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ORIGINAL ARTICLES

The "Wits" appraisal of jaw disharmony

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Many analyses tend to be cumbersome and far too complex for routine clinical use. Numerous measurements are employed which do not differentiate between meaningful information and inconsequential details. Others at the opposite end of the scale employ too few measurements to yield adequate information for appraisal of the orthodontic problem. An analysis of choice is one which employs the least possible number of measurements to be adequate.

The "Wits"* appraisal of jaw disharmony, however, is not an analysis per se; rather, it is intended as a diagnostic aid whereby the severity or degree of anteroposterior jaw disharmony can be measured on a lateral cephalometric head film.

Cranial and denture landmarks

Nasion is related functionally to the ectocranial table of the calvaria, in which case growth may alter its vertical and horizontal position in space.[15] However, for practical purposes, nasion may be conveniently regarded as the anteriormost point on the anterior cranial base from which to relate the dentures.

Point A is located at the deepest point on the contour of the maxilla between the anterior nasal spine and the alveolus. The anterior nasal spine is a process, as is the alveolar process, and between these two lies the most basic part of the denture base at the anterior limit. All bone in the anterior part of the maxilla is thin and laminated and subject to change when upper incisor teeth are moved. Since point A was originally defined, clinicians and investigators have sought a better reference point but have somehow continued to revert to the basic point first described.[17] From a practical standpoint, therefore, point A must be regarded as the anterior limit of the maxillary denture base.

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*Abbreviation for University of the Witwatersrand.

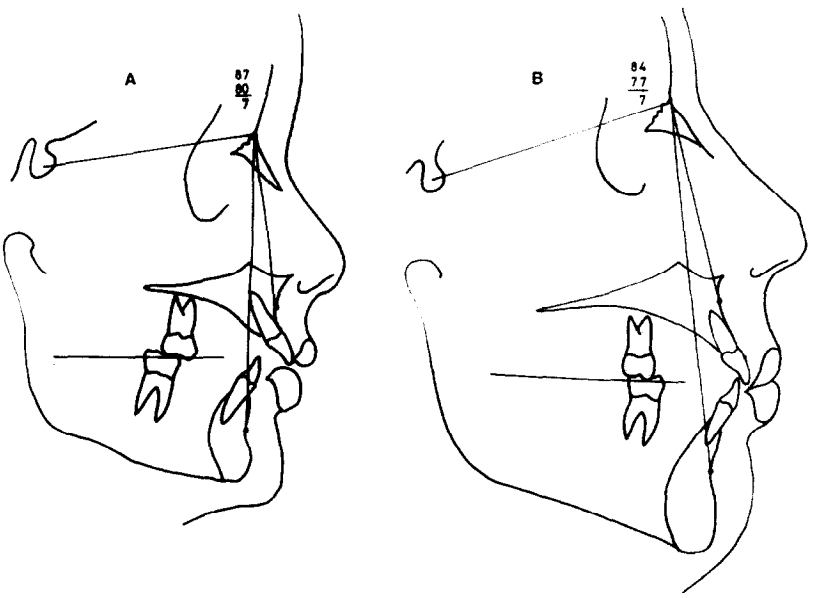

Fig. 1. Lateral cephalometric head film tracing of a Class II malocclusion (**A**) and a normal occlusion (**B**) each having an ANB angle of 7 degrees.

Point B was described by Downs[5] in 1948 as a point at the deepest curvature of the outline of the symphysis of the chin. This point is located at the junction of basal and alveolar bone. A deepening of the body of the symphysis occurs with eruption of the teeth. The bony tissue that is alveolar in the young is incorporated in the body and becomes basilar in the adult, so that point B moves horizontally and vertically. Point B was referred to earlier by Björk[1] as supramentale, the anthropometric term.[11] This point which, like point A, is subject to mild change with lower incisor movement may be regarded as the anterior limit of the lower denture base.

In appraising the horizontal disharmony of the face, the ANB angle (the difference between the SNA and SNB angles) is the most commonly used measurement. The SNA reading, Steiner reports, is of little concern because it merely shows whether the face protrudes or retrudes below the skull.[23-25] However, rather than ignore or discount the relative relationship of the denture bases to cranial reference planes, this article endeavors to emphasize an awareness of this relationship in the over-all interpretation and assessment of cephalometric analyses.

ANB angle as a measure of jaw dysplasia

The ANB angle in normal occlusions is generally 2 degrees.[18] Angles greater than this indicate tendencies toward Class II jaw disharmonies; smaller angles (extending to negative readings) reflect Class III anteroposterior jaw discrepencies. The foregoing is an acceptable generality. However, there are numerous instances in which the contention does not obtain. Fig. 1, *A* for instance shows a

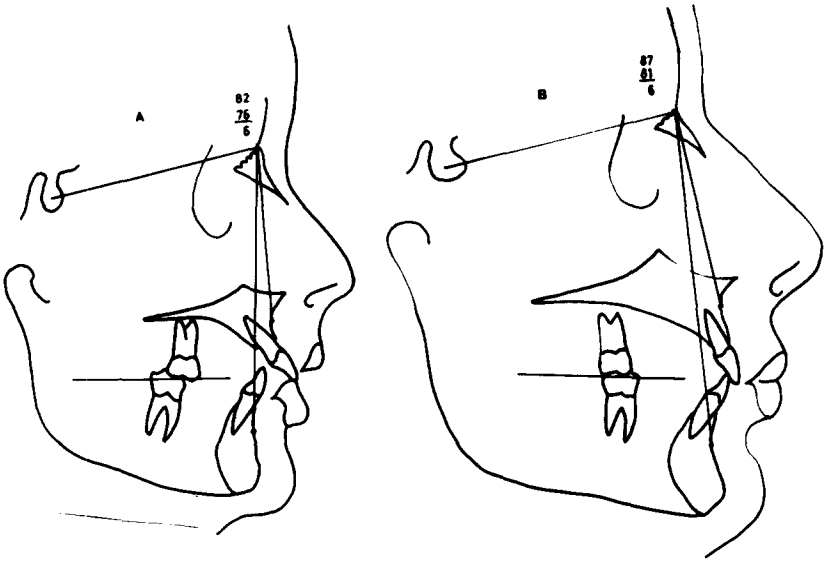

Fig. 2. A further example of a Class II malocclusion (**A**) and a normal occlusion (**B**) having identical ANB angle readings (6 degrees).

lateral cephalometric head film tracing of a Class II malocclusion. The ANB angle is 7 degrees, which is regarded as being high and typical of a Class II jaw dysplasia. Fig. 1, *B*, on the other hand, shows a lateral head film tracing of a patient with a perfectly normal occlusion. Paradoxically, here too the ANB angle measures 7 degrees. The tracing in the latter instance was that of the male student adjudged by the Department of Conservative Dentistry as having the best occlusion in the school. Fig. 2, *A* and *B* shows a further example of a Class II malocclusion and an excellent normal occlusion with identical ANB angle readings of 6 degrees. The anteroposterior relationship of the jaws in these examples is not satisfactorily reflected by the ANB angle readings. These general variants, therefore, assume importance when one endeavors to appraise degree of craniofacial skeletal disharmony in orthodontics.

Relating jaws to cranial reference planes presents inherent inconsistencies because of variations in craniofacial physiognomy. Included among the craniofacial skeletal variations are (1) the anteroposterior spatial relationship of nasion relative to jaws and (2) the rotational effect of the jaws relative to cranial reference planes.

The anteroposterior position of nasion. The relative forward or backward positioning of nasion by virtue of an excessively long or short anterior cranial base (represented by line SN) or a relative posterior or anterior positioning of both jaws within the skeletal craniofacial complex will directly influence the ANB reading.

Fig. 3 shows a lateral cephalometric head film tracing of a normal occlusion with an ANB reading of 2 degrees. Fig. 4 is a diagrammatic representation of the same tracing with the landmarks, nasion and point A and B identified.

Fig. 5, *A* shows a diagrammatic representation of a tracing of a normal oc-

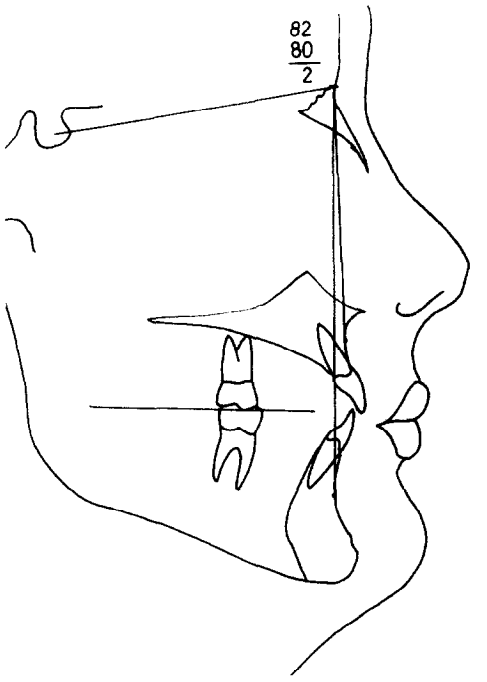

Fig. 3. Lateral cephalometric head film tracing of an "average" normal occlusion with an ANB angle of 2 degrees.

clusion with an ANB angle of 2 degrees. In Fig. 5, *B*, the relationship of the jaws to each other remains unchanged. Nasion, however, is positioned farther forward in that the anterior cranial base length has been increased. This has the effect of reducing the ANB reading, in this instance from 2 degrees to −2 degrees. A similar reduction in the ANB reading is effected by the jaws (bearing the same relationship to each other) being retropositioned in the craniofacial complex. Fig. 5, *C* shows an unchanged relationship of the jaws to each other, only now nasion is retropositioned (reduced anterior cranial base length). This has the effect of increasing the ANB angle, in this instance from 2 degrees to no less than 5 degrees. Forward positioning of the jaws in the craniofacial complex would have the same effect of increasing the ANB angle reading.

Rotational effect of jaws. Clockwise or counterclockwise rotation of the jaws relative to cranial reference planes (SN in the examples cited) likewise radically affects the ANB angle reading.

Fig. 6, *A* is a diagrammatic representation of a lateral head film tracing of a normal occlusion with an ANB reading of 2 degrees.

In Fig. 6, *B* the relationship of the jaws to each other is unchanged, but the jaws are now rotated in a counterclockwise direction relative to the SN plane. The rotation has had the effect of producing a Class III type of jaw relationship. The ANB angle had been reduced from 2 degrees to minus 5 degrees.

A clockwise rotation of the jaws relative to the cranium or the SN reference

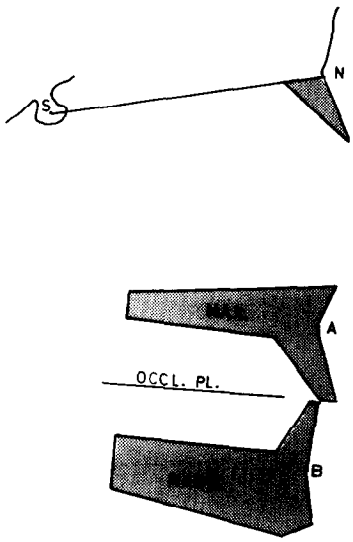

Fig. 4. Diagrammatic representation of a lateral cephalometric head film tracing with nasion and points A and B identified.

plane produces the opposite effect; that is, a Class II type of jaw relationship. In Fig. 6, *C* the relative clockwise positioning of the jaws has increased the ANB angle reading from 2 to 8 degrees in spite of the jaws maintaining an identical relationship to each other.

Clockwise or counterclockwise rotation of the SN line (due to nasion or sella turcica being positioned relatively superiorly or inferiorly to each other) either increases or decreases the SNA reading. Conventional analyses would suggest that the maxilla is positioned either forward or backward in the craniofacial complex. This is a specious interpretation, as is evident in Fig. 7. The SNA reading in this instance is 69 degrees instead of an average normal of 82 degrees, which would suggest maxillary (and mandibular) retropositioning. It is obvious from the cephalometric head film tracing that this is not the case; it is evident that it is the anterior part of SN plane which is superiorly tipped. The rotational effect of the SN line virtually has no anteroposterior positioning effect on nasion point, in which case the ANB angle reading is hardly affected by any angular deviation of SN from the horizontal.

The "Wits" appraisal of jaw disharmony

The "Wits" appraisal of jaw disharmony is a measure of the extent to which the jaws are related to each other anteroposteriorly. The method of assessing the degree or extent of the jaw disharmony entails drawing perpendiculars on a lateral cephalometric head film tracing from points A and B on the maxilla and mandible, respectively, onto the occlusal plane which is drawn through the region of maximum cuspal interdigitation. The points of contact on the occlusal plane from points A and B are labeled AO and BO, respectively (Fig. 8).

In a sample series of twenty-one adult males selected on the basis of excellence

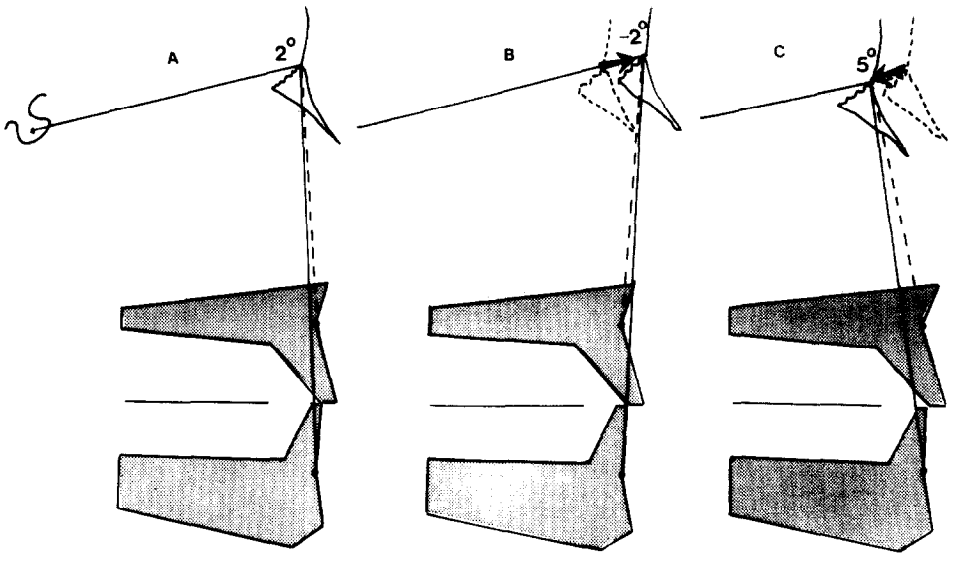

Fig. 5. A, Diagrammatic representation of an "average normal occlusion." **B,** Nasion located farther forward. This has the effect of reducing the ANB angle reading in this instance from 2 degrees to −2 degrees. **C,** Nasion positioned further back has the effect of increasing the ANB angle, in this example, from 2 degrees to 5 degrees.

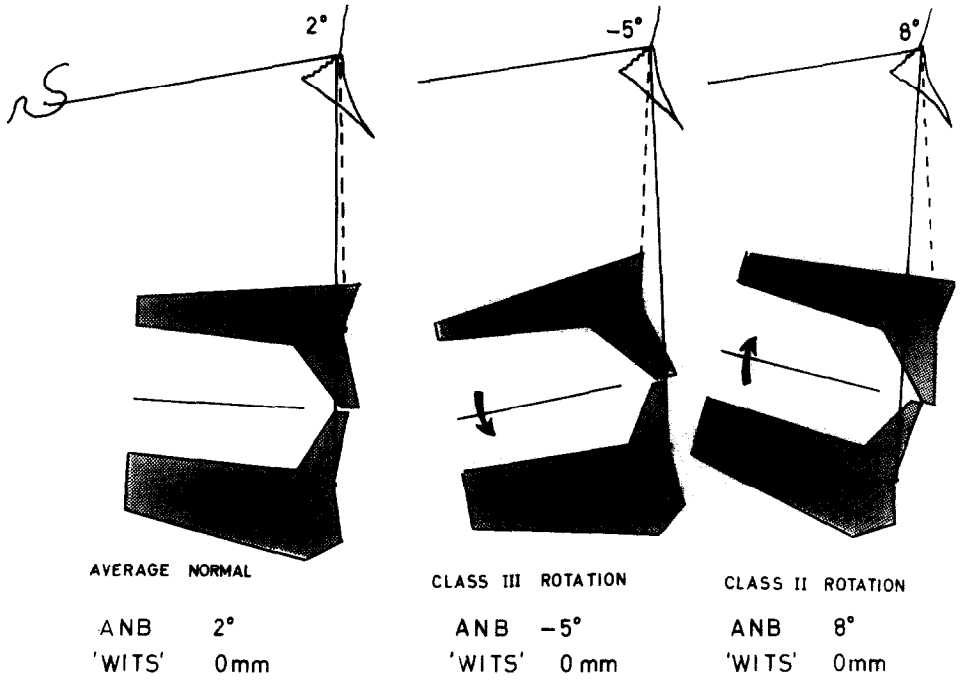

Fig. 6. A, Diagrammatic representation of an "average", normal occlusion. **B,** Counterclockwise rotation of the jaws has the effect of reducing the ANB angle (in this instance, from 2 degrees to −5 degrees). **C,** Clockwise rotation of the jaws has the effect of increasing the ANB angle (from 2 degrees to 8 degrees).

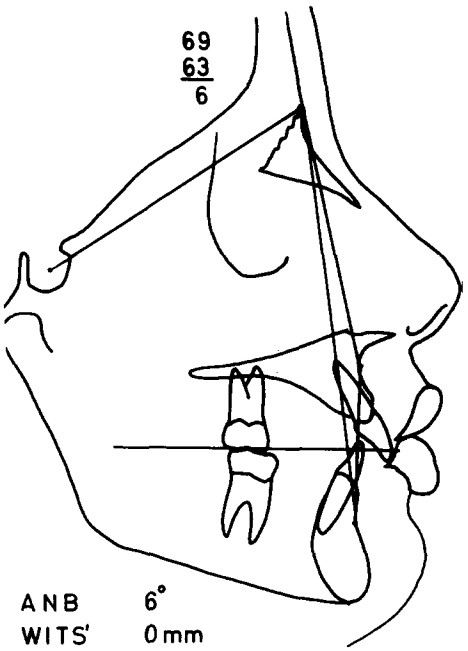

Fig. 7. Tipped anterior cranial base effecting reduction of SNA and SNB angle readings.

of occlusion, it was found that point BO was approximately 1 mm. ahead of point AO. The calculated mean reading was 1.17, S.D. 1.9 (range, –2 to 4 mm.). In twenty-five adult females selected on the same basis, points AO and BO generally coincided. The calculated mean reading was –0.10 mm., S.D. 1.77 (range, –4.5 to 1.5).

In sum, therefore, the average jaw relationship according to the "Wits" reading is 1 mm. in males and 0 in females. In skeletal Class II jaw dyplasias, point BO would be located well *behind* point AO (a positive reading) whereas in skeletal Class III jaw disharmonies, the "Wits" reading would be negative, namely, point BO being forward of point AO. The more the "Wits" readings deviate from 1 mm. in males and 0 in females, the greater the horizontal jaw disharmony.

Application of the "Wits" appraisal

Fig. 9, *A* and *B* shows the head film tracings of the Class II malocclusion and the normal occlusion illustrated in Fig. 1, *A* and *B*. The ANB in each instance is 7 degrees. According to the "Wits" appraisal, however, the Class II reading is 10 mm. (markedly Class II), whereas the reading for the normal occlusion (Fig. 9, *B*) is 0 mm. (normal).

Fig. 10, *A* and *B* shows repeat tracings of Fig. 2, *A* and *B*. Here again, the ANB angle readings in both is 6 degrees, whereas the "Wits" appraisal clearly reflects the difference between the Class II and the normal occlusion. The "Wits" reading for the Class II malocclusion is 6 mm., whereas the normal occlusion reading is 0 mm.

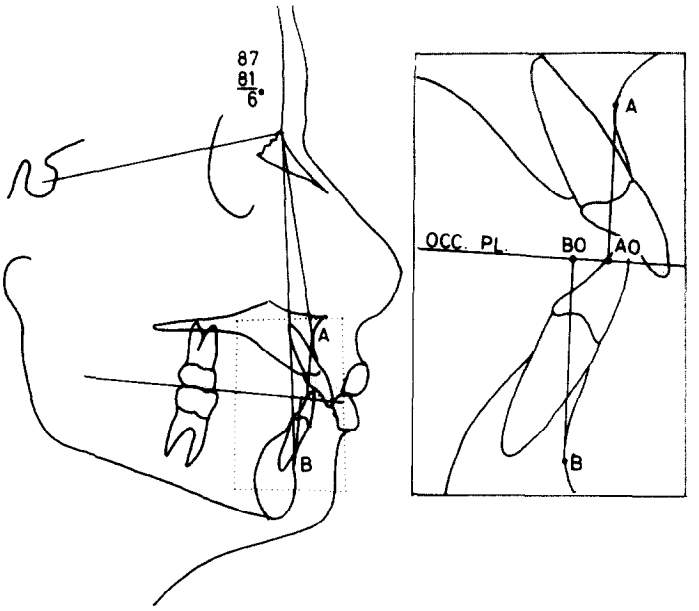

Fig. 8. Perpendicular lines dropped from points A and B onto the occlusal plane. "Wits" reading (enlarged in right-hand block) is measured from AO to BO.

Fig. 11, *A* and *B* shows lateral head film tracings of two Class III malocclusions. The ANB readings differ only slightly, namely, –1 degree and –1.5 degrees, respectively. The "Wits" appraisal, however, places a completely different complexion on the scene. According to the "Wits" reading, Fig. 11, *A* is –1.5 mm., reflecting a mild discrepancy in the relationship of the jaws to each other, whereas the "Wits" reading in Fig. 11, *B* is no less than –12 mm., a major jaw disharmony. In fact, the latter patient is scheduled to undergo a bilateral mandibular osteomy. The severity of the jaw disharmony is clearly reflected in the "Wits" appraisal but not so in the conventional ANB angle reading.

Fig. 12, *A* and *B* shows further examples of Class II malocclusion tracings. The ANB angle in each instance was 9 degrees. The "Wits" readings in *A* and *B*, however, were 8 mm. and 2.5 mm., respectively. Interpreted, this means that the anteroposterior jaw discrepancy in *A* was severe, whereas that of *B* was mild (in spite of the identical ANB angle measurements). Because of this, the high mandibular plane angle and the divergent type of profile, *A* proved most difficult to treat. By contrast, *B* proved easily treatable, the anteroposterior discrepancy being mild and the vertical profile dimensions favorable.

Fig. 13 shows the lateral cephalometric head film tracing of a patient with an ANB angle measurement of no less than 10 degrees. In spite of the high ANB angle, the "Wits" reading was only 2 mm. and easily treatable.

Fig. 14, *A* and *B* shows similar tracings of Class II malocclusions with ANB angle measurements of 7 degrees. The anteroposterior disharmony, according to the "Wits" appraisal in *A*, was severe (9 mm.), whereas that in *B* was minimal (1 mm.). The anteroposterior jaw correction in *A* entailed considerable therapy

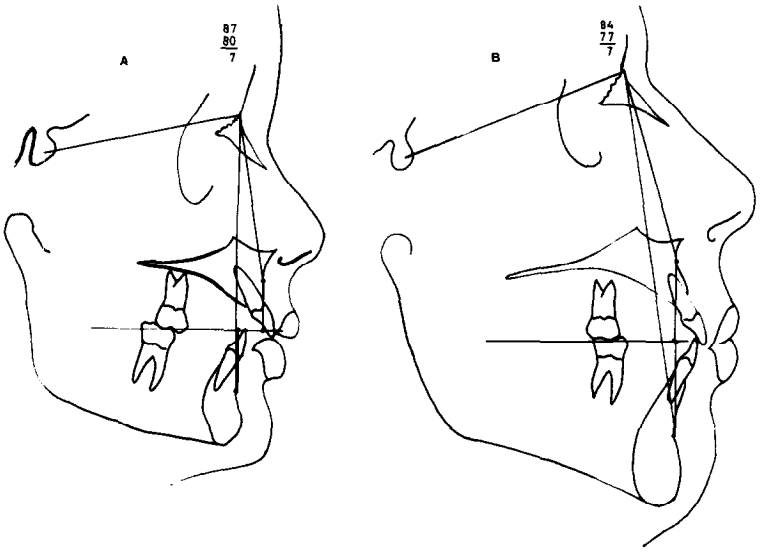

Fig. 9. Repeat tracings of Fig. 1 incorporating "Wits" readings. **A,** Class II malocclusion; ANB angle, 7 degrees "Wits" reading, 10 mm. **B,** Normal occlusion; ANB angle, 7 degrees; "Wits" reading, 0 mm.

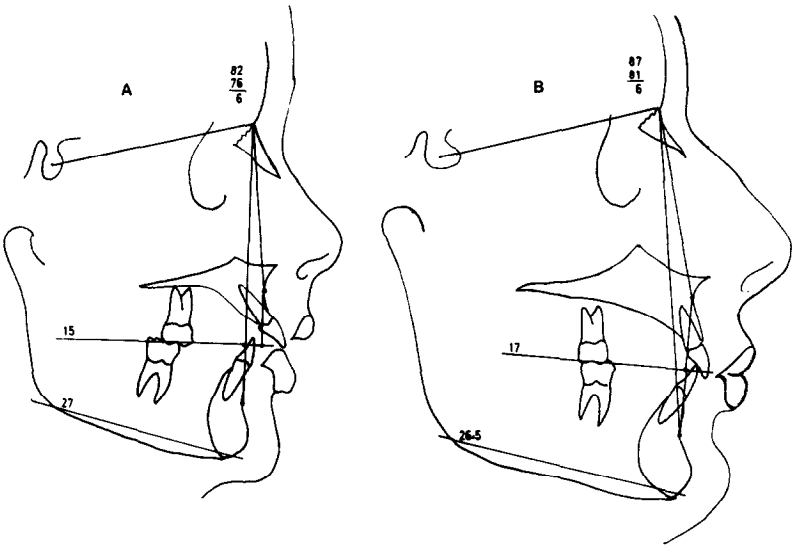

Fig. 10. Repeat tracings of Fig. 2 incorporating "Wits" readings. **A,** Class malocclusion; ANB angle, 6 degrees "Wits" reading, 6 mm. **B,** Normal occlusion; ANB angle, 6 degrees; "Wits" reading, 0 mm.

in spite of what appeared to be a favorable convergent type[9] of craniofacial skeletal pattern. The biggest problem in correction of *B* was not the anteroposterior jaw disharmony (which, according to the "Wits" appraisal, was minimal) but that of vertical dimension and its associated orofacial muscular disharmonies.

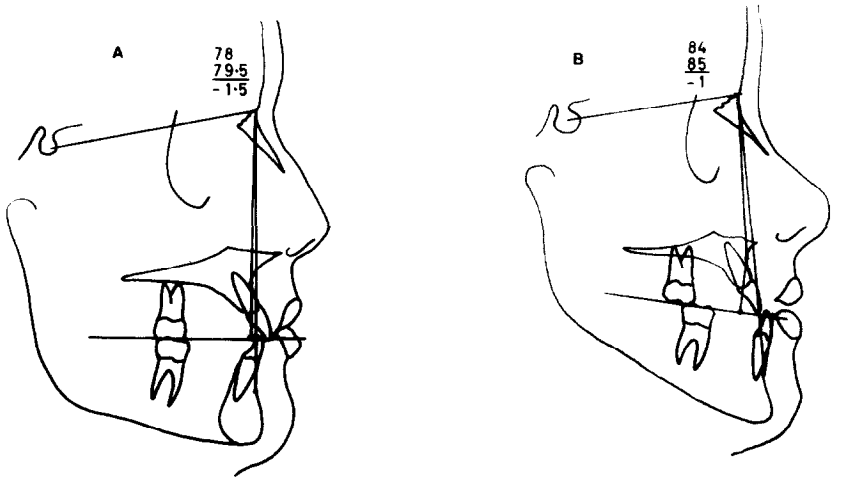

Fig. 11. Class III malocclusion tracings with approximately same ANB angle readings. **A,** Mild Class III jaw disharmony; ANB angle, −1.5 degrees; "Wits" reading, −1.5 mm. **B,** Severe Class III jaw disharmony; ANB angle, 1.0 degrees; "Wits" reading, −12 mm.

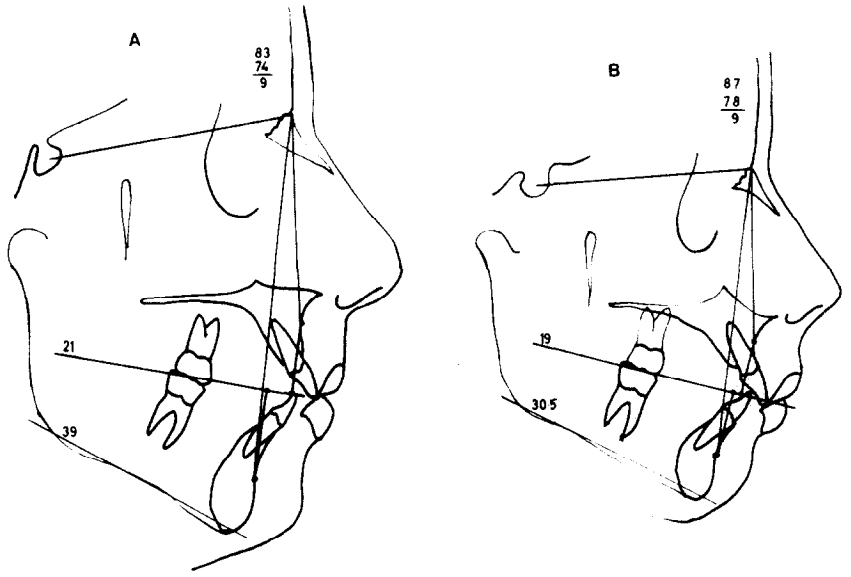

Fig. 12. Class II malocclusion tracings with identical ANB angles (9 degrees). **A,** "Wits" reading of −8 mm. reflects a severe Class III jaw disharmony. **B,** "Wits" reading of −2.5 mm. indicates a mild Class III jaw disharmony.

A 2 degree ANB angle, by conventional assessment of jaw disharmony, is normal. In Fig. 15 the ANB angle measures 2 degrees; the "Wits" measurement, however, is −4.5 mm., indicating a Class III jaw, which is the type of malocclusion presented by the patient.

A final example of discrepency in interpretation between the conventional ANB angle and "Wits" readings is manifest in Fig. 16. The ANB angle is 0

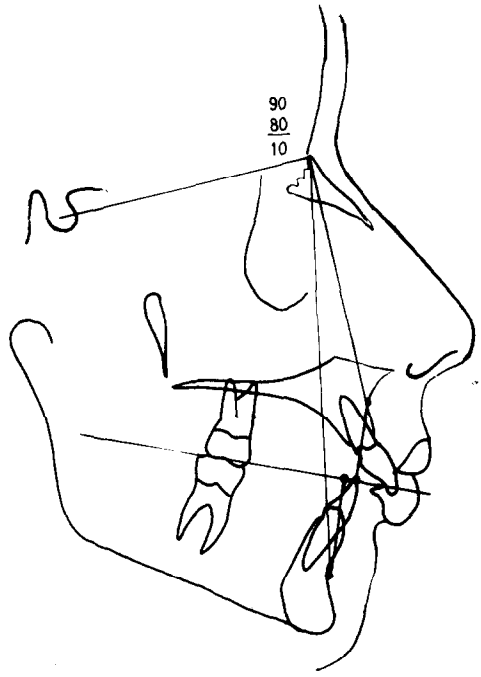

Fig. 13. The ANB angle measures 10 degrees. By conventional assessment, this is a severe Class II jaw disharmony. According to the "Wits" appraisal (2 mm.), the malocclusion is that of a mild Class II skeletal pattern.

degrees, suggesting a tendency toward Class III malocclusion. The "Wits" measurement, however, is no less than –9.5 mm., indicating severe anteroposterior jaw disharmony. This particular Class III malocclusion required surgical correction.

Discussion

Various cranial reference planes have been used as base lines from which to determine degrees of jaw dysplasia. De Coster[4] superimposed on outlines of the floor of the brain case from planum sphenoidale forward into the anterior cranial edge of the spheno-occipital synchondrosis over sella, drawing a reference line from there to nasion. Broadbent[2] developed the Bolton triangle, and the same triangle was modified by the substitution of basion for the Bolton point.[3]

All of the above reference planes deal with cranial morphology and, as such, are most useful in relating the jaws to the cranium. Measurements from the cranial base, however, do *not* necessarily provide a reliable expression of anteroposterior jaw relationship in the dentofacial complex.[13, 14] The line of reference from which anteroposterior jaw relationships should be assessed must, of necessity, be extracranial and relate to true vertical or a horizontal perpendicular to it.

Relating the jaws to an extracranial perpendicular may provide an expression of anteroposterior jaw relationship which is important from an esthetic standpoint. However, when one is endeavoring to appraise severity of antero-

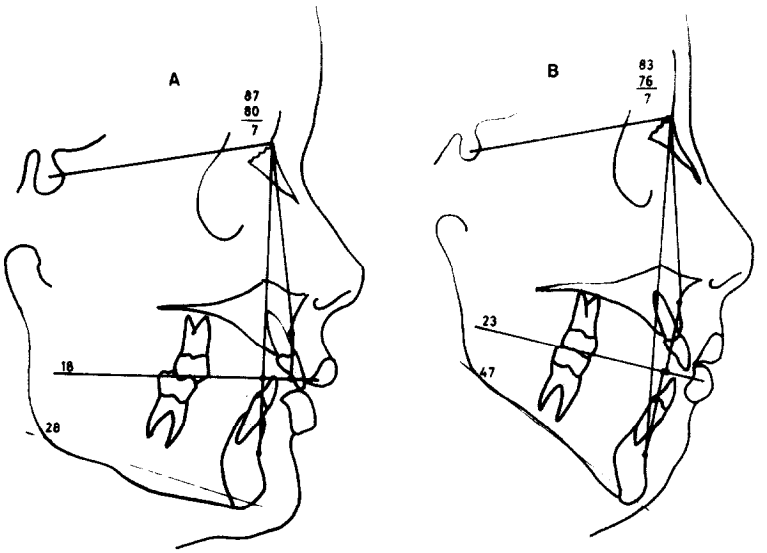

Fig. 14. Class II malocclusions with identical ANB angle readings (7 degrees). **A,** "Wits" appraisal (9 mm.) indicating severe Class II jaw disharmony. **B,** "Wits" appraisal (1 mm.) indicating mild Class II jaw disharmony.

posterior jaw disharmony or dysplasia, the jaws must of necessity be related to each other and to neither cranial nor extracranial landmarks. A reference plane, common to both dentures and one most suitable from which to relate both jaws, is that of the occlusion, namely, the occlusal plane. When relating the jaws to this common plane, clockwise or counterclockwise rotation of the jaws relative to cranial or extracranial reference planes will in no way affect the over-all assessment of severity of jaw disharmony.

The "Wits" appraisal thus provides a reliable indication of extent or severity of anteroposterior skeletal disharmony of the jaws. It does not necessarily relate to degree of difficulty in treatment. A low "Wits" reading should not always be interpreted as being a malocclusion that is easily corrected. Factors such as posterior vertical dimension, ramus width, symphseal thickness,[7, 16, 19-22] etc. must be taken into account in predicting growth trends. The latter, in effect, still remains educated guesswork. Whereas a low mandibular plane angle in Class II malocclusions usually indicates favorable mandibular growth,[6, 12] investigators have shown how readily this forward growth of the mandible can be counteracted by backward movement of the condyle due to posterior cranial base growth.

The limitations of treatment must be recognized, not only from a mechanical standpoint but also biologically, since we are unable with any degree of certainty to predict, in the face of random environmental influences, the final manifestations of the growth pattern or the severity of the malocclusion.[8] The "Wits" appraisal is thus intended not as a single diagnostic criterion but as an additional measurement which may be included in existing cephalometric analysis to aid in the assessment of degree of anteroposterior jaw disharmony.

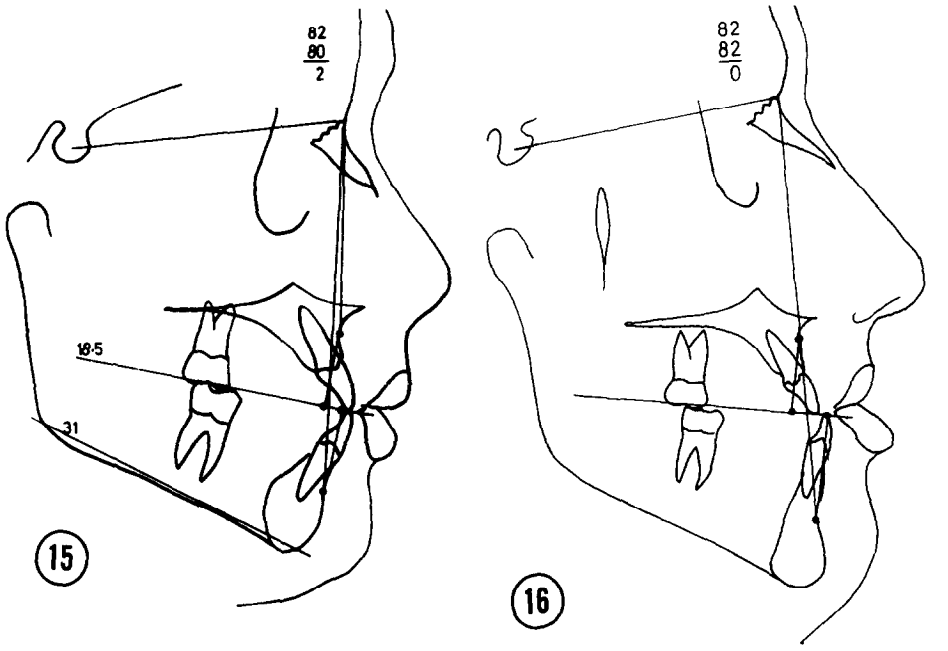

Fig. 15. Cephalometric tracing of Class III malocclusion with ANB angle of 2 degrees. According to conventional assessment, this would appear to be an "average" normal occlusion. The "Wits" reading of –4.5 mm. suggests a definite Class III skeletal disharmony.

Fig. 16. The ANB angle of 0 degrees suggests a Class III tendency by conventional assessment. According to the "Wits" appraisal (–9.5 mm.), the malocclusion is that of a severe Class III.

Summary

The "Wits" appraisal of jaw disharmony is a simple method whereby the severity or degree of anteroposterior jaw dysplasia may be measured on a lateral cephalometric head film.

The method entails drawing perpendiculars from points A and B on the maxilla and mandible, respectively, onto the occlusal plane. The points of contact of the perpendiculars onto the occlusal plane are labeled AO and BO, respectively.

In a sample of twenty-one male and twenty-five female adults selected on the basis of excellence of occlusion, it was found, on the average, that in females points AO and BO coincided and in males point BO was located 1 mm. ahead of point AO.

In skeletal Class II jaw dysplasias, point BO would be positioned well behind point AO (positive reading), whereas in Class III skeletal jaw disharmonies, the "Wits" reading would be negative, that is, with point BO ahead of point AO.

The advantages of the "Wits" appraisal over that of the conventional ANB angle reading are illustrated and discussed.

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