Balance and Harmony

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Balance and harmony, that ever evasive quality, still remains as one of the most important considerations in orthodontic diagnosis.

What is balance and harmony? Simply stated it is that position of the teeth, relative to themselves and their surrounding structures that results in a stable well-functioning dental mechanism, healthy investing tissues, and satisfactory facial esthetics. When we speak of the dental mechanism and its surrounding structures we are referring to the teeth, the bones and joints of the head, and all the muscles involved in mastication, deglutition, speech, and respiration.

What constitutes satisfactory facial balance is another of the controversial questions in orthodontics. Without doubt, orthodontists have placed themselves on a high pedestal as supreme judges of facial contour and esthetics.

Goldsman[1] found that the artist's concept of ideal facial harmony was more liberal than that of orthodontists. Their selection of ideal faces included prognathic and retrognathic as well as mesognathic faces. Orthodontists, on the other hand, had somewhat prejudicial ideas as to what constituted ideal facial balance; their preference was for flat facial profiles.

Reidel[2] reported two occasions where cephalometric radiographs of beauty contestants and Hollywood stars were submitted to a group of orthodontists for evaluation. Those faces that were straight with little or no dental protrusion were judged as pleasing; those that were convex or protrusive were judged as fair to poor.

Wylie,[3] in an excellent critique on the lower incisor and its influence on treatment and esthetics, stated that in the matter of esthetics we cannot claim superior judgment over laymen, as most emphatically we do in matters of health. "Yet today a number of orthodontists are so convinced of the importance of facial change that they present to their clientele recommendations which confuse esthetics with health, and the customer does not fully understand what he is about to pay for." When facial esthetics can be set forth as a consideration in itself, the orthodontist has the obligation to share the discussion with the parent on an open basis. The esthetic preference of the orthodontist should be frankly presented as such and not put on a par with physiologic considerations which the parent cannot adequately judge. We cannot become so preoccupied with facial change that we regard this as the main objective of orthodontic treatment. And let us not forget that we are intervening for a relatively short time into the developmental processes of our patients. Much in the way of facial change frequently takes place after our corrective procedures.

Because there is an interplay of so many dynamic forces in the human head, it is illogical to assume, and it has certainly never been proven, that there is any immutable guide for the orthodontic positioning of the dentition. It has been the considered opinion of many fine clinicians, however, that there are certain guides for positioning the teeth; and further, some of these men have documented their theories with statistical evaluations and found rather narrow ranges of variations in their chosen methods.

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Probably more attention has been paid to the lower incisor as a guide to denture positioning than any other tooth. Tweed, Margolis, Speidel, Stoner and others have proposed that the lower incisors be positioned at an angle of 90 degrees to the lower border of the mandible. The philosophy regarding this was that such an angular relationship was associated with ideal facial esthetics.

Higley[4] took exception to this. His contention was that the mandibular incisal apex, and therefore its axial inclination as well, was not always in good relation to the mandible and the skull.

Tweed[5] by further interpolation introduced the FMIA which took into account deviations of the Frankfort mandibular plane angle from 25 degrees. While Tweed's sample of adults with good facial balance averaged a FMIA of 68.20 degrees, he arbitrarily selected 65 degrees as the ideal treatment goal. Downs[6] and Goldsman, in their studies of groups with excellent occlusion and facial balance, found wide ranges in the FMIA. Downs further stated, "In a number of instances the demands of repositioning the incisors to 65 degrees to the Frankfort horizontal did not seem to be justified when considered in the light of all diagnostic factors." He was also of the opinion that the relationship of the lower incisor to the mandibular plane is not a good criterion for interpreting its position in the face because the reference plane, the mandibular plane, is not directly associated with the profile and exhibits a wide range of variation.

The Frankfort horizontal also presents several deficiencies when appraising the inclination of the lower incisors, viz.:

1) The relationship of importance to us is that of the lower incisor to a profile plane or arc, not a cranial plane such as Frankfort horizontal.
2) The location of porion is fraught with considerable error.

Downs in his great contribution to orthodontics introduced the first method of appraising the dentofacial skeleton and coordinating the position of the denture to the skeletal pattern for a given individual. Here was an analysis that could be applied to the individual, no dogmatic angular or linear measurements with which to conform. Convex faces had more protrusive dentures. Concave faces had retrusive dentures and straight faces had upright dentures. Down's measurements for the most part had large ranges and standard deviations with the exception of one linear measurement, the upper central incisal to the A-Pogonion plane.

Björk[7] after making extensive investigations on his own corroborated the Downs theory. He could see no need or desirability for making it a general aim in orthodontic treatment to correct the lower incisors to a practically vertical position. He found that in cases where the difference between maxillary and mandibular prognathism was great, the overjet in many cases was partly negated by the forward inclination of the lower incisors. The position of the incisors seemed to accommodate themselves to facial morphology. Thus mandibular incisors often have a marked forward inclination in cases of pronounced maxillary overjet, and a more rearward inclination in cases of mandibular overjet. Correction of the incisors to an upright position in these cases would serve to accentuate the overjet, with the result that the difference in prognathism between the upper and lower arches would become still more pronounced. Treatment in such cases should aim at correcting the incisors according to the facial structure.

Steiner[8] in a careful appraisal of methods in current use suggested that the relationship of the lower incisor to the plane NB was of value. He found the average angulation to be 25 degrees with the incisal edge of the lower incisor 4 mm anterior to the plane. The upper central incisor he related to the plane NA. Average angulation was 22 degrees with the incisal edge 4 mm anterior to NA.

Holdaway[9] suggested an interrelation between the NB plane and both pogonion and the labial surface of the lower central incisor. An ideal relationship exists when both pogonion and the labial of the lower incisors are equidistant from NB. The individual linear measurement of each is not important. Variation of 1 - 2 mm in either direction would be considered within normal limits.

Downs, in a further refinement of his analysis and in an effort to simplify diagnostic procedures, offered the profile arc for consideration. The profile arc intersects points nasion, subspinale or point A, and pogonion. Concave arcs occur with more frequency as the mandible becomes more prognathic. Convex arcs are found in retrognathic or prognathous faces.

Ricketts suggested relating the lower incisor to the profile via the plane APo. This also permits variation according to facial type. As the differential between the maxillary and mandibular denture bases increases, so does the labial inclination of the lower incisors even though they maintain the same relationship to APo. The reverse occurs in straight or concave faces.

Reidel,[2] in a group of thirty cases with good facial balance, found that in 30% of the cases the long axes of the upper and lower central incisors intersected exactly on the APo plane. In another 30% the intersection was within 3 mm of this plane. He felt that when the axes of the incisors intersected close to the APo plane, the individual was more likely to have good facial balance.

Lindquist[9] considered the methods of Tweed, Steiner and Holdaway to be of value only when the denture base differences, as measured by the angle ANB, were less than 4 degrees. This would not be true of Reidel's, Rickett's or Downs' methods. He and Wylie[10] also agreed that angular measurements are often misleading when positioning the lower incisors and that linear measurements would be of more value.

Method

To the author it has seemed that there have been certain inadequacies in either the determination or the evaluation of most of the aforementioned methods of incisor positioning.

Very little in the way of statistical evaluation of the measurements representing the various methods of incisal positioning has been done. While there may be a clinical basis for certain of the methods discussed, it is not enough to present them on this basis alone. Clinical observations must be backed up by statistical support. A method of incisal positioning, to be of any use to a practicing orthodontist, must show very little variation from one individual to another when applied to a group with excellent occlusion and good facial balance.

The calculations used in the present study were the range, mean, median, standard deviation, and the variance ratio test.

One standard deviation on either side of the mean represents about 67% of the population, two S.D. about 95% of the population. The standard deviation therefore tells us how reliable these measurements are. If the S.D. is large we know that there is a great deal of variation in the measurement from one individual to another and we should not consider this method of incisor positioning as infallible or with excessive importance when making diagnostic decisions.

The standard deviations of two measurements representing different methods of incisor positioning can be compared by the *variance ratio* test. This test reveals whether there is a significant difference in the amount of variation shown by each measurement. By consulting the "F" table of variance the appropriate level of confidence is selected which indicates whether a real difference in variation exists or whether the difference is merely a chance difference. This helps us to select more accurate methods of incisor positioning.

Certain valid criticisms also seem in order concerning the sample selection of previous investigators. Many of the groups studied were not characterized by excellent stable *occlusion* but instead by satisfactory to excellent *facial type* as determined by the author. This is quite prejudicial, particularly with those men who show a preference for the flat or straight face. Also we should be as much or more interested in the characteristics of stable excellent occlusions as we are in those of pleasing facial form.

The best selected sample seems to be that of Downs although his cases also were perhaps too carefully selected as to facial contour, as indicated by the fact that the ranges of most of his measurements are smaller than the ranges of the same measurements done by other investigators. This may be due, however, to the small size of his sample.

The study of adult groups seems preferable when trying to establish guides for incisor positioning. It is virtually impossible for every individual in a younger group to be in the same stage of growth even though their ages may be the same. The pubertal growth spurt does not occur at the same age for all individuals, and individual facial morphology does change during growth. The disadvantage of using an adult sample, of course, is the fact that one must rationalize in reverse in order to visualize what this individual looked like as a growing child.

Another area worthy of a new approach seemed to be the plane with which the incisors were to be related.

Frankfort horizontal and the mandibular plane were discarded for the reasons previously mentioned. The plane NB was not considered because the point N is far removed from the area of interest and is not related to either the upper or lower incisors. It might, in fact, be considered a cranial point.

The planes that seemed to have the most merit were the profile arc of Downs and the plane APo which is virtually the same.

The point pogonion does, however, present some problems. Downs[13] selected point A over ANS because of the latter's great variability in length and form and because it could be considered as part of the nose. And further, point A is located on the anterior surface of the maxilla at the theoretical junction of the alveolar bone and the true maxillary bone. Its position is influenced by the central incisors and therefore is changeable when the teeth and their alveolar processes are shifted in an anteroposterior direction. Do not the same arguments favor the use of point B over pogonion?

According to the phylogenetic reduction theory of Weidenreich, as discussed by Berger,[11] ANS and the chin do not exist in apes or early man. With the reduction of the tooth bearing parts, i.e., the anterior portion of the alveolar processes, they have become quite prominent in the face. Continuing, he states

Table I

MEASUREMENT	RANGE	MEAN	MEDIAN	S.D.MEAN
angle ⌊1 APo	11° to 37°	23°	23°	6.11°
angle ⌊1 AB	18° to 41°	27°	27°	5.02°
mm. ⌊1 APo	-.5mm.to 8.5mm.	4.67mm.	4.5mm.	2.21mm.
mm. ⌊1 AB	2.5mm.to 10mm.	6.1mm.	6.5mm.	1.85mm.
angle ⌈1 APo	15° to 36°	25.5°	25°	4.58°
angle ⌈1 AB	10° to 32°	21.1°	21°	4.88°
mm. ⌈1 APo	-1.5mm.to 7mm.	3.09mm.	3.0mm.	2.30mm.
mm. ⌈1 AB	1.5mm.to 8.5mm.	4.77mm.	5.0mm.	1.82mm.

that pogonion is in an especially vehement developmental stage during and after puberty. Gerhardd described changes in both the inclination and configuration of the chin. Meredith reported changes up to 2.6 mm in the depth of the anterior concavity thus reflecting on the position of pogonion. Berger summarized: "It would, therefore, seem that we have to observe extreme reserve when meeting with conclusions regarding the incisor position in relation to pogonion."

The present study included a measurement of the perpendicular distance between point B and the APo plane. The range was .5 to 6 mm with a mean of 3.1 mm. This would seem to be in line with Berger's conclusions and it is therefore probable that the large range in this measurement could throw considerable error into our interpretations of lower incisor position when related to pogonion.

It was therefore the purpose of this project to examine the relationship of the upper and lower central incisors to both the AB and the APo planes. Both angular and linear measurements were taken. For each relationship the following calculations were made: range, mean, median, and the standard deviation. The accuracy of the various methods was compared by the variance ratio test which in effect compared the standard deviations. The smaller the S.D., the less the variation of a relationship and therefore the more accuracy it provides when used as a diagnostic aid.

Radiographic tracings of a group of forty-eight white adults were made. Their ages ranged from 17 years, 3 months to 52 years, 8 months. Only one subject was below the age of 20. There were thirteen females and thirty-five males.

Subjects were accepted in the sample if they fulfilled the requirement of stable excellent occlusion in all respects with no previous history of orthodontic treatment. Soft tissue contours had to be unstrained with satisfactory balance of the component parts. All morphologic types were included. The angle of convexity for the group ranged from

Table II

RATIO	VARIANCE	SIGNIFICANCE
angle ⌊1 AB / angle ⌊1 APo	25.200 - / 37.332 - 1.481	Slightly less than 80% confidence that there is a real difference between the variances and not just a chance difference
mm. ⌊1 AB / mm. ⌊1 APo	3.422 - / 4.884 - 1.427	Slightly less than 80% confidence that there is a real difference between the variances and not just a chance difference
angle ⌈1 AB / angle ⌈1 APo	23.814 - / 20.976 - 1.135	Differences between the variances are chance and not real
mm. ⌈1 AB / mm. ⌈1 APo	3.312 - / 5.290 - 1.597	Between 80% and 90% confidence that there is a real difference between the variances and not just a chance difference

—12° to +13.5°. The mean was +1.59° with a S.D. of 4.99°. The dispersion of facial types was quite large since approximately 95% of the sample ranged from —8.5° to +11.5°.

Findings

Table 1 shows the range, mean, median and standard deviation of the mean of the measurements calculated.

Table 2 illustrates the variance ratio tests performed and their results. The last column indicates the level of confidence that can be attached to the findings. In each case, with the exception of the angular measurement /1̅ AB plane versus /1̅ APo plane, the AB plane proved to be superior to the APo plane as a diagnostic reference plane. Variation in these three measurements was significantly less when the AB plane was employed than when the APo plane was used.

Table 3 represents a comparison of the measurements and calculations of this study with similar ones done by other investigators.

Discussion

Nearly all measurements were characterized by rather large ranges indicating the diversity of the sample. In

Table III

INVESTIGATOR	TYPE SAMPLE	MM. /1 APo			ANGLE /‾1 APo			MM. /‾1 APo		
		Range	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.
DOWNS	Mixed-excellent occlusion & facial type	-1to5	2.7	1.80	17to29	23,19	3.	-2to3	0	
GOLDSMAN	Good facial type - very selective	-.8 to 8.6	3.6	1.95						
PETRAITIS	Adult female normals	.5to10	5.4							
REIDEL	Seattle Seafair Princesses	-1to10	4.63		12 to 28.5	23.16		-1.5 to 9.5	3.95	
REIDEL	Adult normal occlusions mixed	.5to9.5	5.09							
REIDEL	30 adult female normal occlusions	2to9	5.45							
FRANTZ	48 Normal occlusions	-.5to 8.5	4.67	2.21	15 to 36	25.5	4.58	-1.5to 7	3.09	2.30

every case where previous investigators had calculated the S.D. of a measurement that was common to this study, it was less than the S.D. of the same measurement in this study. This could be accounted for by the fact that the size of the sample of this study was larger and because the selection of subjects by the author was perhaps more liberal with respect to facial form than that of previous investigators.

It was the purpose of the author to have as diverse a sample, inclusive of as many facial types, as possible. This is what we deal with in our practices. If we are to have any useful diagnostic aids they must be applicable to and derived from as many different individuals as possible, not just a select few. A measurement that shows a small S.D. and therefore little variation under these conditions is meaningful.

The standard deviations of the measurements are listed in the last column of Table 1. It will be noticed that they vary in size from 6.11° for angle /1 APo down to 1.82 mm for /‾1 AB. The measurements that show the least variation and therefore are the most useful diagnostically are angle /1 AB, angle /‾1 APo, angle /‾1 AB, mm /1 AB, and mm /‾1 AB. The measurement showing the smallest range (7 mm) and S.D. (1.82) was mm /‾1 AB. On the basis of the data presented this would seem to be the least varying measurement in adults with stable excellent occlusions and balanced facial components.

It might be a useful treatment goal to strive to place the labial surface of /‾1 from three to seven mm anterior to the AB plane. Cases with a small ANB difference would be closer to three and those with higher ANB differences closer to seven.

When the AB plane was compared with the APo plane as a reference plane by the variance ratio test, the results were as follows:

1. Angle $/\underline{1}$ AB was superior to angle $/\underline{1}$ APo at slightly less than the 80% confidence level.

2. Mm $/\underline{1}$ AB was superior to mm $/\underline{1}$ APo at slightly less than the 80% confidence level.

3. The differences between angle $/\overline{1}$ AB and angle $/\overline{1}$ APo were insignificant. Neither method was superior to the other although, as mentioned before, both had rather small standard deviations and might be useful as diagnostic aids.

4. Mm $/\overline{1}$ AB was superior to mm $/\overline{1}$ APo at between the 80% and 90% confidence levels.

As stated before, and noted in Table 3, the S.D. of measurements taken in this study are larger than the standard deviations of the same measurements taken by other investigators. The possible reasons for this have been stated. Under those conditions, i.e., a diverse sample, it is interesting to note that two measurements had S.D.'s that were quite small. These were mm $/\underline{1}$ AB (1.85), and mm $/\overline{1}$ AB (1.82). This would seem to support the contentions of Lindquist and Wylie who stated that linear measurements are of more value than angular measurements.

Summary

A cephalometric evaluation of forty-eight adults with excellent untreated occlusions has been presented. The subjects had a full variety of facial form with satisfactory balance of the component parts.

Methods of positioning the upper and lower central incisors relative to the profile planes AB and APo were statistically evaluated and compared.

In three out of four cases the AB plane was superior to the APo plane as a reference plane and would therefore seem to be more useful diagnostically.

The relationships mm $/\underline{1}$ AB plane and mm $/\overline{1}$ AB plane showed the least amount of variation in the samples studied. It would therefore seem that they would be the most useful of all the measurements studied as diagnostic aids in helping us to determine where we would like to position these teeth during treatment.

It was suggested that a realistic treatment goal would be to position the labial surface of the lower central incisors between three and seven mm anterior to the AB plane, depending on the ANB angle. Where this angle is high the incisors would be positioned closer to seven, where low closer to three mm anterior to the AB plane.

The standard deviations of mm $/\underline{1}$ AB and mm $/\overline{1}$ AB were quite low, especially when considering the diversity of the sample.

Linear measurements seem to be more reliable than angular measurements.

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References

1. Goldsman, Samuel: Variations in Skeletal and Denture Patterns in Excellent Adult Facial Types, *Angle Orthodont.*, 29:63, 1959.
2. Reidel, Richard: An Analysis of Dento - Facial Relationships, *Am. J. Orthodont.*, 43:103, 1957.
3. Wylie, Wendell: Discussion of "The Lower Incisor - Its Influence on Treatment and Esthetics", *Am. J. Orthodont.*, 45:50, 1959.
4. Higley, L.B.: Rational Approaches in Orthodontic Diagnosis, *Am. J. Orthodont.*, 40:109, 1954.
5. Tweed, C. H.: Frankfort Mandibular Incisor Angle in Diagnosis and Treatment Planning and Prognosis, *Angle Orthodont.*, 24:121, 1954.
6. Downs, William B.: Analysis of the Dento - Facial Profile, *Angle Orthodont*, 26:191, 1956.
7. Björk, Arne: The Nature of Fa-

cial Prognathism and Its Relation to Normal Occlusion of the Teeth, *Am. J. Orthodont.*, 37:106, 1951.

8. Steiner, Cecil C.: Cephalometrics for You and Me, *Am. J. Orthodont.*, 39:729, 1953.

9. Lindquist, John T.: The Lower Incisor - Its Influence on Treatment and Esthetics, *Am. J. Orthodont.*, 44:112, 1958.

10. Wylie, Wendell L.: The Mandibular Incisor - Its Role in Facial Esthetics, *Angle Orthodont.*, 25:32, 1955.

11. Berger, H.: The Lower Incisor in Theory and Practice, *Angle Orthodont.*, 29:133, 1959.