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## RESEARCH ARTICLE

# JS SAGITTAL DYSPLASIA – A NEW FRONTIER FOR TRUE ASSESSMENT OF ANTERO-POSTERIOR RELATIONSHIP OF JAWS

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**ABSTRACT**

***Objective:*** There are several methods to determine anteroposterior dysplasia but the reliability of the landmarks used have always been questioned as misleading factors may provide false results. Thus the objective of this article is to develop a new composite method, using stable landmarks, to assess the antero-posterior sagittal dysplasia. ***Material and methods:*** Lateral cephalograms of 1500 patientswere selected for study. Out of these based on exclusion and inclusion criteria,42 patients with class I , 42 patients with class II and 41 patients with class III were selected.10 angles were designed to evaluate the antero-posterior dysplasia and the values for each parameter was measured for each patient. The values were measured independently by two investigators. Cephalometric measurements were done by a trained orthodontist with more than 92% intra-rating agreement. ***Results:*** A new JS sagittal dysplasia indicator based on relatively stable landmarks, utilizing the S1-post surface of ramus, S2-mandibular plane angle and MNG angle can be used to evaluate the sagittal dysplasia. ***Conclusion:*** Patients with the JS sagittal dysplasia indicator values of 15.59 indicates Class I malocclusion, 7.99 indicates Class II malocclusion and -8.50 indicates Class III malocclusion. This new indicator can be used as an adjunct with various other parameters in evaluating the antero-posterior jaw relationship.



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## INTRODUCTION

The first step in the cephalometric evaluation of anteroposterior jaw relationshipwas Down's description of point A and B (Downs, 1952). Riedel used ANB angle and it became part of many analysis (Riedel, 1952). However, there has been lot of claims about the ANB angle being affected by many misleading factors and giving false results. The reliability of ANB as an antero-posterior discrepancy indicator has always been questioned. ANB has limitations because of it dependency on structures like patient's chronological and biological age, jaw rotation, vertical growth and the length of the anterior cranial base i.e. the antero-posterior position of Nasion, which according to Jacobson (Jacobson, 1975) makes cephalometric interpretation more complex and confusing.

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To overcome the problem of ANB, Jacobson introduced a linear method called as the Wits appraisal to assess the A-P discrepancy involving the functional occlusal plane. This plane has no problem with the Nasion or jaw rotation but is not accurately reproducible and gets affected by its inclination, eruption of the teeth, alveolar bone development and facial growth direction. Similarly, Kim and Vieta in 1978 proposed Antero-Posterior Dysplasia Indicator (APDI) where reading is obtained by calculating from the facial angle, A-B plane angle and the palatal angle (Kim, 1978). Frankfurt horizontal plane has its own disadvantages owing to large variation with the true horizontal. APDI uses point A and B which can be changed by orthodontic treatment and growth. Beta angle was developed by Baik in 2004 (Baik, 2004) to determine the true apical base relationship no involving the cranial reference planes or the dental occlusion. It involves the uses of point A which can be altered and locating condylion on the closed mouth lateral films can be difficult.

In 2009, Neela et al introduced the YEN anglefor indicating sagittal dysplasia. It measures the angle between the SM and MG as the true apical dysplasia can be masked because of growth or orthodontic treatment, similarly to ANB angle. Moreover, The true antero-posterior apical base relationship can't be determined by single measurement. Point A and B are commonly used variables to measure changes but are affected by bone remodelling during orthodontic treatment or natural growth. The antero-posterior position of mandible is also affected by the position of glenoid fossa and the vertical growth of the jaws. To overcome these existing limitations, a new composite indicatorneeds to be developed. Since the position of Sella has found to be relatively stable after the age of 6 years, this indicator uses this landmark and other derived reference planes which would be valuable to assess true sagittal discrepancy. The objective is to develop a new composite method, using stable landmark, to assess the antero-posterior sagittal dysplasia.

## MATERIALS AND METHODS

Lateral cephalograms of 1500patients with permanent dentition form the age group of 12-25 years were included in the study. Inclusion criteria comprised of patients having no history of previous orthodontic treatment,patients having healthy periodontium, patients having full cusp class II , or class III molar relation. Exclusion criteria being – patients with subdivision (class II or Class III), syndromic patient , malocclusion due to pathologic migration or trauma from occlusion , pts having asymmetry, pts with cleft lip an palate.
After the initial selection, selected the x-rays were traced for ANB to classify the patients in Angle's Class I, Class II and Class III malocclusion. Method of sample selection was random sampling.Sample size consisted of 676 patients with Class I, 475 patients with Class II and 349 patients with Class III malocclusion. Out of these based on exclusion and inclusion criteria , 42 patients with class I , 42 patients with class II and 41 patients with class III were selected. (Table 1)
10 angles were designed to evaluate the antero-posterior dysplasia and the values for each parameter was measured for each patient. The values were measured independently by two investigators. Cephalometric measurements were done by a trained orthodontist with more than 92% intra-rating agreement.

**Variables used in the study (Figure 1)**

**S1:** True vertical line drawn on sella (S)

**S2:** True horizontal line drawn on sella (S)

**S1-Condylion:** angle formed between S1 and centre of condyle

**S1-Post surface of ramus:** angle formed between S1 and post surface of ramus

**S2-Palatal plane:** angle formed between the S2 and the palatal plane

**S2-Mandibular plane:** angle formed between the S2 and mandibular plane (tangent)

**S2-AB plane angle:** angle formed between the S2 and AB plane angle

**S2-NPog:** angle formed between the S2 and NPog

**S1-PNS:** angle formed between the S1 and PNS

**MNG Angle:** angle formed between the centre of maxilla (M), nasion (N) and centre of the largest circle that is tangent to the internal inferior, anterior and posterior surface of the mandibular symphysis

**MCG Angle:** angle formed between the centre of maxilla (M), condylion (C) and centre of the largest circle that is tangent to the internal inferior, anterior and posterior surface of the mandibular symphysis

**SN-TH Angle:** angle formed between the SN plane and the true horizontal (TH)

**Statistical analysis:** Statistical analysis was performed using R software version3.2.2. Data was summarized by calculating the meanand standard deviation for all the 10 angles in the three classes of malocclusion. The one-way analysis of variance (ANOVA) was used followed by post-hoc Tukey's comparison to determine whether there was a statistically significant difference between the mean values of the angles in the different classes of malocclusion (Table 2) A p-value of <0.05 was considered to be statistically significant. Pearson's correlation statistics (Table 3) was applied to relate the angles with each other. Regression analysis (Table 4) was performed to ascertain the effect of different angles on the various classes of malocclusion and to predict the antero-posterior dysplasia in terms of Angle's malocclusion based on the various angles used in this study. (Table 5)

## RESULTS

A total of 125 patients participated in the study (Table 1). One-way ANOVA showed that all the angles were statistically significant for different malocclusions (Table 2). Post-hoc Tukey's comparison showed that only three angles, S1_post surface of ramus, S2-Mand plane and MNG angle were found to be statistically significant in all the three classes of malocclusion.

**Table 1. Demographic details of the sample according to gender and malocclusion**

| Gender | Class I | Class II | Class III | Total |
|---|---|---|---|---|
| Male | 22 | 24 | 19 | 65 |
| Female | 20 | 18 | 22 | 60 |
| Total | 42 | 42 | 41 | 125 |

Strong correlation (>0.7) was found between the following angles (Table 3). S1_Condylion and S1_post surface of ramus, S2_NPog, S1_PNS angle; S1_post surface of ramus and S2_AB plane angle, S2_NPog, S1_PNS angle; S2_palatal plane and S2_mand plane, S2_AB plane angle; S2_mand plane and S2_AB plane angle, S2-NPog, S1-PNS, APDI; S2_AB plane and S2_NPog, S1_PNS, MCG angle, APDI; S2_NPog and S1_PNS, SN_TH angle, APDI; S1_PNS and APDI.

On the basis of the results of post-hoc comparison,a regression model was formulated using the statistically significant angles found between the three classes of malocclusion, (Table 4).

**Table 2. ANOVA results of the various angles and APDI in three classes of malocclusion with post-hoc Tukey's comparison**

| | | | | | | | F | p value | 1 VS 2 | 1 VS 3 | 2 VS 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class I (n=42) | | Class II (n=42) | | Class III (n=41) | | | | | | |
| | Mean | S D | Mean | S D | Mean | S D | | | | | |
| Age | 20.6 | 2.25 | 20.9 | 2.15 | 20.6 | 3.68 | 0.21 | 0.809 | | | |
| S1_condylion (centre) | 25.5 | 4.16 | 25.5 | 3.49 | 17.6 | 1.34 | 81.13 | < 0.001 | NS | ** | ** |
| S1_post surface of ramus | 9.3 | 3.86 | 11.2 | 2.49 | 16.1 | 3.05 | 51.12 | < 0.001 | * | ** | ** |
| S2_palatal plane | 3.3 | 2.49 | 3.3 | 1.90 | 6.5 | 1.99 | 31.77 | < 0.001 | NS | ** | ** |
| S2_mand plane (tangent) | 26.2 | 5.03 | 23.2 | 3.19 | 7.7 | 5.82 | 177.73 | < 0.001 | * | ** | ** |
| S2_AB plane angle | 82.1 | 4.78 | 82.9 | 5.48 | 95.1 | 4.04 | 94.95 | < 0.001 | NS | ** | ** |
| S2_NPog | 85.8 | 3.57 | 85.7 | 2.10 | 96.4 | 3.69 | 153.20 | < 0.001 | NS | ** | ** |
| S1_PNS angle | 25.0 | 3.23 | 24.7 | 4.47 | 36.6 | 4.22 | 118.81 | < 0.001 | NS | ** | ** |
| MNG angle | 2.8 | 1.21 | 5.5 | 1.23 | 1.6 | 1.87 | 77.57 | < 0.001 | ** | ** | ** |
| MCG angle | 31.0 | 2.79 | 30.1 | 2.32 | 27.0 | 1.00 | 36.82 | < 0.001 | NS | ** | ** |
| SN_TH angle | 8.7 | 3.79 | 8.1 | 3.72 | 15.6 | 2.97 | 58.00 | < 0.001 | NS | ** | ** |
| APDI | 77.6 | 2.00 | 77.5 | 2.06 | 85.7 | 2.69 | 177.75 | < 0.001 | NS | ** | ** |

**Table 3. Pearson's correlation coefficient results of the angles used in the study**

| Correlations | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S1_post surface of ramus | S2_palatal plane | S2_mand plane (tangent) | S2_AB plane angle | S2_N Pog | S1_PNS angle | MNG angle | MCG angle | SN_TH angle | APDI |
| S1_condylion (centre) | Pearson Correlation | -0.759 | -0.477 | 0.664 | -0.681 | -0.789 | -0.740 | 0.401 | 0.305 | -0.577 | -0.664 |
| | p value | < 0.001 | < 0.001 | < 0.001 | < 0.001 | <0.001 | < 0.001 | <0.001 | 0.001 | < 0.001 | < 0.001 |
| S1_post surface of ramus | Pearson Correlation | | 0.630 | -0.669 | 0.744 | 0.755 | 0.827 | -0.306 | -0.39 | 0.649 | 0.570 |
| | p value | | < 0.001 | < 0.001 | < 0.001 | <0.001 | < 0.001 | <0.001 | < 0.001 | <0.001 | < 0.001 |
| S2_palatal plane | Pearson Correlation | | | -0.706 | 0.700 | 0.670 | 0.680 | -0.435 | -0.493 | 0.517 | 0.613 |
| | p value | | | < 0.001 | < 0.001 | <0.001 | < 0.001 | <0.001 | < 0.001 | < 0.001 | < 0.001 |
| S2_mand plane (tangent) | Pearson Correlation | | | | -0.846 | -0.895 | -0.766 | 0.391 | 0.684 | -0.671 | -0.786 |
| | p value | | | | < 0.001 | <0.001 | < 0.001 | <0.001 | < 0.001 | < 0.001 | < 0.001 |
| S2_AB plane angle | Pearson Correlation | | | | | 0.830 | 0.701 | -0.449 | -0.704 | 0.579 | 0.748 |
| | p value | | | | | <0.001 | < 0.001 | <0.001 | < 0.001 | < 0.001 | < 0.001 |
| S2_N Pog | Pearson Correlation | | | | | | 0.863 | -0.481 | -0.578 | 0.796 | 0.774 |
| | p value | | | | | | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| S1_PNS angle | Pearson Correlation | | | | | | | -0.492 | -0.367 | 0.811 | 0.742 |
| | p value | | | | | | | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| MNG angle | Pearson Correlation | | | | | | | | 0.281 | -0.438 | -0.546 |
| | p value | | | | | | | | 0.002 | < 0.001 | < 0.001 |
| MCG angle | Pearson Correlation | | | | | | | | | -0.197 | -0.562 |
| | p value | | | | | | | | | 0.028 | < 0.001 |
| SN_TH angle | Pearson Correlation | | | | | | | | | | 0.605 |
| | p value | | | | | | | | | | < 0.001 |

**Table 4. Regression analysis of the significant angles found with post-hoc comparison**

| | Unstandardized Coefficients | | Standardized Coefficients | t | p value | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | 0.825 | 0.680 | 0.672 | 0.468 |
| (Constant) | 2.507 | 0.261 | | 9.62 | 0.000 | | | | |
| S1_post surface of ramus | -0.042 | 0.013 | 0.220 | 3.17 | 0.002 | | | | |
| S2_mand plane (tangent) | +0.061 | 0.006 | -0.700 | -9.76 | 0.000 | | | | |
| MNG angle | -0.042 | 0.021 | 0.113 | 2.02 | 0.045 | | | | |

**Table 5. Regression model results for the different classes of malocclusion**

| Regression model values | | |
|---|---|---|
| Class I | Class II | Class III |
| 15.59 | 7.99 | -8.50 |

The regression model was used to calculate the values for different classes of Angle's malocclusion (Table 5).

**Regression model:** Class I/II/III = 1.493- 0.042 (S1_post surface of ramus) + 0.061 (S2_mand plane) - 0.042 (MNG Angle)

# DISCUSSION

Various angles and measurements have been used to determine the antero-posterior jaw relationship which is an important step in the diagnosis and treatment planning. ANB[1], Wits[3], APDI[4], W angle (Bhad, 2011) and beta angle (Baik, 2004) have been suggested for cephalometric analysis. Most of these measurements can be flawed as they are affected by changes in face height, jaw inclination, total jaw prognathism and the reference plane used. ANB angle which is most commonly and widely used for AP jaw relationship can be affected easily by the position of the anterior cranial base, vertical growth pattern and the rotation of jaw bases. The Wits analysis has the problem in identifying the functional occlusal plane as the points are not clear especially in the mixed dentition analysis. APDI on the other hand is dependent upon the points A, B, FH plane and Nasion which can vary in every individual. Beta angle utilizes the points A and B which can be altered by bone remodelling. Yen angle and beta angle which utilizes the angle SM and MG can be affected by the rotation of the jaw bases.

So, many of the current antero-posterior jaw relationship analysis are affected by some factors like the jaw rotation, growth pattern, changes in reference planes, poor reproducibility of cephalometric landmarks. Antero-posterior dysplasia is affected by many factors and not only by the sagittal relationship but also by the vertical relationship. The rotation of the jaw bases affects the vertical relationship thereby altering the sagittal dysplasia. For example, a case of Class II can be due to dimensional and positional variation of the maxilla or mandible. So, there is a need of an indicator which considers both the antero-posterior and vertical relationship in assessing the true sagittal dysplasia. Posterior surface of ramus has an effect determining the growth pattern of an individual. According to Rakosi, there was a considerable variation for the posterior gonial angle formed on the tangent to the posterior border of ramus. As the gonial angle opens out posteriorly, the lower gonial angle reduces suggesting a horizontal growth pattern. When the gonial angle opens out anteriorly, the upper gonial angle reduces suggesting a vertical growth pattern.

A large upper gonial angle suggest horizontal growth and a large lower gonial angle suggests a vertical growth. Hence it is important to know about the inclination of the posterior surface of ramus, vertical and sagittal jaw relationship. True horizontal and true vertical planes passing throughsella would be more appropriate because of their stability and reliability. To overcome the limitations of various previous methods for assessing sagittal dysplasia, a new JS sagittal dysplasia indicator was developed. It does not depend upon the unstable or unreliable cephalometric landmarks, instead it utilizes the horizontal and vertical reference planes drawn on sella which is considered more stable after 6 years of age; unlike APDI, which uses Frankfort horizontal plane as reference which is not considered a stable plane due to instability of landmarks like orbitale and porion. The different angles used in this study were analysed for the different classes of malocclusion based on ANB angle and Wits appraisal. The three angles S1_Post surface of ramus, S2-Mandibular plane and MNG were found to be statistically significant in the three classes of malocclusion as in shown in Table 2. The regression model in table 5 was used to predict the range for the malocclusion and it was found that the value 15.59 represents class I malocclusion, 7.99 represents class II malocclusion and -8.50represents class III malocclusion. The JS sagittal dysplasia indicator can be valuable tool in assessing the antero-posterior dysplasia. It is independent of the cranial base length and therefore predicts the true skeletal patterns. Hence it can be used for planning orthognathic and orthopaedic procedures. Since this indicator uses sella it can be used to evaluate the growth or treatment changes. Although, high quality radiographs are recommended to locate the points M and G on the lateral cephalograms.

Dependency on any singular measurements or analysis is not recommended for any orthodontic assessment.In skeletal malocclusion , the defect may lie with maxilla or mandible or a combination of two can be present. Thus there are factors which affect anteroposterior position of jaws including the placement of jaws in relation to each other or to cranium or the individual length of the jaws which may be at fault. Thus the JS sagittal dysplasia indicator is based on all these factors like vertical placement of jaws , growth rotations etc. and can be used as a valuable adjunct in assessing the antero-posterior jaw relationship.

**Conclusion**

A new JS sagittal dysplasia indicator based on relatively stable landmarks, utilizing the S1-post surface of ramus, S2-mandibular plane angle and MNG angle can be used to evaluate the sagittal dysplasia. Patients with the JS sagittal dysplasia indicator values of 15.59 indicates Class I malocclusion, 7.99 indicates Class II malocclusion and -8.50 indicates Class III malocclusion. This new indicator can be used as an adjunct with various other parameters in evaluating the antero-posterior jaw relationship.

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