INFLUENCE OF THE FACIAL PATTERN ON ANB, AF-BF, AND WITS APPRAISAL

Aim: To assess the correlation between Wits and AF-BF appraisals with the ANB angle, and verify the influence of the facial type on these appraisals. Methods: Lateral cephalometric radiographs from 118 untreated individuals were separated into 3 groups according to the facial pattern (brachyfacial, mesofacial, and dolicho facial). The radiographs were digitized and submitted to ANB angle and Wits and AF-BF appraisals on computer software. All radiographs were retraced for intraobserver and interobserver error tests. Results: The Student’s t test demonstrated no statistically significant differences on the intraobserver’s test (P > .05). There were statistically significant differences in the readings of Wits values of the 3 groups and for AF-BF values in the brachyfacial and mesofacial groups (P < .05). The multiple linear regression tests demonstrated high correlation between ANB and AF-BF for the 3 groups (r², 0.768). The same result was found for ANB and Wits (r², 0.624). Conclusion: Facial pattern does not have an influence on the correlation between ANB and AF-BF nor between ANB and Wits, but it does influence the measurements of ANB, AF-BF, and Wits. World J Orthod 2006;7:369–375.

The sagittal relationship between the maxilla and the mandible is critical for orthodontic diagnostic and treatment planning.1–5 Riedel1 described the ANB angle, recommended by Downs, as the difference between the SNA and SNB angles. The ANB angle demonstrates the anteroposterior relationship between the jaws. Riedel1 suggested 2 degrees as an ideal difference between the SNA and SNB angles. The ANB angle has been one of the primary parameters for measuring the sagittal discrepancies between the jaws.3,6–9 However, this measurement does not always provide an adequate assessment of the skeletal discrepancies, since the measurement results for this angle can be inconsistent. Factors that interfere with the ANB angle include sagittal and vertical dislocations of the point nasion (N), facial prognathism, age (ie, the reduction of the angle with age), and rotation of the jaws in relation to the cranial reference planes.6–9 The last item is closely related to the facial type of the individual.

As a means of assessing the deficiencies of the ANB angle, Jacobson6 introduced the Wits appraisal. This method uses the linear measurements of the perpendicular projections of points A and B (represented as A’ and B’, respectively) on the functional occlusal plane to assess the sagittal discrepancies between the jaws. An average female with normal occlusion will have A’ and B’ coincident on the occlusal plane (Wits equals 0). On the other hand, in males with normal occlusion, B’ is located, on average, 1 millimeter in front of A’ (Wits equals ~1 mm).

Chang2 created a new system to evaluate sagittal discrepancies between the maxilla and the mandible, which was based on the linear distance of the perpendicular projections of points A and B (AF and BF, respectively) to the Frankfort horizontal plane. This appraisal was referred to as AF-BF. A positive value is given if the AF point is located in front of the BF point. An advantage of this method is the absence of point N, which is considered to be one reason for the inconsistencies of the ANB angle. Hence, AF-BF may be considered a more precise measure of sagittal jaw discrepancies.
As already mentioned, the Wits and AF-BF appraisals are based on planes of reference (functional occlusal plane and Frankfort horizontal plane, respectively) that may be affected by the inclination of the horizontal planes and the rotation of the jaws. The amount of rotation is greatly related to the facial pattern of the individual. Therefore, the aims of the present study were to: (1) evaluate the influence of facial pattern on the correlation between the Wits appraisal and AF-BF with ANB; and (2) evaluate differences in the readings of the mean values of ANB, AF-BF, and Wits among the groups.

MATERIAL AND METHODS

From a total sample of 365 lateral cephalometric radiographs (archive of Oral and Maxillofacial Radiology, Dentistry School of São Jose dos Campos, São Paulo State University, UNESP, São Paulo, Brazil), 118, from both genders, were selected for this study. The inclusion criteria were image quality, absence of previous orthodontic and/or orthopedic treatment, and concordance between the 2 methods of facial type classifications employed in this study.

The images were divided into 3 groups according to their facial type, based on the facial height ratio (FHR) described by Siriwat and Jarabak and on Tweed’s Frankfort-to-mandibular plane angle. The FHR method of classification of facial pattern is based on the ratio between the posterior facial height (sella–constructed gonion, S-Goc) and anterior facial height (nasion-menton, N-Me) (Fig 1). Dolicho- and brachyfacial individuals will have a FHR < 59%; mesofacial individuals will have a FHR between 59% and 63%; and brachyfacial individuals will have a FHR > 63%. Tweed classified the facial patterns into
type I (FMA between 21 and 29 degrees); type II (FMA < 21 degrees), and type III (FMA > 29 degrees) (Fig 2). The reason for using these 2 methods of facial pattern classification is that the FHR is constructed on anatomic landmarks, while the FMA involves a plane of orientation. This ensures that neither anatomic variations nor inaccurate orientation will influence facial-type classification.13

Thereafter, group 1 (brachyfacial) had 50 individuals, group 2 (mesofacial) had 43 individuals, and group 3 (dolichofacial) had 25 individuals. The sample ranged in age from 14.91 to 36.08 years. The radiographs were digitized on a flatbed scanner with a transparency unit (HPScanjet 4C/T; Hewlett-Packard, Palo Alto, CA, USA) with a fixed resolution of 75 dots per inch (DPI) and in 100% scale sharp black and white mode. All the images were saved in tagged image file format (TIFF). This resolution was selected because it provides a 1:1 scale of the digitized image on the software used in this study.

For the measurements of the ANB angle, the Wits appraisal, and the AF-BF, the digitized radiographs were imported to a software program designed for cephalometric analysis (Radiocev v. 4.0; Radiomemoria, Belo Horizonte, MG, Brazil), which allows the creation of custom analysis based on existent factors or with the creation of new ones.

Eleven cephalometric points and 3 factors were used for this study (Figs 3 and 4). The points were determined on the radiographs by an orthodontist. For the intraobserver test, all the points were re-determined after a 1-month interval. For the interobserver test, all radiographs were analyzed by an experienced oral radiologist.

Data were then submitted to a Student’s t test to assess any intraobserver and interobserver error. Multiple re-ges-
sion analysis was used to check the correlation between the AF-BF values and ANB angle and between the Wits appraisal and ANB angle, in the 3 facial types. To assess any statistically significant differences of the mean values among the groups, the authors then selected the ANOVA test.

RESULTS

The mean and standard deviation for the measurements of the parameters in the 3 facial groups demonstrated that the values of the ANB angle were smaller in the brachyfacial group and higher in the dolichofacial group. Accordingly, the same was observed for the AF-BF values, but the Wits values did not follow the same pattern (Table 1).

There were no statistically significant differences between the means of the first and second readings of ANB, AF-BF, and Wits by observer 1 (P > .05). However, there were statistically significant differences in the mean values of the readings of ANB. Table 2 shows the P values for the intraobserver and interobserver error.

Table 3 shows the determination value of the regression analysis for AF-BF and Wits, in relation to the ANB for the 3 groups. The authors found a better correlation between the ANB and AF-BF than between ANB and Wits.

Table 4 shows the regression equations of the multiple regression analysis for ANB × AF-BF and ANB × Wits for each facial type. For the regression between ANB × AF-BF, the regression equations for the 3 facial groups were the same. However, the intersection (linear coefficient) was smaller for the dolichofacial group. The same was observed for the angular coefficient of the regression of ANB × Wits, but the linear coefficient was smaller for the brachyfacial group.
DISCUSSION

Among the criteria that the orthodontist requires for diagnostic and the treatment planning, the sagittal relationship between the maxilla and the mandible is critical.\textsuperscript{1-5} Many parameters to evaluate the intermaxillary relationship have been described in the literature, but the ANB angle suggested by Riedel\textsuperscript{1} is the most popular and, therefore, the most disseminated.\textsuperscript{3,6,9,14,15} As a standard value, Riedel\textsuperscript{1} proposed 2 degrees as the ideal ANB angle. Nevertheless, some authors state that the ANB angle does not represent the actual sagittal discrepancies between the jaws,\textsuperscript{6-9} since it may be influenced by external factors, such as facial type.

As a complement of the ANB angle, the Wits appraisal was introduced by Jacobson in 1976.\textsuperscript{6} This method is based on linear measurements of the perpendicular projections of points A and B.

In this study, the intraobserver test for ANB, AF-BF, and Wits did not show any statistically significant differences in any of the groups. The interobserver test demonstrated statistically significant differences for the Wits values in the 3 groups and for the AF-BF values in the brachyfacial and mesofacial groups (see Table 2). The differences between the results of the 2 examiners may be due to differences in the interpretation of the anatomic structures and because of the difficulties that can occur in the determination of the exact location of the points based on teeth and on the petrotympanic aspect of the temporal bone.

A correlation between the ANB angle and the Wits appraisal has been described in the literature.\textsuperscript{15,17} However, predicting one from the other may bring inconsistent results, since other authors have found no correlation between the ANB angle and the Wits values, if the latter is negative.\textsuperscript{14}

The authors decided to use a multiple regression analysis to compare the ANB and Wits values in all 3 groups at once, instead of comparing these 2 parameters separately for each group. This was done because when comparing the values of the 3 groups together, it was possible to more accurately assess any correlation between the parameters and to find any possible influence of facial type on the measurements. The multiple regression analysis demonstrated a considerable determination value ($r^2$, 0.624) for the Wits and the ANB angle in all the facial groups. In other words, it was possible to determine the ANB value by the Wits value with success in 64.5% of the cases. This indicates that facial type does not have an influence on the correlation between ANB and the Wits appraisal, as demonstrated by the angular coefficient of the regression equation of the 3 groups. Thus, there is a proportional increase of the ANB values with the increase of the Wits values. Hence, when the ANB angle is higher (a characteristic of skeletal Class II disharmony between the jaws), the Wits value will also be proportionally high. Conversely, for smaller values of the ANB angle, which indicate skeletal Class III disharmony between the jaws, the value of the Wits will be proportionally smaller.

Nevertheless, it is important to emphasize that the Wits appraisal is influenced by geometric factors, such as the inclination of the occlusal plane.\textsuperscript{2} The authors observed that the higher the clockwise rotation of the horizontal plane, the higher the tendency for point B to be projected ahead of point A. This can be explained by the regression equations for each group (see Table 4). According to the statistical analysis, the regression equations for the mesofacial and the dolicho facial groups demonstrate that the ANB angle will assume a higher value when the Wits values equal zero. In the brachyfacial group, the regression equation shows a smaller value for the ANB angle if the Wits equals zero. This result demonstrates the tendency of the ANB value to be smaller in brachyfacial individuals, because of relatively greater horizontal growth over the vertical growth. The mean values show higher ANB values for the dolicho facial group in comparison to the mesofacial and dolicho facial groups. The same pattern would be expected for the Wits values. However, because the functional occlusal plane is based on dentition points, variability of tooth position is
observed independently of the facial type in the individual patient. Therefore, it could be inferred that the occlusal plane assumed a wide variety of rotations in the 3 facial groups, which explains the lack of coherence of the mean values for each group.

It has been shown in the literature that the functional occlusal plane tends to present negative Wits values, in comparison with the bisected occlusal plane and the mandibular incisor occlusal plane, since the functional occlusal plane is rotated more clockwise in comparison to the traditional occlusal plane and, therefore, presents less correlation with the ANB angle. A possible solution for the rotation effect of the occlusal plane relies on the use of a bisector plane between the maxillary plane and the mandibular plane. This plane is not dependent upon the dentition position and is not based on cranial references, which makes it more reproducible, with the advantage of being highly correlated with the ANB angle. However, it is possible that an influence of the individual facial type will occur, since the palatal plane and the mandibular plane clockwise rotation will be greater on dolicho- and brachyfacial individuals.

Another system for measuring the sagittal discrepancies between the jaws is the AF-BF, introduced by Chang in 1987. This system may also be influenced by the facial type, since it is based on a horizontal plane that presents various degrees of inclination, depending on the individual facial type and skeletal anatomy.

In this study, the multiple regression analysis demonstrated high determination value ($r^2$, 0.768) for the AF-BF and the ANB angle in all 3 facial groups. In other words, it was possible to successfully calculate the ANB angle from the AF-BF value in 76.8% of the cases. The results also showed that the facial type does not influence the correlation between these 2 factors, since the angular coefficient of the regression equation for the 3 groups is the same. This means that the AF-BF also increases proportionally with the increments of the ANB, in all 3 groups. Therefore, the greater the ANB value, the greater the AF-BF value. This result is in agreement with the findings of Oktay and Judy.

Although a high correlation between the AF-BF values and the ANB values was found for the 3 facial groups, facial type did influence the results of the measurements; the regression equation (see Table 4) demonstrated a higher linear coefficient for the ANB angle in the brachyfacial and dolicho- and dolichofacial groups, which means that a higher ANB value is expected for these groups, in comparison to the dolicho- and dolichofacial group when the AF-BF equals zero. This can be explained by the higher clockwise rotation of the horizontal planes of the dolicho- and dolichofacial individuals. Geometrically, if the Frankfort horizontal plane is rotated clockwise (as expected in dolicho- and dolichofacial individuals), the AF point tends to move backward while the BF point tends to move forward. However, if the mean values of the AF-BF are analyzed, there was a tendency for higher values of this factor in the dolicho- and dolichofacial group, which can be explained by the tendency for greater vertical growth, over horizontal growth, in these individuals. Consequently, a greater incidence of skeletal Class II relationships is expected in the dolicho- and dolichofacial group, as shown by the ANB and the AF-BF values found in this study, which were higher in the dolicho- and dolichofacial group in comparison to the meso- and brachyfacial groups.

One advantage of the AF-BF is that the Frankfort horizontal plane is based on skeletal structures. It is clear that these points will not be dependent on tooth position alone, which can result in inconsistencies similar to those that occur when using the occlusal plane. Nevertheless, porion cannot always be precisely determined on every cephalometric radiograph. This could be a factor for inconsistency of the AF-BF appraisal.
CONCLUSIONS

1. The Wits appraisal and the AF-BF can be used as a complement for the ANB angle in all 3 facial groups.
2. The facial pattern does not influence the correlation between the ANB angle and the AF-BF and Wits values.
3. The facial pattern influences the results of the measurements of ANB, AF-BF, and Wits.

REFERENCES