the most effective way

in which the benefits of studying this material may be shared with orthodontic colleagues is through the systematic superimposition of tracings upon one another, using different superposition points to study different areas. While this may be done quite effectively at a scientific meeting, it would be unconscionably expensive for any journal to attempt to document the story by means of engravings. Therefore the reader is requested to take certain general observations on faith, although later in the paper it will be a simple matter to show quantitative data bearing upon the main point at issue.

First of all, Dr. Tweed not only preaches the reduction of the profile about the lips, but he achieves those changes to a marked degree in his own patients.

Secondly, he undeniably moves teeth back in relation to the bony base, not only just by tipping, but oftentimes by moving teeth bodily. His own material shows, however, that the good facial changes cannot be ascribed to tooth movement entirely, for in young patients the improvement gained is largely related to the amount of mandibular growth which has occurred, establishing a new and better position for the chin. Furthermore, the lingual movement of anterior teeth is not always accompanied by proportionate lip change. Several cases were found where facial improvement occurred, where there was lingual bodily movement of anterior teeth, yet where the soft tissue outline of the lips superimposed exactly upon the original soft tissue lip position.

Growth undoubtedly has an important role in the successful outcome of Tweed's cases, and to an unusual degree he manages the course of orthodontic treatment so as to capitalize most effectively upon the natural processes of growth. For these reasons, and for reasons which are about to be set forth in quantitative style, I wish to take friendly disagreement with him when he ascribes his obvious successes to such a simple matter as altering the inclination of a tooth. His advocacy of a single measurement as the keystone of orthodontic diagnosis is not merely an oversimplification of a complex problem: in centering his readers' attentions upon a small and perhaps relatively unimportant aspect of his clinical procedures, Dr. Tweed is guilty of selling himself short.

This discourse on Dr. Tweed's material thus far has been merely descriptive and has ignored the fact that our writing for material in the first place was prompted by the desire to make a quantitative study of Dr. Tweed's method of straightening the facial profile. More specifically, how important is it that the lower incisor be uprighted if Tweed's objectives are to be attained?

Findings:

While we did not choose to interpret dates on the films as a reliable indication of duration of treatment, the impression was gained that the average treatment time was about 13 months. In this series of 29 cases the average amount of angular change of uprighting the lower incisor was 10.3° and in one instance the lower incisor was uprighted by 24°. The average amount of uprighting of the upper incisor was 7.5° mm with an extreme of 18 mm. In many instances movement of the upper incisor was bodily rather than by tipping. In terms of angles the average amount of tipping was 11°, while one upper incisor was actually tipped back as much as 28°. On the average the mandibular plane angle was made steeper by 1.6°. It must be emphasized that these mean values provide only a general sort of information and do not warrant any particular conclusion.

Rather than devoting any more time to averages, let us consider individual cases and specifically examine just how uprighting the mandibular incisor is related to straightening the profile, as seen in Tweed's cases. Fig. 1 shows how we measured quantitatively the straightening of the soft tissue profile. We call the measurements shown here the "soft tissue angle of convexity", for each of the three points which determine this angle is roughly the soft tissue equivalent to the bony landmarks which define Downs' angle of convexity. Obviously, Dr. Tweed's avowed purpose in most orthodontic cases is to reduce the soft tissue angle of convexity. We therefore measured in each of his cases the change which he obtained in the soft tissue angle of convexity. We can give him very high marks with respect to the attainment of this objective, for on the average he straightened up the soft tissue profile by 6.5°; the greatest change was one of 16°.

Fig. 1. Depicting the manner in which the two variables were measured, axial inclination of the lower incisor, and the "soft tissue angle of convexity". Actually, for the purposes of this study, only *net change* in the two variables is considered. The soft tissue angle of convexity is a rough equivalent of the angle of convexity as defined by Downs, and it involves the prominence of the forehead, the most prominent point on the upper lip, and the most prominent point on the fleshy chin. The soft tissue angle of convexity is measured from points taken on the fleshy profile, not on bony points.

Surely no one in his right mind would contend that Tweed is unsuccessful in what he sets out to do. The figures quoted establish that he straightens up the profile, and earlier figures indicate that in substantial fashion he uprights incisors. It has been presumed that there is a cause and effect relationship between the two, and in fact Dr. Tweed currently builds his entire concept of diagnosis and treatment planning on the assumption that the lower incisor's long axis should stand so that it intersects the Frankfort horizontal plane at an angle of no less than 65°. He assures us in his recent article". . . by blindly following this formula, facial esthetics will be from good to excellent in 90% of the cases . . . ." *

In a long and painstaking article Dr. Tweed has shown us that he has undoubtedly achieved through treatment the kind of facial changes he advocates; at the same time he has shown that he has altered the inclination of the mandibular incisors so as to more nearly approach his ideal of 65° (Frankfort mandibular incisor angle (FMIA)) or larger. He has provided no evidence, however, that there is any cause and effect relationship between the two.

If the uprighting of the lower incisors a specific number of degrees is so vitally necessary in the process of straightening the profile, then we should very fre-

* A re-reading of the entire paragraph reassures me that I am not essentially quoting out of context, although the sentence quoted is preceded and followed by certain qualifying phrases.

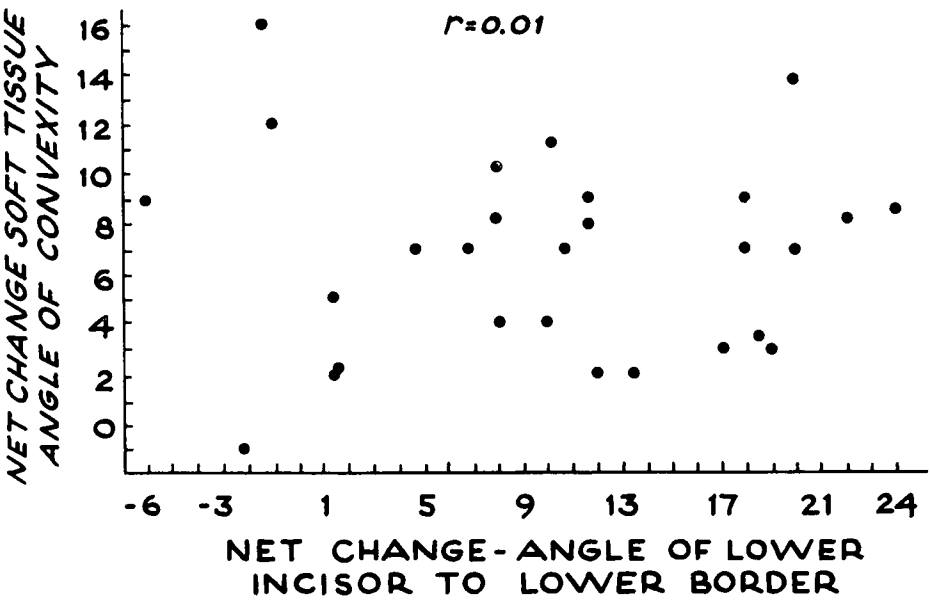

Fig. 2. This scattergram shows the degree in which there is a relationship between the amount of uprighting of lower incisors and the amount of straightening of the soft tissue profile. Each dot is located on the chart by the amount of soft tissue change obtained by Dr. Tweed and by the amount of uprighting of mandibular incisors. Negative numbers refer to forward tipping of the lower incisor. "r" is the symbol for the coefficient of correlation which measures the degree of relationship between two variables. Perfect positive correlation gives an "r" of 1.0; completely random relationship leads to an "r" of 0.0.

quently find associated with the cases in which there has been the greatest amount of net change in the lower incisor, a correspondingly large amount of improvement in the facial profile. What actually occurs in Tweed's cases is easily shown in graphic form by means of Fig. 2, a scattergram. On the vertical is plotted the amount by which the facial profile was straightened and along the horizontal the amount by which the lower incisor was uprighted. If these two changes were closely related to one another, or if profile changes were dependent upon lower tooth inclination, these dots should string out to approximate a straight line. The most casual inspection shows that this is not so, and a more detailed examination shows that in the instance of the greatest change in soft tissue profile, one of 16°, the lower incisor was actually tipped forward 1°. The most extreme amount of tipping, 24°, led to a profile change of only 9°, just a few degrees better than average. The dots in the upper left corner do not discredit the FMIA principle these are probably cases in which little changes in inclination was prescribed by it, yet appreciable facial change was possible. In the lower right, however, are depicted amounts of tipping which exceed Dr. Tweed's average of 11°, but which led to facial changes of only 2° to 4°.

Another method of studying the net change of mandibular incisor position is to measure it in terms of millimeters of movement of the crown in relation to some plane of reference not effected during the course of treatment. In order

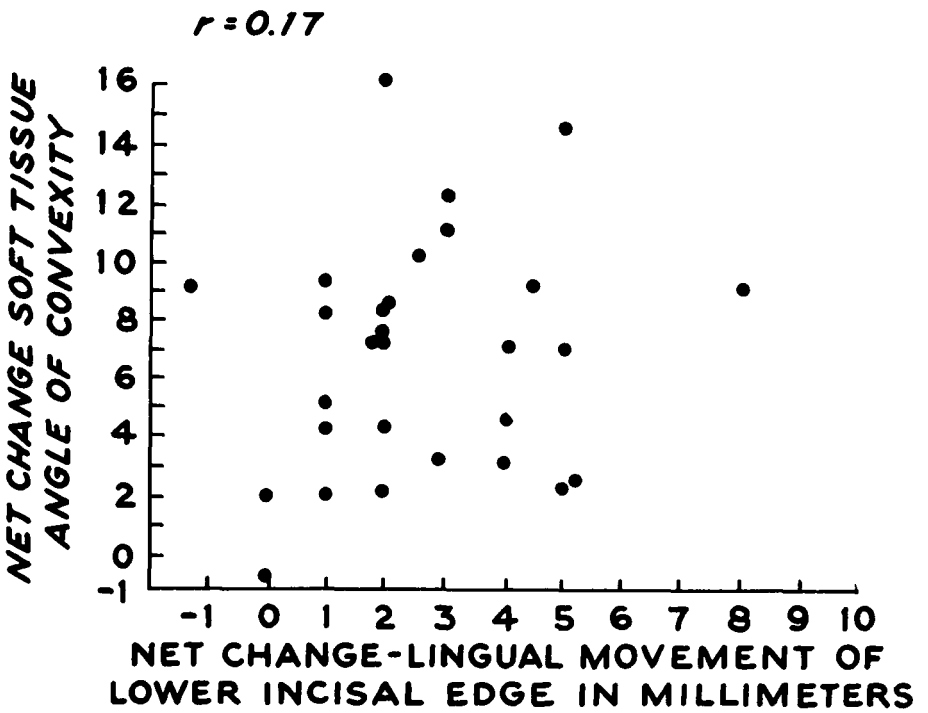

Fig. 3. Here net change in the soft tissue angle of convexity is plotted against millimeters of mandibular crown movement. The latter was measured by superimposing before and after tracings of the mandible on the lower borders with symphyses registered, and erecting a perpendicular to the lower border as a base line for measuring the difference in anteroposterior position to the labial surfaces of the lower incisors before and after treatment.

to determine this in each of Tweed's cases, the before and after tracings were superimposed on one another with the inferior borders coinciding and the symphyses registered. The reference plane selected was a perpendicular to the inferior border erected through the most anterior point on the chin. Actually, since only the difference in tooth position was recorded, the location of the plane is actually immaterial.

The desirability of making this measurement is evident to anyone who will reflect that it is possible to alter the angulation of the lower incisor by moving the root apex. If this were carried to an extreme where the incisal edge became the center of rotation while the apex went forward, it could seldom be interpreted as desirable orthodontic movement. Therefore, if one assumes that anteroposterior position of mandibular anterior teeth has any significance in facial esthetics, then a measurement of crown movement in millimeters might show more significance than alteration in axial inclination expressed in degrees.

The relationship between net changes in the soft tissue angle of convexity and in the movement of mandibular incisor crowns in millimeters is portrayed in Fig. 3. The relationship is somewhat better, although one must rely more upon the coefficient of correlation than upon the array of dots.

These data suggest that if one wishes to use precise criteria in diagnosis for the placement of mandibular incisors, he would do better to follow the pro-

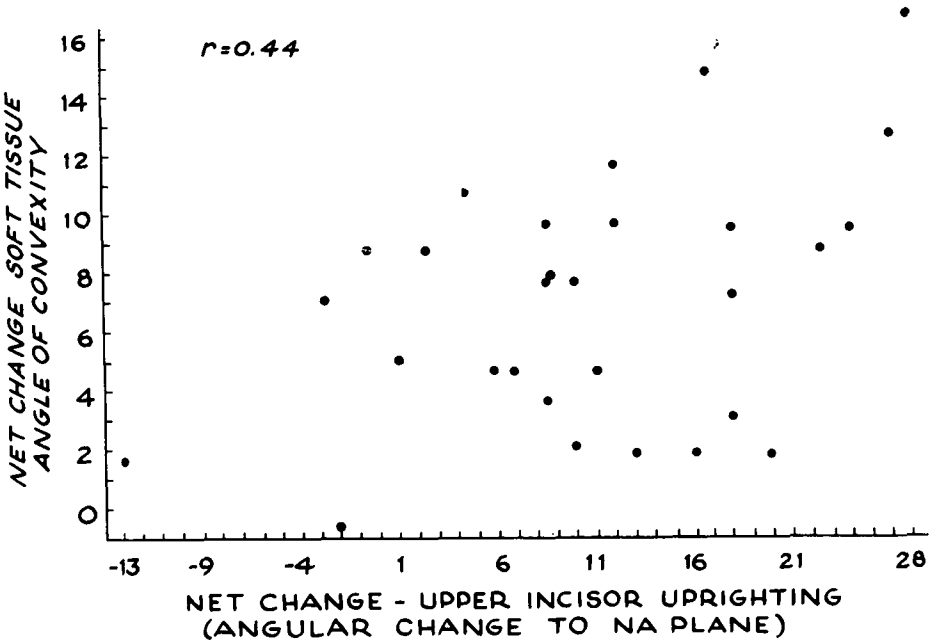

Fig. 4. Plotting net change in the soft tissue angle of convexity against the amount of lingual tipping of upper incisors, measured in degrees. The reference plane was the *original* NA plane, transferred to the subsequent tracings after the manner of Steiner.

cedure of Steiner[3], wherein the labial surface of the mandibular incisor is related to the plane NB. In the 29 cases of Dr. Tweed's, the average amount of lingual crown movement of the lower incisors was 2.6 mm; one case amounted to 8 mm, and at the other extreme, in one individual the lower incisor was moved forward 1 mm.

Consider next the upper incisor. In Fig. 4 we plot net change in the soft tissue angle of convexity against net change in the inclination of the upper incisor. If this scattergram does not produce a straight line, at least it resembles a sausage. Notice that the greatest amount of facial improvement, 16°, was found where there occurred the greatest amount of lingual tipping of the upper incisor, 28°. In similar fashion, the least amount of change, a case in which the soft tissue angle of convexity actually became greater, was found in a case where the upper incisor was moved forward 2°. The coefficient of correlation here is 0.44, and moderately large for biological material. It is not larger because facial change is still dependent upon the chin and a variety of other factors besides the axial inclination of the upper incisor. We are still not entitled to say that this is the only significant thing involved in improving the facial profile, nor are we even entitled to say that the angulation of the lower incisor is *never* important in the improvement of the facial profile. We can say, so far as the inclination of teeth is concerned, that we should expect improvement of the facial profile if we can retract the upper incisors. If it is necessary to retract the lower incisors to do so, obviously we cannot look for much improvement in the face until we upright *both* teeth.

We have already said that one who places his diagnostic trust in measurements of tooth position should work

with millimeters of mandibular crown movement, rather than angular changes in lower anterior teeth. Perhaps even better advice would be to determine the requisite in maxillary crown movement, and to tailor the mandibular cloth accordingly. I leave this, however, to those who trust the cephalometer to tell them where they are going. I shall continue to rely on it chiefly to tell me where I have been.

The Johnson data, involving a much larger series of cases, lead to identical findings as reported here. Many other possible factors were studied in that series and are not likely ever to be reported, since they indicate that orthodontic results arise from the interaction of many things, no one of which should be elevated into exaggerated importance.

Discussion:

The gist of this article is that Dr. Tweed is more successful in attaining the kind of facial changes he advocates than he is in explaining his own success. He asserts that the kind of facial change he likes is more often seen in his own patients now that he is relying upon the FMIA than was seen previously. He is assured by his many followers that while they aspire to attaining the facial changes commonly observed in his practice, they fall short of his level of performance. Let us assume that his results have improved since he became devoted to this diagnostic procedure. Let us also assume that he is attaining facial changes to which others aspire, others who have yet to adopt the FMIA criterion. One can accept either or both of these points of view without being obliged to accept the interpretation that the diagnostic device leads to the facial changes. Since the data shown in Fig. 2 shows that there is no clear-cut relationship between soft tissue profile changes and alterations in the axial inclination of the lower incisor, one who is really interested in explaining Tweed's successes must consider not only this phenomenon but also every other one which (1) sets his mode of treatment apart from other orthodontists', and (2) distinguishes between his present procedures and those which he employed when his facial changes were less to his liking. In all probability no one but Dr. Tweed can guess what all these factors might be. It is evident to me from material which his own generosity has put at my disposal, that the explanation which he favors falls short of being satisfactory. As indicated before, seeing the long series of Dr. Tweed's clinical photographs was like, for me, seeing old friends, since many of them had been in the series lent me for study. The opportunity to study the cephalometric tracings, rather than merely to measure angles upon them, was the most rewarding part of that experience. Unfortunately, space would not permit the publication in his article of a comparable examination of these cases. However, in his article Tweed has included the tracings of six cases which are new to me, but which comprise a valuable portion of his paper. While he directs the attention of the reader to changes in the lower incisor, even this limited series of consecutively treated cases provides evidence that lower anterior teeth are only a part of the story. His Figs. 77 and 78 show gratifying facial changes, but it must be noted that in both there was substantial mandibular growth during the interval under study. These changes accomplished with the intervention of growth are more pleasing than the change observed in Fig. 79, an adult in whom no growth could be expected. Orthodontists naturally expect better changes in facial lines during the growing period, but the contrast between this adult and younger individual is mentioned here because it

should be kept in mind that if facial change were simply a matter of tooth movement, the result should be as gratifying in the adult as it is in the younger individual. Fig. 80 provides an instance of good forward growth of the mandible in a younger child, but Fig. 81, while also showing substantial amounts of growth, shows growth principally in a vertical direction. Facial change in Fig. 81 is not as good as it is in others where the growth was disposed horizontally. The last case in the series, Fig. 82, was also helped along by growth.

In fairness to Tweed it must be pointed out that he does not discount the phenomenon of mandibular growth, and that he shares my opinion that it is within the capability of orthodontists in some, if not all, cases to elicit a natural growth response in the mandible which would not have come about except through orthodontic intervention. Indeed, he has defended the vigorous posterior movement of lower anterior teeth on the grounds that it permits mandibular growth, by getting the teeth back so that the mandible can swing forward. This is a provocative idea, but if the axial inclination of the lower incisors were as important as his simple diagnostic procedure imples, this should be borne out by a significant relationship in Fig. 2.

Insofar as this article is intended to be critical of Dr. Tweed, it criticizes not so much what he does as an orthodontist as what he chooses to emphasize; not so much what he says as what he does not say. In addressing himself to young orthodontists whom he sincerely wants to help, he has failed to say enough about other ways in which his results differ from more usual ones: the way he carries maxillary incisors posteriorly in bodily fashion, so that at the end of treatment they do not have an unnatural lingual inclination. He has somehow left out the secret of how he can effect profound changes in tooth position without changing any more than he does the occlusual plane and the Frankfort mandibular plane angle for the worse. He is seemingly not as impressed as I am with his obtaining, in a relatively short period of time when there is relatively little growth in the upper portions of the face, sizable amounts of growth in the mandible. He moves anterior teeth substantial distances and does so bodily, but minimizes the fact that it is done with minimal forward displacement of posterior teeth. These are significant attainments and should not be minimized in order to stress a diagnostic measurement whose chief merit is that it is simple.

Some comment is in order on his 95 individuals selected on the basis of pleasing facial type. The average FMIA for the group is 68.2°; the most frequently observed reading is 65°, and the range is 56° - 80°. (Chart I, p. 138.) In this Tweed sees justification for his FMIA principle; I contend that the angulation of the tooth is merely incidental to a more important feature plainly evident in each of the persons he has selected. Every one of them shows a well developed mandible, as seen in the lateral films or in both photographs. Generally speaking, the mandibular incisors tend to be more upright in individuals with more mandibular development. This is a symptom rather than an essential facial feature. In other words, where Dr. Tweed emphasizes incisor angulation in his "selectees", I see strong mandibular form; in his treated cases he emphasizes alteration of incisor angulation while I see mandibular growth.

In this connection we should remember another diagnostic device which was advocated in much the same fashion. Twenty years ago orthodontists were admonished to establish arch width and form in conformity with the

Bonwill-Hawley chart. The conformity was there, but it was based on the fact that growth had produced sufficient facial width to allow even alignment of teeth and, incidentally, conformity with the charts. Attempts to superimpose this arch on the narrow faces of orthodontic patients were not rewarding. The shadow had been confused with the substance.

Tweed, of course, does not advocate tailoring dental arches to the Bonwill-Hawley; as I understand, archwires "passive with respect to width" are standard operating procedure. The analogy is cited only as an illustration of how, since our actual clinical procedures are directed at the teeth, orthodontists are tempted to assign importance to teeth when sometimes it properly belongs to deeper seated structures.

Summary:

Modification of the facial profile by orthodontic means depends on other factors besides the inclination of anterior teeth, so much so that diagnostic criteria based solely on this factor are likely to be unreliable. Examination of Tweed's treated cases shows, unmistakably that clinically he does what he sets out to do. It also shows, however, that skillful treatment and a seeming ability to elicit mandibular growth is more responsible for his success than merely the establishment of a specific angulation for the mandibular incisor.

Caution must always be observed in assigning cause and effect relationships, particularly when results are good, lest we assign credit to the wrong factor and fail to obtain the results we admire. Those who admire Dr. Tweed's results are advised to direct their attention to the painstaking clinical procedures he has developed over the years, rather than to the Frankfort mandibular incisor angle.

For obvious reasons, I wish to thank Dr. Tweed for allowing me such ready access to his clinical records. As much as I appreciate this, I value even more the long friendship between us which allows the expression of open disagreement, especially when it could not have been expressed without his assistance and tacit approval.

University of California
Medical Center

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