INTRODUCTION

Since the introduction of radiographic cephalometry in 1934 by Hofrath in Germany and Broadbent¹ in the United States, a number of analyses have been proposed to assist orthodontic clinicians and research workers to assess the sagittal jaw relation. The most popular and currently used cephalometric diagnostic methods to assess sagittal jaw relationship are “Angle ANB” and “Wits Appraisal”. Accuracy and reliability of both these have been questioned due to many factors that influence both “SN” and “Occlusal” planes. Lateral Cephalogram of 75 subjects from age group of 18 to 23 years were studied for their sagittal relationship according to parameters located on palatal plane, namely “App-Bpp”, “App-Pogpp”, “Mpp-Dpp” and “Mpp-Pogpp” and to compare the relative effectiveness and accuracy of the parameter App-Bpp with that of Angle ANB and Wits Appraisal for assessing sagittal jaw relationship. ANOVA was applied for determining the accuracy and sensitivity of new parameters and Correlation coefficient “r” was found between the parameters Angle ANB, Wits Appraisal and App – Bpp. P value (< 0.01) was significant for all parameters thus indicating they are efficient enough to identify and differentiate different types of skeletal pattern with great accuracy. High correlation coefficient value between parameter Angle ANB and App-Bpp suggested that whenever there is a doubt, one can confirm the underlying skeletal pattern by the parameter App-Bpp.

ABSTRACT

The most popular and currently used cephalometric diagnostic methods to assess sagittal jaw relationship are “Angle ANB” and “Wits Appraisal”. Accuracy and reliability of both these have been questioned due to many factors that influence both “SN” and “Occlusal” planes.²,³,⁴ Lateral Cephalogram of 75 subjects from age group of 18 to 23 years were studied for their sagittal relationship according to parameters located on palatal plane, namely “App-Bpp”, “App-Pogpp”, “Mpp-Dpp” and “Mpp-Pogpp”. Hence present study was undertaken to find out the reliability and accuracy of six different parameters to assess the sagittal jaw relationship using 75 cases with different types of dentition and skeletal pattern.

Thus the aim of the study was to find out whether palatal plane can be used as a reliable Cephalometric diagnostic tool to assess sagittal jaw relationship, to find out whether parameters located on palatal plane, namely “App-Bpp”, “App-Pogpp”, “Mpp-Dpp” and “Mpp-Pogpp” (Fig. 2) are accurate and sensitive enough and lastly to compare the relative effectiveness and accuracy of the parameter App-Bpp with that of Angle ANB and Wits Appraisal for assessing sagittal jaw relationship.

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MATERIALS & METHODS

Angle ANB and Wits Appraisal (Fig 1) are the most
popular and currently used methods to assess sagittal jaw relationship. Attempt has been made for assessing sagittal jaw relationship by substituting occlusal plane with palatal plane and along point A and Point B and few other landmarks.

For the present study, total 75 young adults of age group 18-23 were selected. Initially lateral cephalograms of 30 young adults (15 Males & 15 Females) who showed normal occlusion, good harmonious facial profile and normal sagittal relationship according to Angle ANB and Wits Appraisal were collected.

To find out applicability and accuracy, the sample was further expanded by adding 45 new subjects with similar age group but different type of malocclusion. The subjects thus were divided in to six groups (A,B,C,D,E & F) according to the type of dentition, and the type of skeletal pattern as per the Angle ANB and Wits Appraisal (Table I).

### TABLE I : Distribution of subjects in all the groups

<table>
<thead>
<tr>
<th>GROUP</th>
<th>DENTITION</th>
<th>ANGLE ANB</th>
<th>WITS APPRAISAL</th>
<th>SAMPLE SIZE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>A*</td>
<td>Class I</td>
<td>0° to 5°</td>
<td>-2 to +2</td>
<td>15 (20%)</td>
<td>30</td>
</tr>
<tr>
<td>B*</td>
<td>Class II</td>
<td>&gt; 5°</td>
<td>&gt; +2</td>
<td>8 (10.5%)</td>
<td>14</td>
</tr>
<tr>
<td>C*</td>
<td>Class III</td>
<td>&lt; 0°</td>
<td>&lt; -2</td>
<td>5 (6.7%)</td>
<td>10</td>
</tr>
<tr>
<td>D**</td>
<td>Class II</td>
<td>&lt; 0°</td>
<td>&lt; -2</td>
<td>5 (6.7%)</td>
<td>6</td>
</tr>
<tr>
<td>E***</td>
<td>Class II</td>
<td>&gt; 5°</td>
<td>&gt; -2 to +2</td>
<td>3 (4%)</td>
<td>8</td>
</tr>
<tr>
<td>F****</td>
<td>Class II</td>
<td>0° to 5°</td>
<td>&gt; +2</td>
<td>7 (9.4%)</td>
<td>7</td>
</tr>
</tbody>
</table>

* Group A, Group B and Group C has Class I, Class II and Class III dentition and skeletal pattern respectively according to Angle ANB and Wits A Appraisal

** Group D had Class II Dentition but Skeletal Class III patterns according to Angle ANB and Wits Appraisal.

*** Group E had Class II dentition but skeletal class I pattern according to Wits Appraisal

**** Group F had class II dentition but skeletal Class I pattern according to Angle ANB

Four new parameters : App-Bpp, App-Pogpp, Mpp-Dpp, and Mpp-Pogpp (Table II) (Fig 2) were derived by drawing perpendiculars to palatal plane from Point A, Point B, Point M, Point D and Pogonion; to assess sagittal jaw relationship, using palatal plane as a reference plane were recorded.

The Angle ANB and Wits Appraisal were measured in the classical way. The new parameters are linear measurements made with a caliper (in millimeters).

The complete sample of 75 subjects was regrouped in three categories according to their skeletal jaw relationship (Class I, Class II and Class III) as per the parameter App-Bpp, Angle ANB and Wits appraisal.
STATISTICAL ANALYSIS:

Mean and Standard deviation of each parameter for each group was found. ANOVA was applied to all the groups for each parameter. Value of P was found to be significant (< 0.01) for all parameters indicating that these parameters are efficient enough to identify and differentiate different types of skeletal pattern with great accuracy.

The coefficient correlation analysis was applied between App-Bpp, Angle ANB and Wits Appraisal for estimating their effectiveness and reliability for assessing skeletal jaw relationship. All the statistical analysis was done using IBM® SPSS® software v 15.0.

RESULTS

Mean and standard deviations for each parameter in each group was calculated. ANOVA test applied to each parameter for all the groups gave highly significant p value (< 0.01) for all 6 parameters, suggesting that all these methods can identify and differentiate different types of skeletal pattern with great accuracy.

Pearson’s coefficient of correlation (“r” value) was calculated by comparing “Angle ANB”, “Wits Appraisal” and “App-Bpp” with one another for the entire sample. And all the parameters were positively correlated as r value was nearer to +1.

TABLE II: Few of the used cephalometric landmarks and linear measurements

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point M</td>
<td>Represents the mid-point of premaxilla in mid sagittal plane. Located on the cephalogram according to the superior, anterior and palatal surfaces of the premaxilla. It was identified as the center of the circle that best fitted the outlines of premaxilla</td>
</tr>
<tr>
<td>Point D</td>
<td>Down's D point</td>
</tr>
<tr>
<td>App</td>
<td>Point A projected perpendicularly on palatal plane</td>
</tr>
<tr>
<td>Bpp</td>
<td>Point B projected perpendicularly on palatal plane</td>
</tr>
<tr>
<td>Mpp</td>
<td>Point M projected perpendicularly on palatal plane</td>
</tr>
<tr>
<td>Dpp</td>
<td>Point D projected perpendicularly on palatal plane</td>
</tr>
<tr>
<td>Pogpp</td>
<td>Point Pog projected perpendicularly on palatal plane</td>
</tr>
<tr>
<td>App-Bpp</td>
<td>Linear distance between Point App and Point Bpp</td>
</tr>
<tr>
<td>App-Pogpp</td>
<td>Linear distance between Point App and Point Pogpp</td>
</tr>
<tr>
<td>Mpp-Dpp</td>
<td>Linear distance between Point Mpp and Point Dpp</td>
</tr>
<tr>
<td>Mpp-Pogpp</td>
<td>Linear distance between Point Mpp and Point Pogpp</td>
</tr>
</tbody>
</table>

Fig. 2: Traced lateral cephalogram showing various anatomic and constructed landmarks used in the study
DISCUSSION

It is very well known that dental arch relation is not a true medium for assessing facial skeletal pattern. Hence it is important to assess underlying skeletal pattern of the jaw bases with the help of lateral cephalogram prior to concluding the type of malocclusion and planning treatment. Since introduction of Angle ANB by Reidel it has become very popular method to assess skeletal sagittal jaw relationship. Jacobson deviated from the traditional ways and introduced Wits Appraisal of jaw disharmony without using cranial landmarks. Point A and Point B being related to occlusal planes, makes it free from influence of the position of nasion and rotation of the jaw bases which had its own limitations.

Freeman in 1950 was first one to show that Angle ANB can be misleading as the position of nasion influences the angle very much. Many others questioned the reliability of the parameter because of the influence of variable position of N point.

Some authors suggested the use of palatal plane as a reference plane to assess skeletal jaw relationship because it itself being skeletal landmark and also being close to the area being surveyed it can act as the most convenient and reliable plane. Broadbent in 1937 wrote that palatal plane appeared to

\[
\begin{align*}
\text{TABLE III: Mean and standard deviation of various parameters for all the groups} \\
\text{Parameter} & \quad \text{Group A} & \quad \text{Group B} & \quad \text{Group C} & \quad \text{Group D} & \quad \text{Group E} & \quad \text{Group F} & \quad \text{F value} \\
& \quad \text{Mean ± S.D.} & \quad \text{Mean ± S.D.} & \quad \text{Mean ± S.D.} & \quad \text{Mean ± S.D.} & \quad \text{Mean ± S.D.} & \quad \text{Mean ± S.D.} \\
\text{Angle ANB}^\circ & 1.90 ± 1.42 & 7.14 ± 1.23 & -4.30 ± 3.62 & -2.67 ± 1.86 & 6.25 ± 0.46 & 3.71 ± 1.25 & 64.98 \\
\text{Wits Appraisal}^\circ & -0.10 ± 1.35 & 7.07 ± 1.64 & -5.70 ± 4.16 & -4.83 ± 1.47 & 1.13 ± 0.99 & 4.00 ± 0.82 & 65.42 \\
\text{App-Pogpp}^\circ & 1.02 ± 3.81 & 4.88 ± 6.77 & -6.45 ± 8.75 & -5.42 ± 3.84 & 9.31 ± 5.01 & 6.36 ± 3.3 & 11.87 \\
\text{Mpp-Dpp}^\circ & 0.77± 4.06 & 5.03 ± 5.49 & -6.35 ± 7.67 & -5.25 ± 3.87 & 8.19 ± 3.74 & 5.07 ± 3.67 & 12.73 \\
\text{Mpp-Pogpp}\circ & -6.48 ± 3.67 & 4.87 ± 6.24 & -12.6± 8.09 & -12.6± 3.67 & 2.44 ± 4.53 & -1.79 ± 3.46 & 32.46
\end{align*}
\]

* p value < 0.01

\[
\begin{align*}
\text{TABLE IV: Coefficient of correlation values when “Angle ANB”, “Wits Appraisal” and “App-Bpp” were compared with one another for the entire sample} \\
\text{Parameter I} & \quad \text{Parameter II} & \quad \text{“r” value} \\
\text{ANB} & \quad \text{Wits} & \quad 0.876 \\
\text{ANB} & \quad \text{App-Bpp} & \quad 0.896 \\
\text{App-Bpp} & \quad \text{Wits} & \quad 0.834
\end{align*}
\]
maintain a parallel relation over the growth range in the population he studied. In a longitudinal study Brodie also found that palatal plane maintains a constant angular relationship with anterior cranial base.

Therefore in this study we have made an attempt is made to find out the accuracy and reliability of the parameters based on palatal plane and then compare one of the parameters (App-Bpp) with the commonly used Angle ANB and Wits Appraisal.

The results we found are very significant with p value < 0.01. Thus the parameters used can be used for determining the sagittal jaw relationship more reliably. The results we have got were because of the stable palatal plane and freedom from various variable factors.

Group A comprised of subjects with normal occlusion, thus the mean value of the group for the new parameters can be considered as the mean for the population for Class I skeletal jaw relation and so can be the values for group B and group C for skeletal class II and class III respectively.

Also the study included Point M and Point D which are considered as geometric center of maxilla and mandible respectively and thus free from the influence of factors like dentoalveolar protrusion that affect Point A and Point B. Thus the perimeter Mpp-Dpp can be used in such cases in which position of Point A and Point B is not reliable.

Also to the Pearson’s correlation coefficient (r) between the parameter App-Bpp to Angle ANB and Wits Appraisal was found to be positive with r value being 0.896 and 0.834 respectively. Thus indicating the use of the parameter App-Bpp in case of doubt on the other two parameters may be helpful in proper diagnosis and treatment planning.

**SUMMARY & CONCLUSION**

Significant differences in mean values of parameters of are “Angle ANB”, “Wits Appraisal”, “App-Bpp”, “App-Pogpp”, “Mpp-Dpp” and “Mpp-Pogpp” for the groups A,B and C suggest that all these method are efficient enough to identify and differentiate different types of skeletal pattern with great accuracy. Also the value of P (<0.01) stood significant for the ANOVA applied for each parameter indicating sensitivity and accuracy of each of the six parameters.

The mean and standard deviation values found for parameters “App-Bpp”, “App-Pogpp”, “Mpp-Dpp” and “Mpp-Pogpp” of group A can be considered as the mean and standard deviation for our population as this group had normal dentition, good harmonious facial profile and normal sagittal jaw relationship as proved by all known parameters.

High correlation coefficient value was found between parameter Angle ANB and App-Bpp suggests that whenever there is a doubt about the reliability of Angle ANB for a particular case during diagnosis, one can confirm the underlying skeletal pattern by the parameter App-Bpp.

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