Validity of W Angle and YEN Angle in a Sample from Pakistani and Bangladeshi Populations

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Abstract: Lateral cephalometric analysis is an integral part of orthodontic diagnosis and treatment planning. The usual practice is to compare the cephalometric analysis of the patient with the established normal values. Since craniofacial morphology varies among different populations therefore it becomes important to establish the cephalometric norms of all cephalometric analyses, for every population. The aims of this study were to evaluate the validity of newly introduced cephalometric analysis using W angle and YEN angle in Pakistani and Bangladeshi samples and to compare both populations with commonly used sagittal measurements. In this study 200 lateral cephalograms of Bangladeshi population and 209 of Pakistani population were traced for ANB, Wits appraisal, Beta angle, W angle and YEN angle. Patients were divided into skeletal Class I, II and III groups. A significant difference was found in all performed measurements among skeletal groups in both the samples (p<0.001). Mean values of ANB, Wits appraisal and YEN angle differed significantly between both the samples in class I and class II subjects (p<0.05). No statistically significant difference was found in Beta angle and W angle values. The norm for W angle was established for the Pakistani (54.5±3) and Bangladeshi population (55±3). YEN angle norm for the Pakistani population was found to be 119.5±3, and for the Bangladeshi population it was 120.5±3. These results suggest that all the performed analyses are valid and can be used to diagnose skeletal discrepancies and diagnosis based on single analysis is insufficient. Bangladeshi and Pakistani populations differ in craniofacial morphology; therefore their own cephalometric norms should be followed for treatment of patients belonging to their respective populations.

Key words: Sagittal discrepancy, W angle, YEN angle, Pakistani, Bangladeshi

Introduction

Cephalometric analysis is an integral part of diagnosis as well as treatment planning in contemporary orthodontics. It is practiced by comparing patient’s radiographic measurements with norms or standard values, most of which are obtained from the researches that involved sample from American or European populations¹. Therefore it is not justified to apply these standard values in other populations because of possible ethnic and racial variations. Many investigators have found marked difference in the craniofacial morphology in various ethnicities which reflects in cephalometric measurements too²-⁵. In a study that involved Chinese and British white children, significant difference was found in sagittal (anteroposterior) and vertical cephalometric measurements⁶. Another study concluded that convex profile with short mandible is more common in Saudis as compared to Europeans-Americans⁷. Korean children are more prone to develop skeletal Class III malocclusion due to smaller anterior cranial base, midface deficiency and larger mandible⁸.

Pakistan and Bangladesh, both are the countries located in South Asia. Although Bangladesh is separated geographically by 1600 km but it was eastern part of Pakistan before the year 1971⁹. Apart from political and economical reasons; linguistic and ethnicity were also causative factors for partition between both the countries. Currently there are more than 1 million Bangladeshis residing in Karachi, Pakistan and many Pakistanis still migrate to Bangladesh for better future perspectives. Therefore it becomes very important to investigate whether Pakistani cephalometric norms differ from Bangladeshi norms.
and vice versa? Whether Pakistani norms are applicable to treat Bangladeshi patients and vice versa? This has never been investigated before.

Facial esthetic is incomplete without profile analysis therefore sagittal cephalometric analysis is a key step in diagnosis and treatment planning for orthodontic patient. The purpose of the study is to compare the difference in commonly used skeletal sagittal analyses, between the samples from Pakistani and Bangladeshi populations and to validate the newly introduced W angle and YEN Angle in both the populations.

Materials and Methods

The sample of this study involved the subjects from two countries i.e. Pakistan and Bangladesh. This examination is allowed by the Institution.

Pakistani sample

The data for this cross sectional study included two hundred and nine pretreatment lateral cephalometric radiographs of patients selected randomly from the Orthodontic department of Baqai Medical University Karachi. Sample comprised of 92 males and 117 females, with the mean age of 17.83 years. All skeletal classes (class I, II and III) with complete permanent dentition including second molars were included in the study. Patients having craniofacial malformations, facial asymmetry and cleft palate; patients with history of previous orthodontic treatment and patient with history of interracial marriage in parents or grandparents, were excluded from the study. All cephalometric radiographs were traced in a standard manner by single investigator as described in figure 1.

Bangladeshi sample

Sample included total of two hundred lateral cephalogram of patients selected systematically from dental students as well as orthodontic patients of Bangladesh Dental Institutes, Dhaka. Hundred males and 100 females were selected with the mean age of 19.24 years. Same exclusion and inclusion criteria were followed as for Pakistani sample. All radiographs were traced by single operator in a standard manner for following measurements (Fig. 1).

Landmarks and planes used in this study for analyses:

- S: Sella (center of sella turcica)
- N: Nasion (frontonasal suture at its most superior point)
- Point A: deepest point at concavity on maxillary alveolar bone
- Point B: deepest point at concavity on mandibular alveolar bone
- Functional occlusal plane: line passing through the occlusion of molars and premolars
- M: midpoint of premaxilla
- C: center of the condyle
- G: center of mandibular symphysis

Analyses performed in this research:

- ANB: SNA-SNB
- Wits appraisal: horizontal distance between two lines (AO and BO) drawn perpendicularly from point A and point B to functional occlusal plane
- Beta angle: C-B line joins center of condyle and point B. A perpendicular line is drawn from point A to C-B line angle. Beta angle is angle between this perpendicular line and C-B line
- W angle: A perpendicular line is drawn from point M to S-G line. W angle is angle between this perpendicular line and M-G line.
- YEN angle: angle between M-G line and S-M line

Patients were classified into skeletal class I, II and III on the basis of their incisor relationship observed from their dental casts10), profile and their cephalometric measurements that included Wits appraisal, ANB and Beta angle.

- Class I: class I incisor relationship, straight or slight convex but esthetically pleasing profile, ANB angle between 2° to 4°, Wits appraisal -3 to +3mm 11), Beta angle 27° to 35°
- Class II: class II incisor relationship, convex profile, ANB>4°, wits appraisal > +3mm, Beta angle <27°
- Class III: class III incisor relationship, concave profile, ANB<2°, wits appraisal <-3mm, Beta angle >35°

Patients who meet at least 3 criteria out of 5 were classified accordingly.

To control the errors in tracing and analysis, Dalhberg’s formula was applied:

\[ ME = \sqrt{\frac{\sum (x_1-x_2)^2}{2n}} \]

Where \( x_1 \) is the first measurement, \( x_2 \) the second measurement and \( n \) the number of repeated records10). This formula determines the difference between 2 measurements taken at least one month apart. Forty (20+10+10) randomly selected lateral cephalometric
radiographs were retracted and re-measured to calculate the error in the method from each population.

This study was designed and conducted according to the guidelines of Strengthening the Reporting of Observational studies in Epidemiology (STROBE), and we applied the STROBE checklist in the preparation of this manuscript.

### Statistical Analysis

The data were verified and analysed statistically using IBM SPSS Statistics Version 20.0 with confidence level set at 5% (P < 0.05) to test for significance. Analysis of variance (ANOVA) was applied to evaluate the difference in the values for three skeletal classes in all sagittal measurements. Independent t-test was applied to find out the difference in analyses between Pakistani and Bangladeshi population.

### Results

The reproducibility of the measurements was assessed by comparing the data taken at one month difference. To test the level of error involved in the present study, lateral cephalometric radiographs from each population were randomly selected and measurements were repeated one month apart. Dahlberg’s
formula was used to determine the method-error, which did not exceed 0.2 mm for the linear variables, 0.66 degree for the angular variables. The combined error for any of the variable was small and considered to be within acceptable limit.

In Pakistani sample 85 patients were skeletally class I; 94 were class II and 30 patients belonged to Class III malocclusion whereas Bangladeshi population comprised of 100 class I, 50 class II and 50 class III.

Table 1 shows the mean values for sagittal analyses i.e. ANB, Wits, Beta angle, W angle and YEN angle in Bangladeshi sample, which shows highly significant difference in the values among all skeletal classes. Similarly in Pakistani population all values measured for sagittal discrepancy were found significant among three skeletal classes.

Table 3 shows significant difference observed between both the populations in the mean value of angle ANB in class I and II cases while in class III cases the difference between both the samples was insignificant. Values for Wits appraisal was also found significantly different for Pakistani and Bangladeshi samples while the values for Beta angle was more or less similar in both the populations in class I cases. However class II and Class III showed significantly different values of Beta angle for Pakistani and Bangladeshi samples.

Table 3: Comparison of Pakistani and Bangladeshi races for sagittal analysis

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Class</th>
<th>Mean difference</th>
<th>95% confidence interval</th>
<th>P</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lower</td>
<td>Upper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ANB (°)</td>
<td>I</td>
<td>0.97</td>
<td>0.04 1.39</td>
<td>&lt;0.001</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>0.61</td>
<td>0.45 0.75</td>
<td>0.034</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>1.00</td>
<td>0.26 1.25</td>
<td>0.003</td>
<td>*</td>
</tr>
<tr>
<td>Wits (mm)</td>
<td>I</td>
<td>0.75</td>
<td>0.26 1.25</td>
<td>0.003</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>2.62</td>
<td>1.60 3.64</td>
<td>&lt;0.001</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>4.88</td>
<td>-6.26 -3.50</td>
<td>&lt;0.001</td>
<td>***</td>
</tr>
<tr>
<td>Beta angle (°)</td>
<td>I</td>
<td>0.10</td>
<td>-1.04 0.84</td>
<td>0.034</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>1.90</td>
<td>0.51 3.30</td>
<td>0.008</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>6.14</td>
<td>3.95 8.33</td>
<td>&lt;0.001</td>
<td>***</td>
</tr>
<tr>
<td>W angle (°)</td>
<td>I</td>
<td>0.78</td>
<td>-1.59 0.02</td>
<td>0.003</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>1.53</td>
<td>-3.08 0.19</td>
<td>0.003</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>8.23</td>
<td>6.53 9.93</td>
<td>&lt;0.001</td>
<td>***</td>
</tr>
<tr>
<td>YEN angle (°)</td>
<td>I</td>
<td>1.10</td>
<td>-2.04 -0.17</td>
<td>0.198</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>6.46</td>
<td>4.10 8.83</td>
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</tr>
<tr>
<td></td>
<td>III</td>
<td>0.86</td>
<td>-2.17 0.45</td>
<td>&lt;0.001</td>
<td>***</td>
</tr>
</tbody>
</table>

Discussion

To analyze jaw relationship in sagittal plane is a crucial step in diagnosis and treatment planning of orthodontic case. Wylie was the first to assess the jaws in AP plane, then number of angular and linear measurements were introduced. Riedel used nasion to define skeletal relationship between maxilla and mandible with angle ANB but later on Jacobson discovered few limitations in that analysis. He explained the possibility of errors in ANB angular measurement with the displacement of Nasion and jaw rotations thus he suggested the use of functional occlusal plane rather than cranial base in his analysis commonly known as Wits appraisal. However functional occlusal plane is not easily identified and reproduced accurately particularly in mixed dentition period when dental development and eruptions influence the linear measurement of Wits. Likewise the Beta angle measurement also does not use cranial base as a reference, rather use condylar axis or condyion to evaluate AP discrepancy. Because the reproducibility of condyle is questionable this led to the development of new angles i.e. W and YEN angle. Both the measurements utilize stable landmarks i.e. Sella, M point and G point. W angle is supposed to remain fairly stable even with vertical growth and rotation of jaws and YEN angle also found to be reliable in assessment of AP discrepancies of jaws.

There are numerous studies on the various cephalometric analyses found in the literature involving Bangladeshi and Pakistani population individually; however their norms have never been compared. In this study a sample from Pakistani population and Bangladeshi population were classified into three
skeletal groups and measured for above mentioned sagittal analyses. The results show that all the measured values were highly significant among three groups in both the populations. In this study ANB angle and Wits appraisal in Pakistani sample for class I cases showed tendency towards skeletal class II as compared to original value of ANB i.e. 2° and -1 to 0 mm Wits value in Caucasian. Previous study also reported ANB value of 4.14° and wits appraisal of 2.46 mm in class I cases among Pakistani sample, which is close to our results. On the contrary Bangladeshi sample in this study showed significant difference from Pakistani sample in both the values of ANB and Wits (p ≤ 0.001) and was found closer to original values in Caucasians. Another study conducted on Bangladeshi population also supports our results. The reason of variation in ANB and Wits values could be the position of nasion and uncertainty about occlusal plane. This was verified by other analyses that involve relatively stable landmarks. There was no significant difference found between both the samples in the mean value of Beta angle for class I patients (p=0.831). The value was also comparable to the Caucasians and also consistent with another study conducted on Pakistani population. Similarly, the value of W angle in class I and class II patients was also more or less similar in both the samples (p=0.056). W angle is relatively new measurement therefore no previous work has been done in Pakistani and Bangladeshi populations yet. However the results found in this study were in accordance with the studies conducted on Indian populations. Results for class III subjects show much higher values of W angle in Pakistani population (P ≤ 0.001) that shows the severity of skeletal dysplasia among patients included in this study. Though Bangladeshi values of W angle in class III patient is in accordance with Indian sample.

YEN angle was found to be significantly higher in Pakistani sample for class I cases (p=0.02) whereas the difference was insignificant in class II subjects (p=0.198). Class III patients showed much higher values for YEN angle as compared to Bangladeshi sample (p = 0.001), studies involving Indian population do not support the results obtained for Pakistani population however values in Bangladeshi population is well supported.

Pakistani population showed more severe malocclusion than Bangladeshi sample as depicted by mean values of ANB, Wits appraisal and Beta angle. However this was not observed in YEN angle and W angle values, reason would be the difference in landmarks used in YEN and W angle. Point A and B are subjected to change with dentoalveolar compensations while point M and G represent true skeletal position. Severity in skeletal class III was collectively observed in all sagittal measurements in Pakistani sample, which may be due to relatively smaller sample size of class III subjects in the group or acceptance of mild class III esthetically in Pakistani society.

It is suggested that clinician should not rely on a single analysis for diagnosis and treatment planning and verification with other measurements is advisable for better results.

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References

2. Cotton WN, Takano WS and Wong WM. The Downs analysis applied to three other ethnic groups. Angle Orthod 21: 213-220, 1951
12. Springate S. The effect of sample size and bias on the reliability of estimates of error: a comparative study of


