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Original Research Article

Comparative evaluation of the reliability of MNG angle with other anteroposterior skeletal dysplasia indicators – A retrospective cephalometric study

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ABSTRACT

Aim: The aim of the study was to evaluate the reliability of the MNG angle for various skeletal malocclusions and to compare and correlate it with ANB angle, Beta angle, Yen angle and W angle in Gujarati population.

Methods and Materials: Lateral cephalograms of 50 Gujarati adults, were divided into three groups based on the ANB angle and the Beta angle measurements. The Yen angle, W angle and MNG angle were measured for all the cephalograms. The mean value for MNG angle was derived for each group. The one-way analysis of variance (ANOVA) and Bonferroni post hoc tests were used to compare the differences between the mean values of the 3 groups. Spearman's correlation analysis was used to determine correlations among the five skeletal parameters.

Results: Analysis of the obtained data revealed a mean MNG angle of -1.22° ± 3.9°, 3.11° ± 2.8° and -6.0° ± 1.5° for Class I, II and III respectively. Spearman's correlation analysis demonstrated a significant co-relation between ANB angle, Beta angle and MNG angle with a p value of $\leq$ 0.05 for skeletal Class I and Class II malocclusions.

Conclusion: The MNG angle can be used as a dependable maker to assess the antero-posterior discrepancy, especially for Class II skeletal pattern.

1. Introduction

Diagnosis and treatment planning have evolved in orthodontics since Broadbent introduced cephalometrics in the 1930s. Establishing the relationship of the maxillary and mandibular jaw bases accurately in all three planes enables improved diagnosis and treatment planning which would ultimately influence the outcome of the treatment.

Determining the true extent of the sagittal skeletal relationship (SSR) between the maxilla and mandible is of utmost importance for treatment planning which in turn affects the treatment result and profile of the patient. Hence, in the pursuit of improved diagnostic parameters, numerous linear and angular measurements have been introduced over the years.[1]

ANB angle, introduced by Riedel et al. in 1952[2], assesses the maxillary and mandibular jaw bases to each other as well as to the cranial base. It has served as a benchmark to assess SSR between the maxilla and the mandible for decades. However, it has been well documented in the literature that it is inaccurate to diagnose a case based on these landmarks alone as they may change due to the rotation of jaws which happen as a result of growth. The reference planes are influenced by the vertical relations between the jaws thus decreasing their validity as a base for evaluation.

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Over the years, many new parameters have been introduced to determine the anteroposterior relation of the jaws to overcome the shortcomings of the ANB angle. Some of them are Beta angle[3], Yen angle[4], W angle[5], Pi angle[6], and many more.

One such parameter, the MNG angle, was proposed by Rachit et al.[7] to correctly and accurately diagnose the sagittal jaw relationship. Nanda R.S. and Merrill R.M. conducted a longitudinal study in which the M point was defined as "The midpoint of the premaxilla in the mid-sagittal plane and was located on the tracings according to the superior, anterior, and palatal incline of the premaxilla and the midpoint was identified with concentric circles to find the circle that best fits the premaxilla or the outline of the premaxilla. The center of this circle was identified as the center of the premaxilla, Point M."[8] The G-point is defined as, "a point representing the center of the largest circle that is tangent to the internal inferior, anterior, and posterior surfaces of the mandibular symphyseal region as seen on lateral cephalograms".[9]

Points used in this study are relatively more stable than those previously used as they do not change their positions with the change in tooth position. Therefore, it may be said that the angle formed by these points will also be stable.

2. Aim and Objective

This study was carried out:

1. To evaluate the MNG angle in patients with skeletal Class I, II, and III pattern in the Gujarati population (18 – 35 years).
2. To correlate the MNG angle in patients with skeletal Class I, II, and III pattern with their Beta, Yen, and W angles.

3. Material and Methods

3.1. Source of data

The present study was carried out on records from patients who had visited the Department of Orthodontics and Dentofacial Orthopaedics at a teaching institute after obtaining clearance from the ethical committee.

4. Methodology

The sample size was determined using a power calculation based on the mean MNG angle value of Class I occlusion (2° ± 1.4°). To detect a change of 2° from this mean value with 85% confidence and 80% power, we required a sample size of 13 in each group. . The sample size estimation for the present study was done using the formula below.

$$\text{Unlimited population: } n = \frac{z^2 \times \hat{p}(1-\hat{p})}{\varepsilon^2}$$

Pre-treatment lateral cephalograoms of 50 patients who had reported for orthodontic treatment were collected retrospectively from the department archives based on the following inclusion and exclusion criteria:

The inclusion criteria were,

1. Patients aged 18 – 35 years
2. Patients having a full complement of permanent dentition excluding third molars.
3. Radiographs of good quality.

The exclusion criteria were,

1. Patients who had previously undergone orthodontic or orthopedic treatment.
2. Patients who had any craniofacial abnormality or functional mandibular shifts.

Patient consent had been obtained before taking radiographs and starting the orthodontic treatment. Manual tracing of all lateral cephalograms was done on 0.003-inch matt acetate tracing paper with a 0.5 mm lead pencil under the same illumination. To minimize errors resulting from inter-operator variations, all the lateral cephalograms were traced by a single operator. Samples were split into Class I, II, and III skeletal groups based on the ANB angle and Beta angle. (Table 1) Skeletal Class I and Class II groups consisted of 18 samples each, while 14 samples were included in the Class III group. In each patient of all the three groups, the cephalometric landmarks were located and analysis was carried out.

Table 1: Descriptive statistics stratified based on ANB and Beta angle

Sr. No.	Criterion	Class I group	Class II group	Class III group
1.	ANB angle(°)	1°-3°	≥4°	≤0°
2.	Beta Angle(°)	27°-35°	≤26°	≥36°

5. Cephalometric Landmarks

The various cephalometric landmarks used in this study are mentioned in Table 2. (seven points)

The MNG angle uses the skeletal landmarks M and G to represent the maxilla and mandible respectively and is formed by drawing and connecting the lines between points M to N and N to G. (Figure 1)

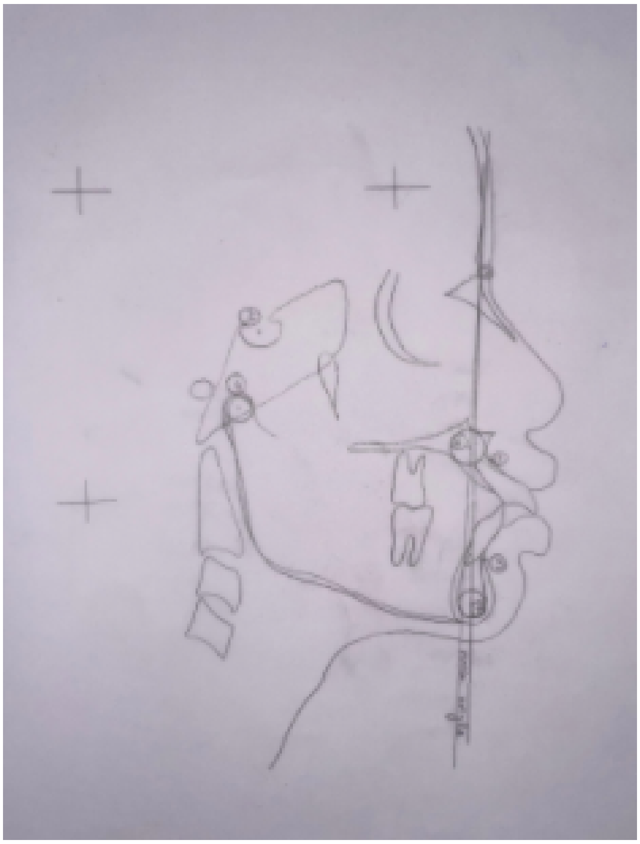

Figure 1: Diagrammatic representation of MNG angle andvarious cephalometric points used in the study

Table 2: Cephalometric landmarks used in the study

Sr. No.	Cephalometric Landmarks	Definitions
1.	Point A	The deepest midline point on the premaxilla between the anterior nasal spine and prosthion (described by Downs)[10]
2.	Point N	The most anterior point on frontonasal suture suture in the mid sagittal plane.
3.	Point B	Most posterior point in the concavity between infradentale and pogonion (described by Downs).[10]
4.	Point C	Center of the condyle is found by tracing the head of the condyle and approximating its center
5.	Point S	The midpoint of sella turcica
6.	Point M	Midpoint of premaxilla
7.	Point G	The center of the largest circle that is tangent to the internal inferior, anterior, and posterior surfaces of the mandibular symphysis

5.1. *Statistical analysis*

All the analyses were done using SPSS version 23 (IBM, USA). Statistically significant differences between the mean values of MNG angle for the three groups were determined using the one-way analysis of variance (ANOVA) and Bonferroni post hoc tests. A p-value less than or equal to 0.05 was considered to be statistically significant. Additionally, the MNG angle was correlated with the ANB angle, Beta angle, Yen angle, and W angle using Spearman's correlation test. Ten tracings were randomly selected and retraced to identify the intra-examiner error and the resultant intra-class error was found to be insignificant according to the intra-class correlation coefficient.

6. Results

The MNG angle mean value in the Class I skeletal pattern group was -1.22° ± 3.9°, for the Class II skeletal pattern group, was 3.11° ± 2.8° and for the Class III skeletal pattern group was -6.0° ± 1.5°.(Table 3)

Significant correlations were found using Spearman's correlation analysis among the five skeletal parameters.

In the Class I group, a statistically significant positive correlation was noted between MNG angle with ANB angle (r = 0.485) and a negative correlation with Beta angle (r = -0.649). Between the MNG angle, Yen angle (r = -0.421), and W angle (r = -0.350) a negative co-relation was noted but it was not statistically significant. (Table 4)

In the Class II group, a statistically significant positive co-relation of MNG angle with ANB angle (r = 0.599) and a negative correlation with Yen angle (r = -0.759) was found. MNG angle correlated negatively with Beta angle (r = -0.323), and W angle (r = -0.409) but this result was not statistically significant. (Table 4)

The Class III group showed a positive correlation between the MNG angle with ANB angle but the Beta angle, Yen angle, and W angle showed a negative correlation. However, the result was not statistically significant. (p-value ≥ 0.05) (Table 4)

7. Discussion

Much research has been done to establish the sagittal skeletal relationship (SSR) between the maxilla and mandible. Various linear and angular measurements have been introduced over the years for the same.

Reidel's ANB angle which has long since served as a benchmark for the assessment of SSR between maxilla and mandible has certain drawbacks.[2] It can be influenced by various factors like the age of the patient, rotation of the SN plane upwards or downwards, clockwise or anti-clockwise rotation of jaws, displacement of the nasion point, and the degree of facial prognathism. Thus, it can be misleading sometimes.[11]

Table 3: Mean values for MNG and the relationship between different malocclusion

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		P value
						Lower Bound	Upper Bound	
MNG	Class I	18	-1.22	3.964	.934	-3.19	.75	0.001
	Class II	18	3.11	2.826	.666	1.71	4.52	
	Class III	14	-6.00	1.519	.406	-6.88	-5.12	

Table 4: Correlations between different malocclusions

Group				MNG	ANB	BETA	YEN	W
Class I	Spearman's rho	MNG	Correlation Coefficient	1.000	.485*	-.649**	-.421	-.350
			Sig. (2-tailed)		.041	.004	.082	.154
			N	18	18	18	18	18
Class II	Spearman's rho	MNG	Correlation Coefficient	1.000	.599**	-.323	-.759**	-.409
			Sig. (2-tailed)		.009	.191	.000	.092
			N	18	18	18	18	18
Class III	Spearman's rho	MNG	Correlation Coefficient	1.000	.193	.029	-.279	-.317
			Sig. (2-tailed)		.509	.920	.334	.270
			N	14	14	14	14	14

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Witt's Appraisal as recommended by Jacobson, uses the functional occlusal plane rather than the cranial base to assess the skeletal mal-relationship extent.[12] However, mixed dentition period and ectopic eruption hamper proper identification of the functional occlusal plane which can in turn cause variations in Witt's measurement.[13–15]

Over time, various additional criteria have been introduced to assess the anteroposterior alignment of the maxillary and mandibular jaws to address the limitations of the ANB angle. These include parameters such as the Beta angle, Yen angle, W angle, and others.

Introduced by Baik and Ververidou in 2004, the Beta angle uses the condylar axis to measure the sagittal discrepancy of the jaws rather than the cranial base as a reference plane.[3] Although the Beta angle paints fairly reliable picture of the discrepancy in the sagittal plane, it utilizes points A and B which are relatively unstable. Also, reproducing the condylar axis accurately is questionable.

With the intent of overcoming the limitations of reproducing the condylar axis accurately, W and Yen angles were introduced. Both the measurements make use of Sella, M point, and G point which are considered to be stable landmarks. The W angle was introduced by Bhad W.A., Nayak S, and Doshi U.H. as a new method for assessing the sagittal skeletal discrepancy between the maxilla and the mandible.[5] Although W angle is considered to remain fairly stable even with hyperdivergent rotation of jaws, there is an inherent drawback. Similar to the Beta angle, it cannot determine whether the dysplasia is in the maxilla and mandible in Class II and Class III skeletal cases.

Doshi et al.[14] introduced the Yen angle and assessed its predictability. Comparison of Yen angle has been done with numerous parameters like ANB angle, A-B plane angle, APDI angle, AXD angle, AXB angle, PABA angle, FABA angle, , Beta angle, Wits Appraisal, to name a few. It has been identified as a highly dependable and uniformly distributed angular measurement for assessing sagittal jaw discrepancy.

Achint Chachada et al.[16] introduced the MKG angle to evaluate the maxillomandibular discrepancy in different malocclusions. However, as the Key Ridge, is a bilateral landmark, there may be increased chances of errors in identification and variability. Also, it can be difficult to locate in patients with facial asymmetry.

So for this study, points M and G were chosen over the key ridge (K) and points A and B due to the ease of location and a greater degree of reproducibility unlike the latter which can be susceptible to changes. According to the studies conducted by Nanda and Merill and Braun et al., the points M and G remain unchanged even when the jaw bases are rotated or when the mandible grows vertically.[8,9]

Significant difference was seen in the MNG angle for different skeletal patterns of the above-conducted study ($P < 0.001$). The mean value measured for skeletal Class I was -1.92° ± 3.9°, Class II was 3.1° ± 2.8°, and Class III was -6° ± 1.5°.In the original study by Rachit et al, the mean value for MNG angle in Class I subjects was found to be -1.86° ± 2.07° and for Class II subjects it was 4.44° ± 3.03°.3 Hence the current study values are in agreement with the above results. The findings of the present study for Class I and Class II groups were similar to the study conducted by Premkumar et al.[17] which was done in the South Indian population. In the Gujarati population there is no such previous study done to the best of the authors' knowledge.

8. Limitations

The limitations of this study are:

1. Determining the premaxilla necessitates obtaining high-quality radiographs.
2. In specific instances of a Class I skeletal base with a prominent chin (based on the ANB angle), the derived MNG was less than zero, creating a misconception of a Class III skeletal base.
3. This study does not consider the potential variation of MNG angle among the genders of the patients.
4. Small sample size and that the samples were collected only from one teaching facility. Therefore, research with an increased sample size would be needed to check the versatility of MNG angle in the near future.

9. Conclusion

The present study concludes that the MNG angle shows a significant difference in all three groups. In Class II subjects, MNG angle and Yen angle were found to be the most significantly different. However, between Class III and Class I subjects, the discretion of the MNG angle were found to be less.

There was a significant correlation of MNG angle with ANB and Beta angle for Class I subjects.

10. Source of Financial Support

None.

11. Conflict of Interest

None.

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