Adjusting A-N-B Angles to Reflect the Effect of Maxillary Position

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The angle A-N-B is a popular indicator of apical base relationships. Maxillary protrusion also has a major influence on that angle that is superimposed on the apical base effect. These effects are algebraically additive, so they may cancel each other in one patient and add together to produce a large reading for the A-N-B angle in another. A simple method of compensation for these misleading effects is presented here.

Even before Edward H. Angle introduced his classification of malocclusion to the profession in the early 1900's, the antero-posterior relation of mandible to maxilla was a most important diagnostic criterion. This relationship can be determined from clinical observation to some degree, but it can be much more accurately evaluated from a lateral radiograph. Broadbent's[1] introduction of his cephalometer in 1931 made such films available, although they were used primarily for research and growth studies until the late 1940's.

As cephalometrics was adapted as a clinical tool for aiding in treatment planning and evaluation, angular measurements were generally preferred over linear. Brodie[2] listed the advantages of using angles as follows: "(1) it eliminates differences which are due to absolute size; (2) it eliminates the necessity of allowing for type, since all types have been shown to possess the same basic pattern; (3) it largely eliminates the need of fixed points as bases of superimpositioning." Downs[3] made a very salient point in regard to using cephalometrics for case analysis when he stated that: "Single readings are not so important; what counts is the manner in which they all fit together and their correlation with type, function, and esthetics."

Early Measures of Apical Base Relationships

The first step in evaluating antero-posterior apical base relationships cephalometrically was Downs'[3] description of points A and B in 1948. He measured the angle formed by the A-B and N-P (facial) lines, illustrated on the right side of Figure 1. Positive and negative signs were used to denote relative protrusion of the mandible. In his study of twenty cases with excellent occlusions, the mean for this angle was found to be minus 4.6°.

A few years later, Reidel[4] measured the S-N-A and S-N-B angles and used their difference, or angle A-N-B, as an expression of dental apical base relationship. This is illustrated on the left side of Figure 1. The A-N-B angle became part of the Northwestern Analysis and has been widely adopted as a principal method for evaluating antero-posterior apical base relationships. Reidel's study of normal occlusions resulted in a mean for the S-N-A—S-N-B Difference (angle A-N-B) of mi-

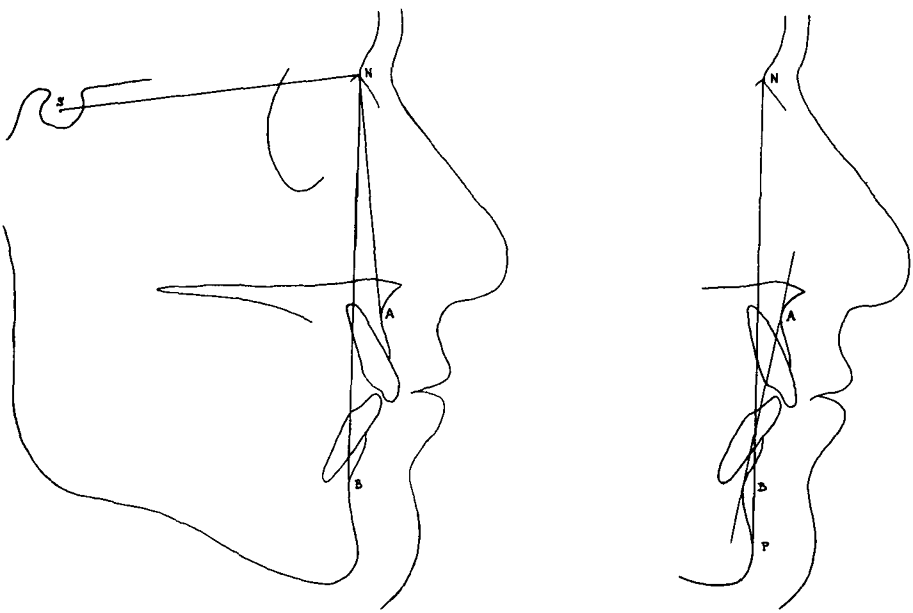


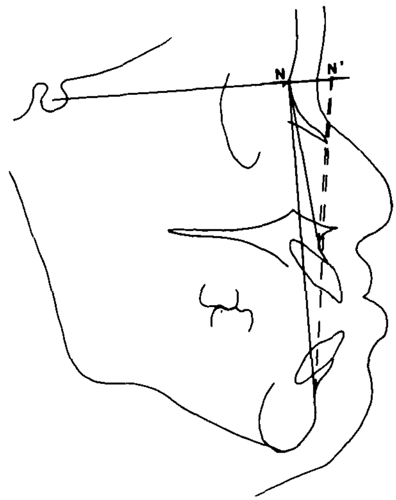
Fig. 1 Downs' points A and B are the basis for most evaluations of relative protrusion of maxilla and mandible. Right, Downs' A-B to facial line (N-P) angle. Left, Reidel's S-N-A and S-N-B angles, often evaluated by the difference (A-N-B).

nus 2.0 for his 50 adult normals, and minus 2.8 for his 24 child normals.

A-N-B Is Unreliable

Angle A-N-B by itself is not a reliable indicator of actual apical base relationships. As Downs said, it is how it all fits together that counts. The position of point A in relation to the front of the cranium is a critical modifier. Angle S-N-A is one indicator of this position. If the S-N-A angle is close to the average or normal range, the A-N-B reading will probably be fairly reliable for most cases, but if the S-N-A angle is high, indicating a forward divergent or mesognathic face, or if it is low, indicating a backward divergent or retrognathic face, the A-N-B reading alone can be very misleading.

Many orthodontists are already aware of this, but it seems that one rarely attends a meeting where at least one clinician does not show tracings of cases and only mention the A-N-B angle. The S-N-A and S-N-B angles may be written on the slide, but they are too often ignored. I recall one presentation where a leading clinician referred to the screen and stated that the case was a "severe Class II with an A-N-B angle of eight degrees." The slides of the models showed a Class I molar relationship on one side, and "Class I½" on the other. The S-N-A reading was 91.0°. Using the method for modifying the A-N-B reading according to the S-N-A angle that will be presented here would put that case in the 4.0 degree range, making it a mild Class II with a forward divergent face. Incidentally, these are the cases that treat out nicely and show large reductions of both the S-N-A and A-N-B readings, as did the case that was shown. An eight-degree difference in a case with an S-N-A of about 76 is an entirely different matter. These are very difficult to treat, and are seldom shown at meetings.



S-N-A	95	S-N'-A	81
S-N-B	90	S-N'-B	82.5
A-N-B	-5	A-N'-B	1.5

Fig. 2 Patient with Class III tendency and A-N-B angle of −5 degrees. If nasion were positioned at N′, the value would be positive.

At one recent meeting, a colleague was showing some problem cases and wondering how a particular patient with a Class III tendency and an open bite could have a negative A-N-B reading of five degrees, which would be markedly Class II. The tracing showed that the patient had an S-N-A angle of 95, which is extremely high. Figure 2 is a simplified tracing of that case. The dashed line illustrates what happens if point N is arbitrarily moved forward to the point where S-N-A becomes 81 instead of 95 degrees. You will note that this changes the A-N-B reading from −5.0 to +1.5 degrees, which would indicate a mild Class III skeletal pattern.

Maxilla-to-N Is the Key

Both Downs' and Reidel's methods do illustrate the apical base relationships, but they are both subject to the

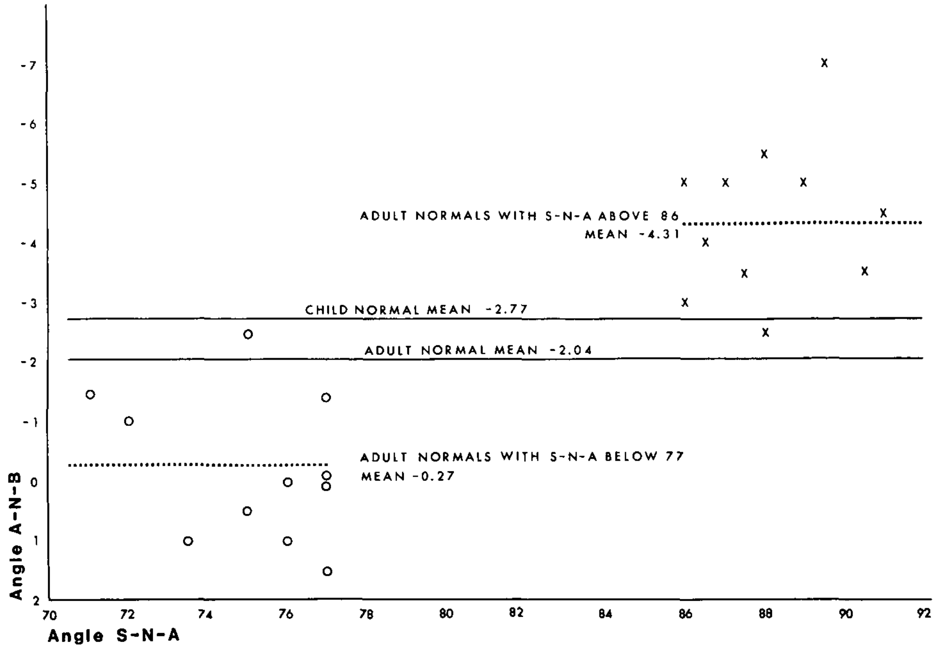


Fig. 3 Distribution of A-N-B angles for subjects in Reidel's normal sample with S-N-A angles below 77 and above 86 degrees. Means for child and adult samples are shown in the center.

same fallacy, in that they fail to directly take into consideration a very important factor—the antero-posterior position of the maxilla.

The S-N-A angle was found to have a mean of 82.0 for Reidel's 50 adult normal occlusion cases, and 80.8 for his 24 child normal occlusion cases. However, the range for angle S-N-A of these seventy-four cases was between 71 and 91 degrees. Twenty-four, or about one third, showed values above 86 or below 77. Figure 3 shows Reidel's normal occlusion cases that have S-N-A angles above 86 and below 77. The values for Reidel's normals are listed on the graph: −2.8° for the child cases and −2.0° for the adult cases.

Note that the mean A-N-B angle for the forward divergent faces is −4.3°, while the mean A-N-B angle for the backward divergent faces is −0.3 degrees. This is a difference of 4.0 between the forward divergent and backward divergent groups.

Considering that these were all Class I cases selected by the same investigator for their excellent occlusions, it is apparent that the divergence of the face is a factor that must be considered in making an analysis of apical base relationships by the S-N-A—S-N-B Difference method.

Simple geometry will further illustrate the point. The left side of Figure 4 shows the obvious fact that if three points x, y and z are in a

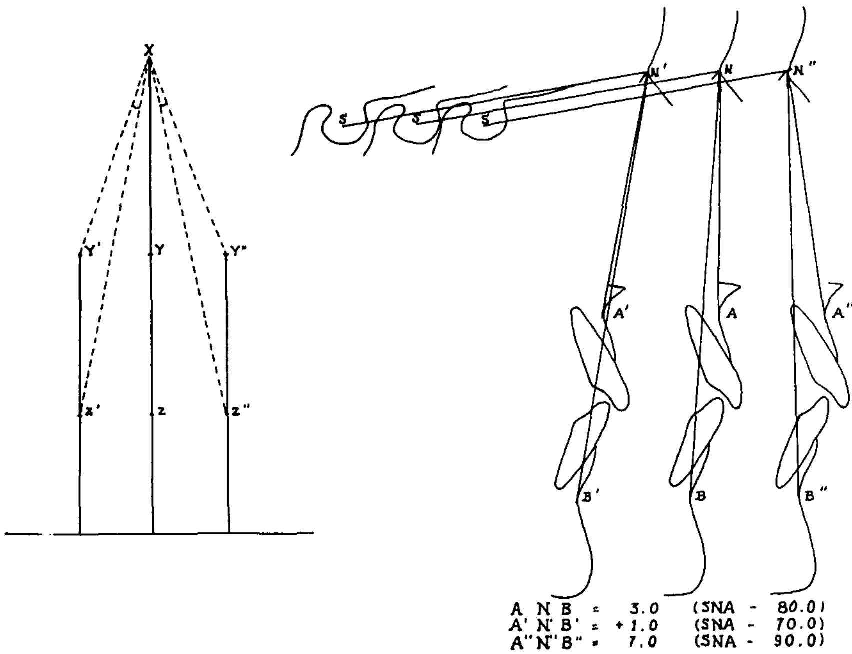


Fig. 4 Geometric effect on A-N-B (x-y-z) angles when the upper point remains constant and lower points are moved forward or backward without altering their relationship to each other.

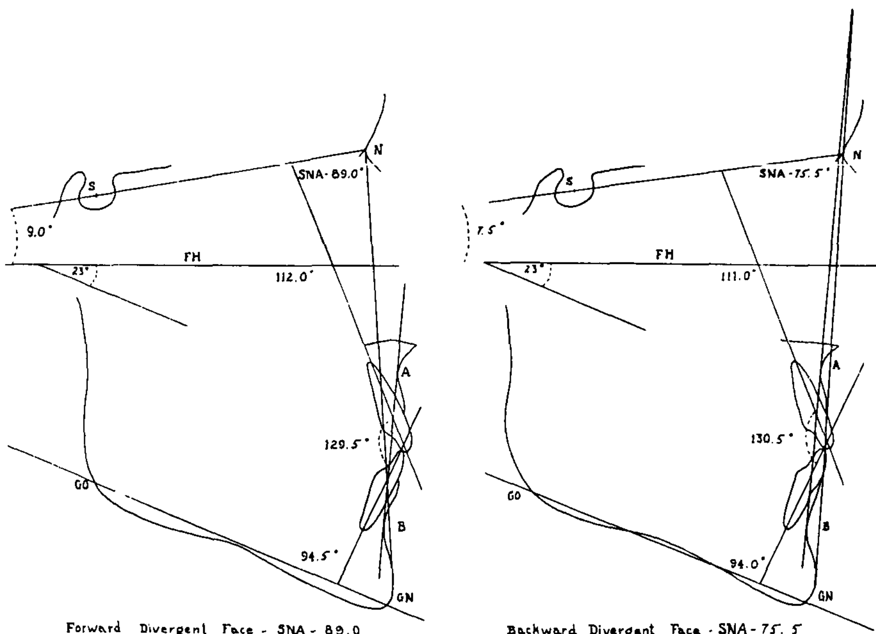


Fig. 5 Two cases from Reidel's normal occlusion group with similar dental relationships, but with A-N-B values reflecting differences in facial divergence rather than alveolar relationships.

straight line and the lower two are moved forward or backward, the angular relationships will change. Moving them back, or to the left, the angle becomes plus 8.5 and moving them forward, or to the right, the angle becomes minus 8.5 degrees. In the tracings on the right side of Figure 5, a hypothetical case has been constructed in the center drawing with points N, A, and B in positions that result in a S-N-A angle of 80 and an A-N-B angle of −3 degrees. The left portion of the tracing illustrates the same relationship of the mandible to the maxilla, but the S-N-A angle has been changed to 70 degrees. This changes the difference, or angle A′-N′-B′ to +1.0 degree. The right portion of the tracing represents a forward divergent face with an S-N-A angle of 90 degrees. Again, the antero-posterior relation of the mandible to the maxilla is unchanged, but the A″-N″-B″ reading becomes −7 degrees.

The foregoing was hypothetical but Figure 5 illustrates two tracings of cases from Reidel's adult normal occlusion group. It can be seen that the dentitions of these two cases are nearly identical, with incisor inclinations and the overbite and overjet very similar. However, the case on the left has a forward divergent face with an S-N-A angle of 89 and an A-N-B reading of −5 degrees. The case on the right has a backward divergent face with a S-N-A angle of 75.5 and an A-N-B reading of plus 0.5 degrees. This difference of 5.5 between the A-N-B angles of these two Class I cases with good occlusion can only be accounted for by the difference in the antero-posterior relation between points A and N, which measures the divergence of the face.

Figure 6 illustrates similar geometric drawings for the same hypothetical cases to show how changing the relationship of point N and point A also affects the A-B—N-P readings, which Downs used for evaluating antero-posterior apical base relationships. Figure 7 illustrates tracings of the same two cases from Reidel's adult normal group, showing one with an A-B—N-P reading of −9.0 and the other 1.5 degrees.

The A-X-B Method

How can apical base relationships be more accurately evaluated in cases with forward or backward divergent faces? The author's 1950 thesis[5] showed a method which eliminates point N, so that the degree of divergence of the face does not affect the readings. This is illustrated in Figure 8. A perpendicular is constructed from point A to Frankfort Horizontal, establishing point X. A line from point X to point B forms angle A-X-B. The mean for the A-X-B measurement in normal occlusion cases was approximately 4 degrees.

A variation of this method, constructing the perpendicular to the S-N line, results in a mean of 6.5°. Figure 9 illustrates all three methods on hypothetical cases where the facial divergence varies from an S-N-A of 73 to 88 without changing the relative antero-posterior positions of the maxilla and mandible. With the S-N-A—S-N-B Difference method on the left, the A-N-B changes from zero to −6.5°. With the A-B—N-P angle method, illustrated in the middle, it changes from minus 0.5 to minus 9.0 degrees. With the A-X-B method, illustrated on the right, both A-X-B readings are 6.0°.

The principal reason for not publishing this material earlier was a reluctance to add another measure-

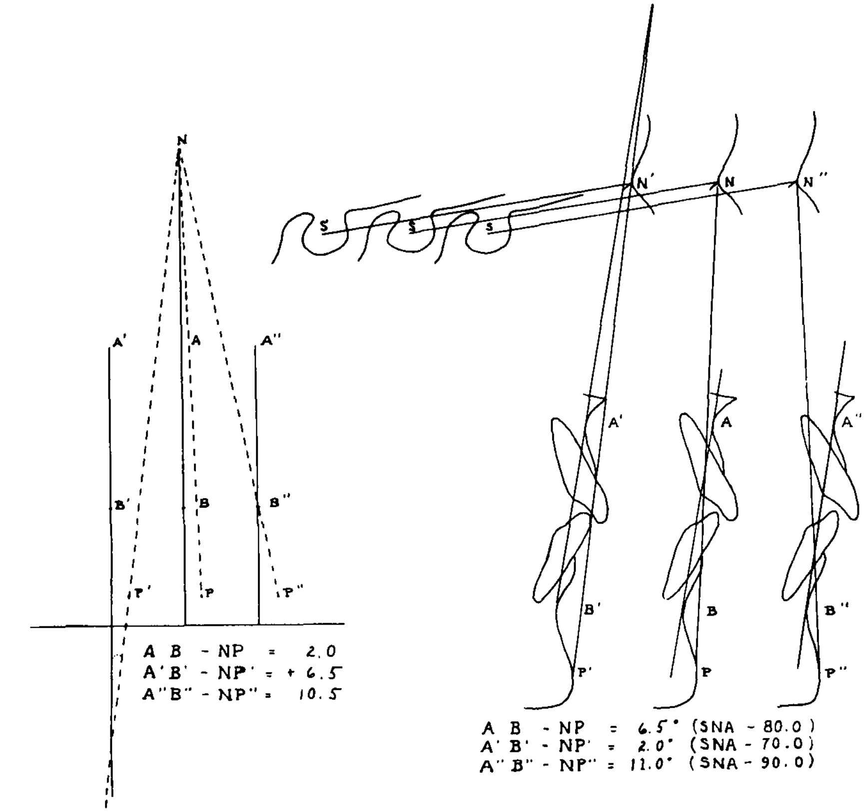


Fig. 6 The angle of A-B to N-P is affected by facial divergence in the same way as the A-N-B angle shown in Fig. 4.

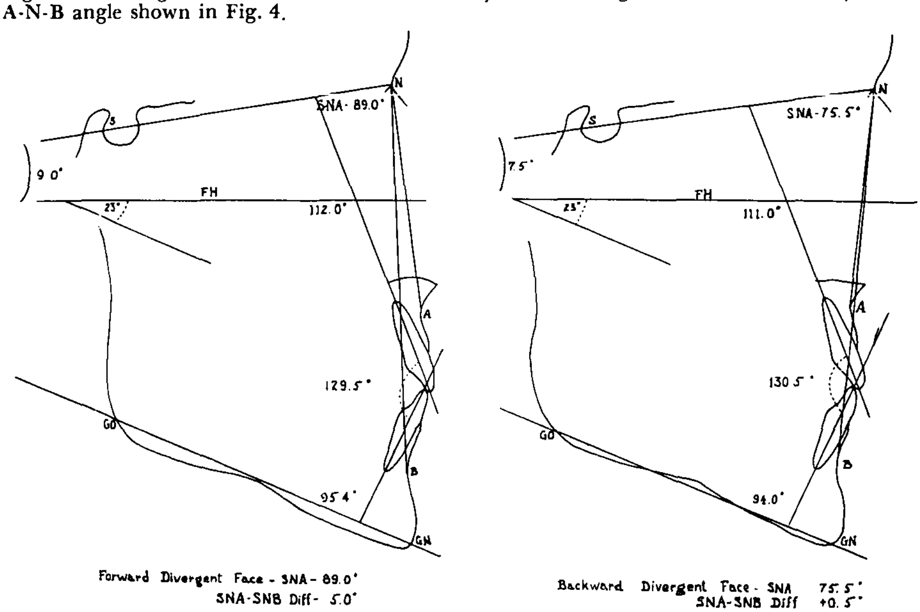


Fig. 7 The same cases shown in Fig. 5, showing differences in the angle of A-B to N-P.

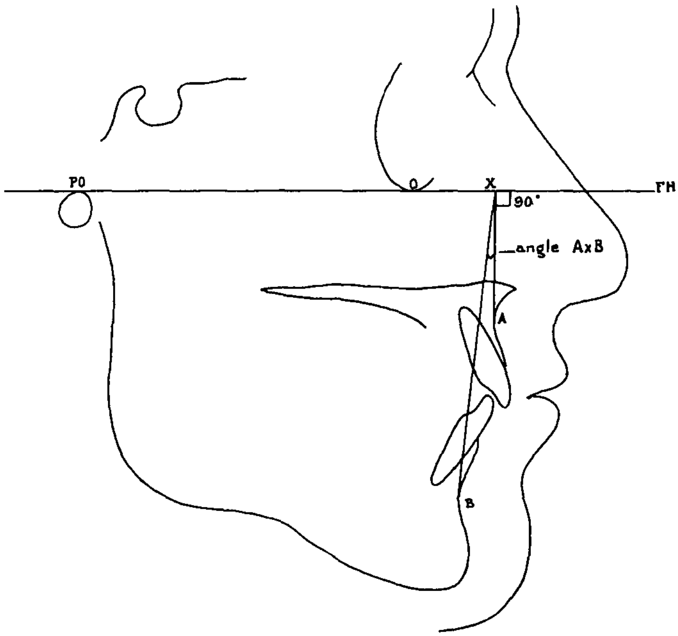


Fig. 8 The A-X-B method of evaluating maxillo-mandibular relationships without reference to the position of nasion.

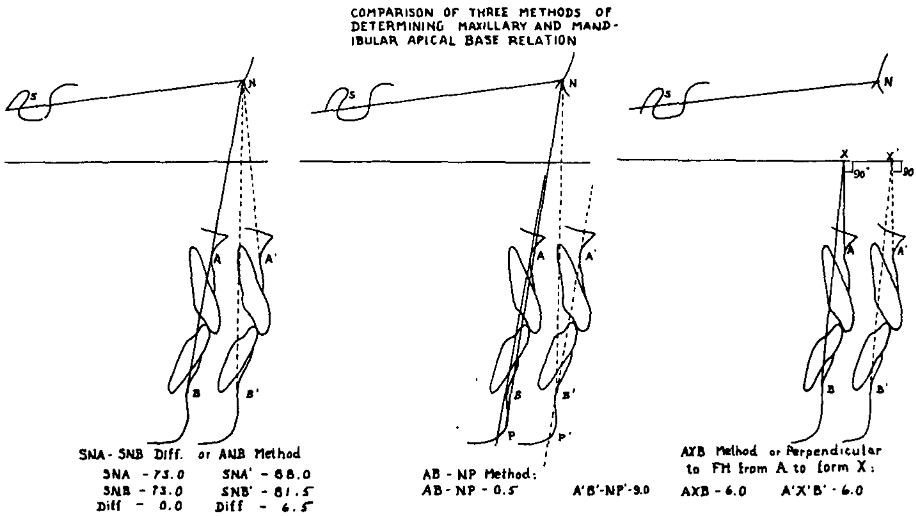


Fig. 9 Three methods for evaluating the relationships between maxillary and mandibular anterior apical bases.

ment to the already crowded list in what Wendell Wylie referred to as "the numbers game."

Point B Based Method

Taylor[6] introduced another method for eliminating the facial divergence factor in his American Board of Orthodontics thesis published in 1969. He constructed a perpendicular from point B to the S-N line, and then measured the linear distance from point A to that line as an expression of the apical base relationship. Dr. Taylor also stressed the shortcomings of the A-N-B method as generally used, and showed the changes in apical base relationships during treatment on 225 cases.

Three of Taylor's conclusions were:

(1) The A-N-B angle is not always a true indication of the apical base relationship.

(2) A-N-B varies according to facial divergence; cases with an S-N-A angle of 86 and over were found to have the largest average A-N-B value, while those with an S-N-A angle of 77 and less had the smallest.

(3) The greatest degree of A-N-B reduction during treatment occurred in the forward divergent cases, those in which S-N-A was 86 and over.

J. S. Johnson[7] of Manchester, England pointed out the same shortcomings of the A-N-B angle and presented another method which is more complicated than the two just described.

Adjusting A-N-B

The following is a simple method of adjusting or modifying the measurements we are presently using. No

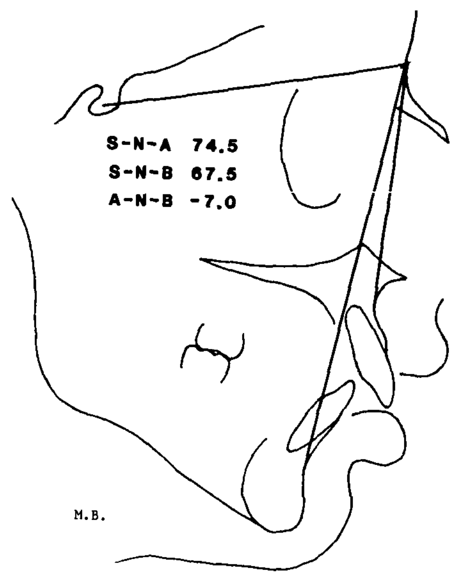


Fig. 10 The A-N-B adjustment method applied to a case with a low S-N-A angle of 74.5 degrees, but also exhibiting a 7 degree A-N-B angle. The equal but opposite difference from the mean calls for the same adjustment in the opposite direction, resulting in an effective A-N-B angle of −10 degrees.

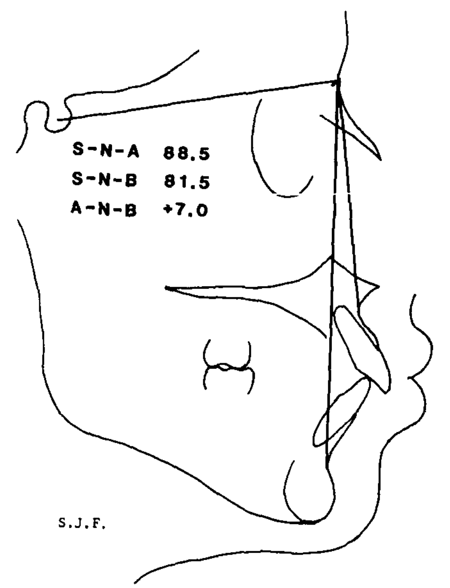


Fig. 11 The A-N-B adjustment method applied to a case with an S-N-A angle of 88.5 degrees, 7 degrees over the mean of 81.5. Half of that difference is 3.5, which is reduced by 0.5 for a net 3 degree adjustment. Adding that to the −7 A-N-B angle gives an effective angle of −4 degrees.

new points or measurements are necessary. This consists of merely subtracting one degree from the A-N-B measurement for every two degrees that the S-N-A reading exceeds 81.5 degrees. It may be helpful to write the adjusted value in parentheses or in red next to the actual reading. Conversely, add one degree to the A-N-B measurement for every two degrees that the S-N-A reading is under 81.5°. This modification over-corrects slightly, so with cases that are more than ten degrees above or below, the total adjustment should be reduced by one degree; a half-degree adjustment may be made for a five-degree difference if desired.

Figures 10 and 11 illustrate the above method on two cases. One can be certain that a Class II case with an S-N-A angle of 74.5° and an A-N-B reading of 7 is a far different case from one with an S-N-A angle of 88.5° and an A-N-B reading of 7 degrees. The figures below the tracings in Figures 10 and 11 show how these measurements were modified so they more accurately illustrate the true apical base problems. In the backward divergent case in Figure 10, the S-N-A angle is 7 degrees less than 81.5°. That requires adding half the difference, or 3.5 degrees. The half may be dropped because the difference is over five, leaving a modified reading of 10.0 degrees. With the forward divergent case in Figure 11 the S-N-A angle is 7.0° more than 81.5°, so 3.5 is subtracted. After again dropping the half, the modified reading is 4.0 degrees. Needless to say, the difference between a 4.0° A-N-B Class II case and a 10.0° A-N-B Class II case is considerable—in regard to both treatment and prognosis.

Every orthodontist can no doubt find several cases that appear to contradict the above rule-of-thumb. There are exceptions to everything, as anyone who has worked with cephalometrics for a few years is acutely aware. There are other factors that have not been mentioned to avoid confusing the issue. Steepness of the S-N line, variations in point A due to root positions (as in Class II, Division II cases), excessively long or short faces and exceptionally long or short mandibles are a few examples of other factors that can affect the geometry. The method presented is not foolproof, but it can be of assistance in making a more accurate determination of a very important factor in case analysis—especially in the 20-30% of the cases with S-N-A angles that deviate from the average by more than four degrees.

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