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Mahamad Irfanulla Khan
Dept of Orthodontics & Dentofacial Orthopedics

Praveen Kumar Neela
Dept. of Orthodontics & Dentofacial Orthopaedics

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A New Cephalometric Innovation for Assessing Vertical Skeletal Discrepancy: the MSG Angle

Abstract

Purpose: The aim of the study was to introduce a new cephalometric parameter, the MSG angle; and to assess the effectiveness of the MSG angle to diagnose the vertical skeletal discrepancy of the face.

Methods: One hundred and fifty pretreatment Lateral Cephalometric Radiographs (LCRs) of patients between 14 to 35years (Mean ± SD: 19.6 ± 4.93) were included. Based on the FMA, Sn-Go-Gn, and R - angle, all the LCRs were subdivided into three groups: low angle (28 female and 22 male); average angle (29 female and 21 male); and high angle (27 female and 23 male), with 50 samples in each group. The MSG angle was constructed using sella (S), M-point (centroid of the premaxilla), and G-point (centroid of the mandibular symphysis), and the center of angle is formed at the S point.

Results: The mean and standard deviation for the MSG angle were calculated in all three groups. The one-way analysis of variance (ANOVA) and Tukey post hoc test were used to determine whether there was a significant difference among the mean values of the MSG angle. The unpaired t-test showed no statistically significant differences in the mean values of the MSG angle between males and females.

Conclusions: The MSG angle was introduced to assess the vertical skeletal discrepancy. A new cephalometric parameter, the MSG angle between 21 to 24 degrees, indicates an average angle; an angle less than 21 degrees can be considered a low angle, and an angle greater than 24 degrees indicates a high angle.

Keywords

Cephalometry; Vertical skeletal discrepancy; Sella; M-point; G-point

ORIGINAL ARTICLE

A New Cephalometric Innovation for Assessing Vertical Skeletal Discrepancy: the MSG Angle

Mahamad I. Khan [a,*], Praveen K. Neela [b]

[a] Associate Professor, Department of Orthodontics & Dentofacial Orthopedics, The Oxford Dental College, Bangalore, India
[b] Professor & Head, Department of Orthodontics & Dentofacial Orthopaedics, Kamineni Institute of Dental Sciences, Narketpally, Andhra Pradesh, India

ABSTRACT

Purpose: **The aim of the study was to introduce a new cephalometric parameter, the MSG angle; and to assess the effectiveness of the MSG angle to diagnose the vertical skeletal discrepancy of the face.**

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Conclusions: **The MSG angle was introduced to assess the vertical skeletal discrepancy. A new cephalometric parameter, the MSG angle between 21 and 24°, indicates an average angle; an angle less than 21° can be considered a low angle, and an angle greater than 24° indicates a high angle.** ***Taiwanese Journal of Orthodontics 2022;34(3):122−126***

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INTRODUCTION

In orthodontic diagnosis, it is imperative to accurately evaluate the patient's facial skeletal pattern in sagittal, vertical, and transverse planes. Vertical growth of the face plays an important role in developing facial harmony.[1] Therefore, variation in vertical growth of the face has certain orthodontic implications, and as the vertical growth is last to end, the assessment of vertical facial discrepancy is critical for efficient treatment planning and maintaining post-treatment stability.[2]

With the introduction of lateral cephalometry into orthodontics, several cephalometric analyses are available to assess the vertical skeletal discrepancies.[3] The routinely used vertical dysplasia indicators are the Frankfort mandibular plane angle (FMA), Y-axis angle, SN-Go-Gn, facial axis angle, Jarabak's ratio, and recently introduced R angle (Figure 1). However, current literature reported that all these existing cephalometric parameters have some inadequacies.

The FMA[4] (angle formed between FH plane and mandibular plane) is not a very reliable parameter as the landmarks forming the Frankfort horizontal plane, the porion and the orbitale, are difficult to identify; and the mandibular plane (tangent to the lower border of the mandible) used in this analysis is not very reliable. Similarly, the Y-axis[5] (angle between S-Gn and FH plane) and SN-Go-Gn[6] (angle between SN plane and Steiner's mandibular plane) are inadequate to assess vertical dysplasia, as both the parameters depend on the location of

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* Address correspondence to Dr. Mahamad I. Khan: Department of Orthodontics & Dentofacial Orthopedics, The Oxford Dental College, Bangalore, India.
E-mail address: drirfankhanmds@gmail.com (M.I. Khan).

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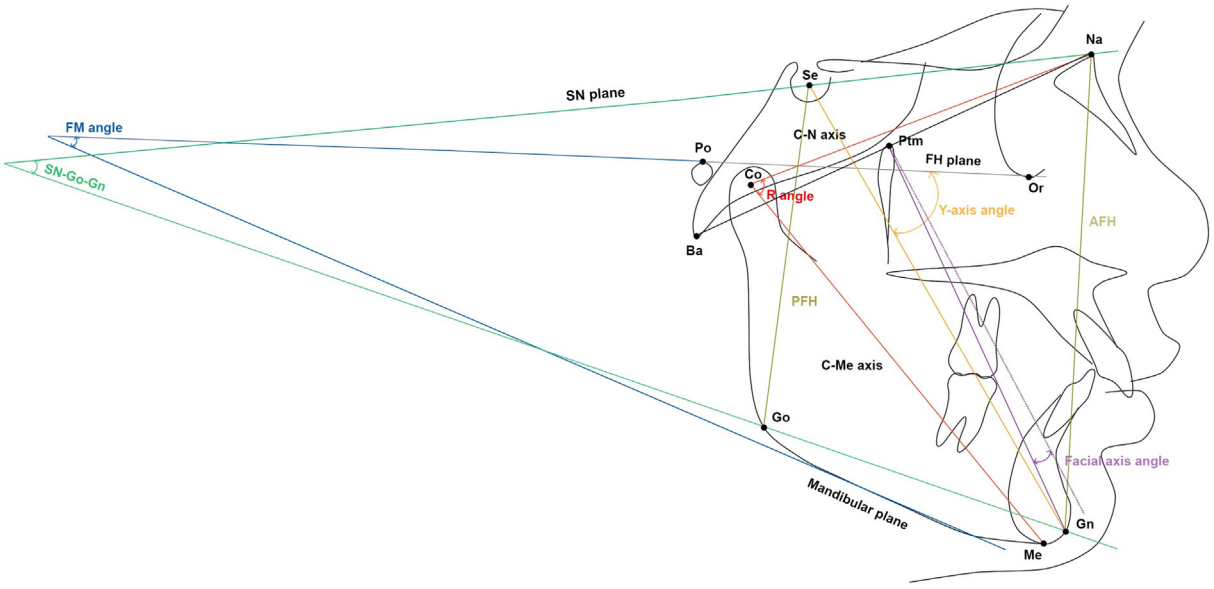

Figure 1. The cephalometric parameters to assess the vertical skeletal discrepancies.

gnathion (Gn), and it varies with the sagittal component of the malocclusion. Therefore, neither parameter is exceptionally reliable in assessing skeletal patterns in the vertical direction.

The identification of the facial axis angle[7] (angle between Ptm-Gn and a line perpendicular to basion-nasion) may not be consistent, because the pterygomaxillary fissure and basion points are less readily identified and depending on the position of the chin projection. Therefore, this angle is more suitable for assessing the orientation of the chin instead of the skeletal patterns.

Jarabak's ratio[8] is a linear cephalometric parameter to assess the vertical growth pattern. It is determined by posterior facial height (PFH)/anterior facial height (AFH) x 100. A 62−65% ratio indicates a well-balanced face, a ratio of less than 62% seen in high angle cases, whereas more than 65% is suggestive of low angle cases. However, Jarabak's ratio evaluates the ratio between anterior to posterior facial heights than truly assessing the vertical skeletal discrepancy.

Most recently the R-angle[9] (angle between nasion, center of the condyle, and menton) was introduced for assessing the vertical skeletal discrepancies. However, R-angle is affected by the anteroposterior position of nasion and difficulty in locating the center of the condyle and menton.

To overcome these inadequacies described above, a new cephalometric parameter, the MSG angle, is introduced to assess the vertical skeletal discrepancies. The aim of the study was to assess the effectiveness of the MSG angle to diagnose the vertical skeletal discrepancy of the face.

MATERIALS AND METHODS

The research was approved by the Institutional Ethics Committee of YDC (IEC No. 239/Vol-1/21). This study consisted of 150 pretreatment Lateral Cephalometric Radiographs (LCRs) of 14−35years (Mean ± SD: 19.6 ± 4.93) with no history of orthodontic treatment and any craniofacial anomalies. All the LCRs had been taken at the same Center with standardized techniques and apparatus (Proline Cephalostat, Planmeca, Finland). A single investigator traced the cephalograms on 0.003" acetate tracing paper, and FMA, Sn-Go-Gn, and R-angles were measured. Based on the above measurements, minimum of two of the three parameters (FMA, Sn-Go-Gn, and R-angle), all the LCRs were divided into three groups: low angle (28 female and 22 male), average angle (29 female and 21 male), and high angle (27 female and 23 male), with 50 samples in each group. The sample size was estimated using G* Power software (version 3.1, Universitat Dusseldorf, Germany). A total of 150 samples (50 in each group: low angle, average and high angle) were required for a statistical power of 80% and a significance level of 0.05.

The MSG angle

The following cephalometric points were used to construct the angle:

Sella (S): midpoint of the Sella turcica

Point-M: center of the premaxilla; determined by the center of the best-fit circle tangent to the anterior, superior, and palatal surfaces of the premaxilla.

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Point-G: center of the best-fit circle that is tangent to the internal inferior, anterior, and posterior surfaces of the mandibular symphysis.

Points M and G were located using a template containing several circles with different diameters. When S, M, and G-points are connected, the angle formed at the Sella point is the MSG angle (Figure 2).

The MSG angle was individually constructed and measured on all the lateral cephalograms randomly to avoid bias. The center of the Sella turcica, S-point, was eyeballed, Points M and G were located using a template containing several circles with different diameters increased in 1-mm increments. Each of the two points was identified by a pinhole in the center of the template. The point M was determined by the center of the largest best-fit circle tangent to the anterior, superior, and palatal surfaces of the premaxilla as described by Nanda and Merill,[10] whereas the point G was determined by the center of the largest best-fit circle tangent to the internal anterior, inferior, and posterior surfaces of the mandibular symphysis as described by Braun et al.[11]

METHOD ERROR EVALUATION

The method error was assessed by measuring all the lateral cephalograms twice at a two-week interval. The intra-examiner accuracy was measured using Dahlberg's formula, ME = $\sqrt{\sum d^2/2n}$, to calculate the difference (d) between the two measurements (n = the number of double measurements). The mean difference was within 0.6° and was insignificant.

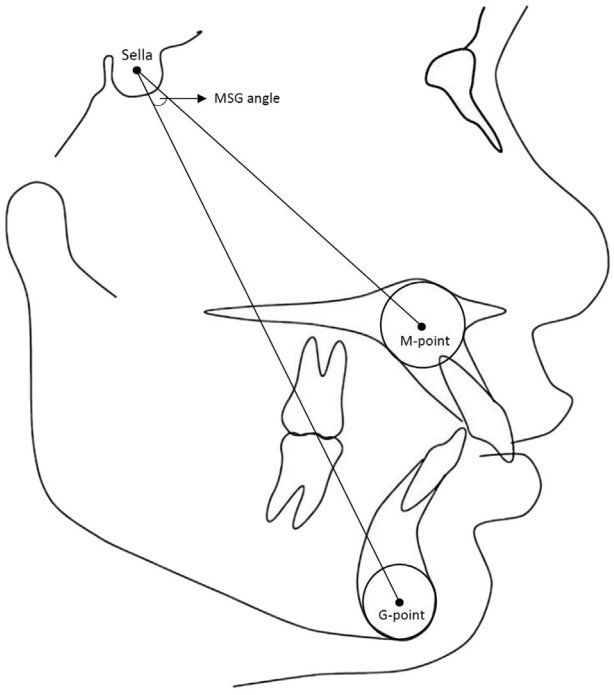

Figure 2. The MSG angle.

Statistical analysis

The data were analyzed using SPSS software version 20. (SPSS Inc., Chicago, IL, USA). The one-way analysis of variance (ANOVA) and Tukey post hoc test were used to determine whether there was a significant difference among the mean values of the angle MSG in all three groups. A p-value $\leq$ .05 was considered to be significant. Receiver operating characteristics (ROC) curves were used to examine the sensitivity and specificity of the angle MSG to discriminate among the low, average, and high angle groups. A p-value of $\leq$0.05 was considered statistically significant.

RESULTS

The mean value for the angle MSG in the low, average, and high angle groups shown in Table 1 and the new MSG angle were statistically significant. The ANOVA and the Tukey post hoc test showed that the MSG angle differed in all three groups. Unpaired t-test showed no statistical significant differences in the mean values of the MSG angle between males and females (Table 2).

ROC curves showed that MSG angle less than 21° had 88% sensitivity and 93% specificity for discriminating a low angle from the average angle group (Figure 3). The angle greater than 24° had 91% sensitivity and 89% specificity for discriminating a high angle group from an average angle group (Figure 4). Hence, any value less than 21° is considered a low angle, and a value greater than 24° is a high angle, while an angle between 21 and 24° is considered an average angle.

DISCUSSION

Vertical facial discrepancy assessment is critical for orthodontic diagnosis and treatment planning. The cephalometric parameters used to precisely and accurately measure true vertical relationships rely on the most stable, reliable, and reproducible cephalometric landmarks. Tweed[4] found that the vertical growth pattern of the individuals correlated with the stability of lower incisors after orthodontic treatment. Because the face's vertical growth is the last to complete, assessing vertical facial discrepancy is more important for accurate diagnosis and treatment planning, as well as preventing relapse after orthodontic treatment.

Table 1. Comparison of the MSG angle between low, average and high angle of the face.

	Skeletal pattern	n	Mean	SD	Min	Max	ANOVA	
							F	p-value
MSG angle	Low angle (°)	50	20.94	2.986	14	27	38.24	<0.001*
	Average angle (°)	50	23.02	2.272	18	29		
	High angle (°)	50	25.42	2.374	18	29		

*p < 0.001 − highly significant.

Numerous cephalometric analyses are available to assess the vertical skeletal discrepancies. However, these analyses have some drawbacks, such as identifying correct cephalometric landmarks and planes. The reliability and reproducibility also were essential factors of these various cephalometric parameters. Paranhos et al.,[12] reported that the Y-axis and SN-Go-Gn depend on the location of gnathion (Gn), which is not easily identified and varies with the sagittal component of the malocclusion. The FMA is unreliable, as landmarks used for the Frankfort Horizontal plane, the porion, and orbitale are difficult to identify. The mandibular plane used in this analysis is not very reliable.[13] So, they are inadequate to assess vertical skeletal discrepancy.

The facial axis angle indicates the chin position with respect to the cranial base rather than the true vertical skeletal pattern.[14] A literature study showed that Jarabak's ratio is a less reliable parameter for vertical growth patterns. In addition, the R angle is affected by the anteroposterior position of nasion and difficulty in locating the center of the condyle and menton.

To overcome the shortcomings of these vertical dysplasia indicators, the new angle MSG was developed. The advantages of the MSG angle are that it uses the Sella point, which is considered to be the most stable cephalometric landmark. Points-M and G are found to be superior to cephalometric points A and B because they do not vary due to remodeling caused by growth or orthodontic treatment.[10,11] The point M is the centroid of the premaxilla described by Nanda and Merill which indicates the growth vector for the maxilla. In contrast, point G is the centroid of the mandibular symphysis proposed by Braun et al. to describe the mandible growth vector. The centroid is the mean

Table 2. Mean (SD) values of the angle MSG in the low, average, and high angle groups according to the classification based on Sn-Go-Gn, FMA, and R-angle.

	Low angle (°)	Average angle (°)	High angle (°)
Male	20.3	23.1	25.2
Female	20.6	23.2	25.3
Total	20.9 (2.9)	23.02 (2.2)	25.4 (2.3)

SD: Standard deviation.

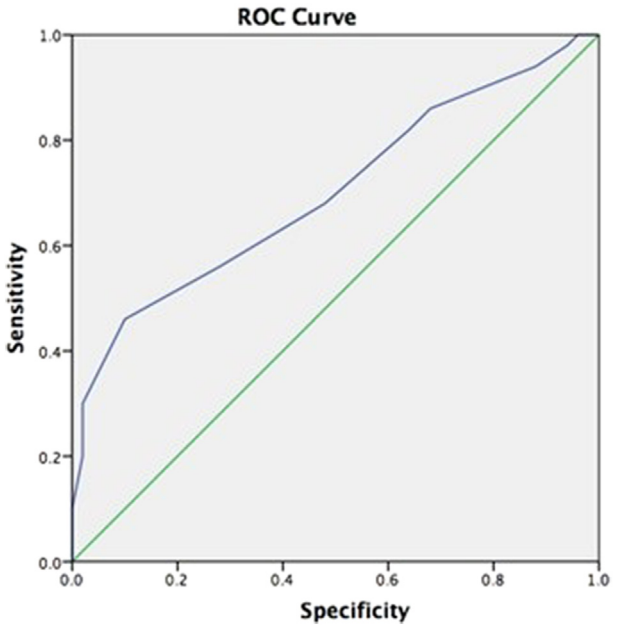

Figure 3. Using ROC curve to differentiate low angle versus average angle group.

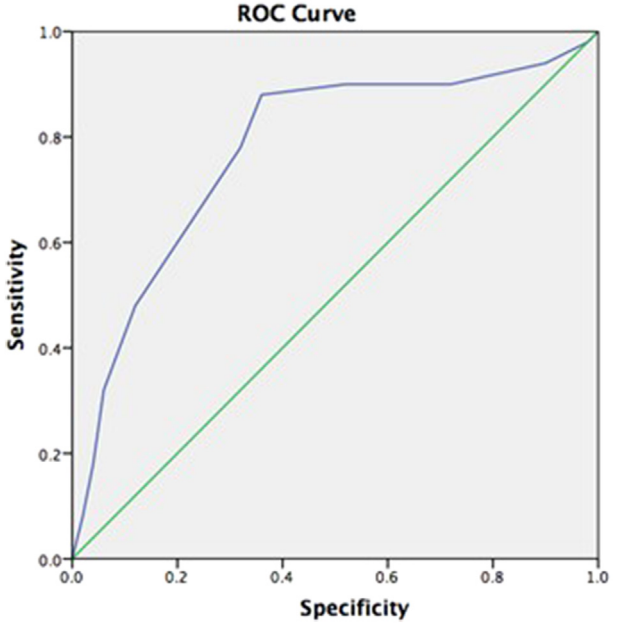

Figure 4. Using ROC curve to differentiate high angle versus average angle group.

point of a structure that varies the least compared to other structural points.[15] Therefore, identifying these cephalometric points will accurately assess the vertical skeletal discrepancy. The MSG angle uses the constructed cephalometric points that represent the true nature of the underlying skeletal pattern.

According to Braun et al.,[16] the growth vector for the maxilla and mandible using C- axis (point M) and G-axis (point G) respectively found that the average yearly growth increments were similar in both males and females. Hence, no statistically significant differences were found in the mean values of the MSG angle between males and females. This was mainly due to the constructive cephalometric points used in this study, and it also indicates the stability and reproducibility of these points during the active growth periods.

CONCLUSION

The MSG angle was developed to assess the vertical facial skeletal discrepancy. A new cephalometric parameter, the MSG angle between 21 and 24°, indicates an average angle; an angle less than 21° can be considered a low angle, and an angle greater than 24° indicates a high angle.

FUNDING

All authors declare that the study has received no financial support.

ETHICAL APPROVAL

The present research was approved by the Institutional Ethics Committee of YDC (IEC No. 239/Vol-1/21), India).

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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