ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 6, Issue – 2, March - 2023, Page No. : 254 - 263

MKG and Dr angle in orthodontic diagnosis - A cephalometric study

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Citation of this Article: Dr. Arulselvi. S, Dr. Nagarajan Sadhasivam, Dr. V. Vignesh Kumar, Dr. Kumaran. V, Dr. Karthi. M, "MKG and dr angle in orthodontic diagnosis - A cephalometric study", IJDSIR- March - 2023, Volume – 6, Issue - 2, P. No. 254 – 263.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aim: To evaluate the reliability of MKG angle and DR angle to determine the sagittal and vertical jaw relationship of the maxilla and mandible.

Materials and methods: A total of 156 pre-treatment lateral cephalograms were selected and segregated into classes I, II, and III based on WITS appraisal, ANB angle, Beta angle, W- angle and Yen angle.

MKG angle was constructed between the lines drawn from point M to point KR and point KR to point G. Then 156 pre-treatment cephalograms were categorised into Norm divergent, Hypo divergent and Hyper divergent based on Y-axis, facial axis, Go Gn-Sn, Jarabak ratio. The DR angle was measured between line drawn from point Co to point G and point Co and point M.

The MKG angle and DR angle were measure to calculate the mean and standard deviation.

Results: After using the one-way analysis of variance and running ROC curves, the results showed that MKG angle with the mean value of angle derived in Class I group was 54.82° ± 2.7°, in Class II skeletal pattern was 61.86° ± 3.73° and in Class III as 47.24° ± 4.09° and DR angle derived the normal range as Normo divergent DR value - 28.5°-32.5°, 32.5° for Hyperdivergent.

The MKG and DR angle which is consistent with the values obtained from the previous study.

Conclusion: MKG and DR angle can be used as an effective diagnostic tool.

Keywords: MKG angle, DR angle, sagittal discrepancy, vertical maxillomandibular relationship.

Introduction

Cephalometric analysis constitutes numerous landmarks, points and planes for measurements, which includes both linear and angular values. It plays the major role as the authentic diagnosis and it is crucial for successful planning of the treatment.

For proper diagnosis and planning the treatment mechanics, appraisal of the antero-posterior and vertical relationship between the maxillary and mandibular complex is of prime importance.

The relative size and Antero posterior positioning of the maxilla in relation to the craniofacial complex has been the one of the major problems. R.A. Riedel (1952) describe the anteroposterior relationship by utilizing Down's7 Point A, Point B and Nasion point provided the ANB angle, used to distinguish between different skeletal malocclusion.

In 1952 Cecil C. Steiner18 familiarized the ANB angle, which was the difference between the SNA and SNB angle with the mean ANB value of 2°. Shortcomings of ANB angle were overwhelmed by Jacobson11 with the WITS appraisal.

In 1976 Young H Kim devised Anteroposterior Dysplasia Indicator (APDI) and Seppo Jarvinen in 1981 insisted the usage of AXD angle and A-D' for measuring the AP discrepancies. Chong Yol Baik1 in 2004 flourished the Beta angle formed between A-B line, and a perpendicular from point A to C-B line. Neela et al in 200915 claimed an angle between SM and MG plane using the points S, M, G called YEN angle. In 2011 Wasundhara A. Bhad2 with co-workers refined the W angle utilizes the points S, M, and G and line connecting SM, MG, SG, line from M perpendicular to SG.

The angle formed between perpendicular from M to S-G. Throughout these years numerous authors described about countless methods of measuring the Antero posterior jaw relationship and proposed several linear and angular methods. Each and every method has its own virtues and faults.

In order to conquer all these approaches, MKG angle was promoted by Achint Chachada et al in 20205, which engages the more constant imprints which was free from cranium but constant in relation to growth such as key ridge KR, point G and M.

All these stable points are used in the assessment of the true anteroposterior discrepancy. Facial vertical growth pattern performs a crucial role in achieving facial balance.

Generally, treatment of these problems was advocated by functional jaw Orthopaedics in growing individuals and by orthognathic surgery in non-growing individuals. Down's Y axis7 expresses the direction of the growth, formed by the intersection of Sella-Gnathion/ Frankfort Horizontal plane bearing the average facial pattern of 59.4° with high angle shows values larger and low angle presents with lesser values. FMA19 formed by Frankfort Horizontal plane and mandibular plane with the average value of 25°.

Mandibular plane (Go-Gn) meets with the S-N plane and forms the Go Gn-SN angle of 32° seen on the well-balanced face. McNamara depicts the facial axis angle, which was the intersection of Basion-Nasion line (Ba-N) and Ptery go maxillary-Gnathion (Ptm-Gn) line with mean value of 90° indicates the Normo divergent individual.

Mc Namara depicts the facial axis angle, which was the intersection of Basion Nasion line (Ba-N) and Ptery go maxillary-Gnathion (Ptm-Gn) line with mean value of 90° indicates the Normo divergent individual. In 2013, Mohammed Rizwan and Rohan Mascarenhas 17 familiarized R angle was created using the landmarks such as Nasion (N), Center of the condyle (C), and Menton (Me).

These methods of measuring the vertical discrepancies have its own shortcomings. In order to overwhelm these, statistically and a clinically momentous new metric for evaluating skeletal pattern in the vertical direction has been developed.

The DR angle, Dhaval Ranjith Bhai Lekhadia12 with his associates in 2017 offered to judge the vertical jaw disagreements with the help of Center of condyle (Co), midpoint of premaxilla (M), Center of the largest circle of the mandibular symphysis G3 This angle molded between the two planes CM axis and CG axis. These steady points are used for weighing the jaw in consistencies in the vertical plane.

The intention of this study is to judge the sagittal and vertical jaw relationship with more humble, consistent and reproducible method. The MKG and DR angle makes sense to the statement, and makes the diagnosis and treatment planning clearer and easier. The purpose of the study is to evaluate the reliability of MKG angle and DR angle.

Materials and methods

This cross-sectional study was conducted using 180 pre-treatments lateral cephalograms obtained from patients who visited the Department of Orthodontics and Dentofacial Orthopaedics for orthodontic treatment. The Sirona Ortho Phos XG5 (Germany) 2009 AIR by Sirona dental system radiography equipment was used for captivating all the cephalograms. The radiographs were taken in the physiologic head position with patient standing upright and looking straight. The Cephalostat was used to clasp the head in the exact position and the red laser beam was projected on the ala-tragal plane parallel to the floor as shown. After careful examination, lateral cephalograms were chosen based on the following standards.

Inclusion Criteria

1) Patient exhibiting varying degrees of skeletal and Dentoalveolar malocclusion

2) Ideal lateral cephalogram

3) Good quality radiographs

Exclusion criteria

1) Congenital anomalies/ syndrome, marked asymmetries.

2) Orthodontically treated patients.

3) Blurred images and artifacts.

156 pre-treatments lateral cephalograms were fulfilled the inclusion criteria, were chosen for the investigation from a total of 180 pre-treatment cephalograms.

Methodology

Tracing method

A single-sided acetate matte finish tracing sheet fastened on the radiographic films which were placed on an A4 LED tracing screen for illumination. The 156- pre-treatment lateral cephalograms were traced manually by single investigator using 3H pencil and Ruler, followed by landmarks, lines, angles and planes were demarcated on cephalometric radiographs.

Cephalometric parameters such as ANB, Wits, Beta, Yen and W angle were used to identify the skeletal sagittal discrepancies and the growth pattern were assessed by Y-axis, facial axis, Jarabak ratio and Go Gn Sn. MKG angle (Fig.1) and DR angles (Fig.2) were traced and analysed to obtain the values.

Grouping for mkg angle

Grouping into the different skeletal pattern was based on the following cephalometric criteria

- Group A-Class I: ANB angle 1º–4º, WITS appraisal 0– 4 mm, and W angle 51º–56º, Yen angle117 º -123 º, Beta angle 27 º -35 º.
- Group B- Class II: ANB angle >4º, WITS appraisal > 4 mm, and W angle 51º, Yen angle <117 º, Beta angle<27 º.

Group C- Class III: ANB angle ≤0º, WITS appraisal < 0 mm, and W angle >56º, Yen angle >123 º, Beta angle >35 º.

Grouping for Dr angle

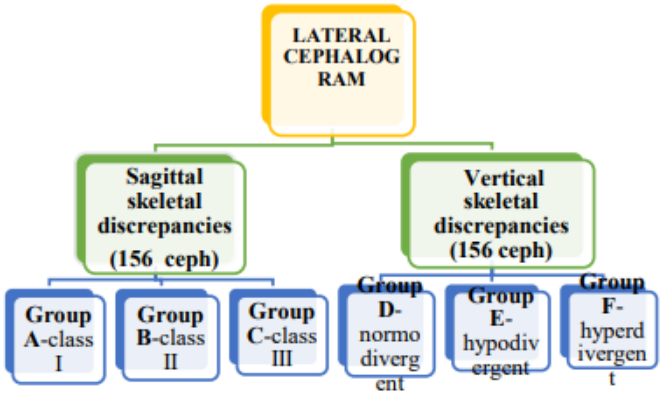
Categorising into different divergence pattern was depend on the following criteria such as

- Group D- Normo divergent: Y-axis 53-66 º, Facial axis 90º ±3 º, Jarabak ratio 60-65%, Go Gn-Sn 32 º±2
- Group E - Hypodivergent: Y-axis 93 º, Jarabak ratio >65%, Go Gn-Sn < 28º
- Group F Hyperdivergent Y-axis >66 º, Facial axis 32 º After segregation into different categories, there were 50 Class I patients who were grouped and the MKG and DR values were tabulated.
- There were 52 Class II patient with MKG and DR values that were tabulated separately. Finally, 54 subjects with Class III, whose MKG and DR values were also complied.
- The distribution of the pre-treatment lateral cephalograms based on their sagittal and vertical values are shown (Graph.1)

Fig 1: MKG angle

Fig 2: DR angle

Graph 1: The sample distribution among the various categories based on the sagittal and vertical relationship.



Results

Table I shows the mean value for the MKG angle in Class I skeletal pattern group is 54.82° ± 2.7°, with upper bound value of 54.05° and lower bound value of 55.59°. The Class II skeletal pattern shows the mean value of 61.87° ± 3.73°, with upper bound 60.83° and lower bound value of 62.9°.

The Class III skeletal pattern shows the mean value of 47.24° ± 4.09°, with upper bound 46.12° and lower bound as 48.36°. These values are calculated in the 95% confidence level.

Table 1: Mean and standard distribution of participants according to MKG calculated by ANOVA.

		N	Mean	SD	95% Confidence Interval	
					Upper bound	**Lower bound**
MKG angle	**Class I**	50	54.82	2.701	54.05	55.59
	Class II	52	61.87	3.73	60.83	62.90
	Class III	54	47.24	4.093	46.12	48.36

Table II shows the mean value for the DR angle in Normo divergent group was 31.60° ± 3.5°, with the confidence interval between 30.58° as the upper bound value and 32.62° as lower bound values.

The mean value for the DR angle in Hypodivergent was 33.15° ± 4.21°, having the upper bound value of 31.98° and lower bound value of 34.33° as the confidence interval.

The mean value for the DR angle in Hyperdivergent was 28.67° ± 3.7° shows the confidence interval of 27.66° as upper bound value and 29.68° as lower bound value. These values are calculated in 95% confidence interval.

Table 2: Mean and standard distribution of participants according to DR angle calculated by ANOVA.

	Facial growth pattern	N	Mean	SD	95% Confidence Interval	
					Upper bound	**Lower bound**
DR angle	Normodivergent	93	31.60	3.574	30.58	32.62
	Hypodivergent	36	33.15	4.212	31.98	34.33
	Hyperdivergent	27	28.67	3.701	27.66	29.68

On comparison of the mean values of 3 groups, conferring to MKG and DR angle, no statistically significant difference was obtained. Cut off values were ascertained by receiver operating characteristics (ROC) curves to differentiate between Class II and Class III from Class I MKG angle. The sensitivity and specificity of DR angle was examined by ROC curves.

Table 3 Represents the area under and coordinates of ROC curve to differentiate Class II from Class I MKG angle. The values clearly shows that an MKG angle less than 58.5° has 85.7% sensitivity and 67.4% specificity for different iating Class II from Class I group (Graph 2)

Graph 2: Differentiation of Class II from Class I ROC curve.

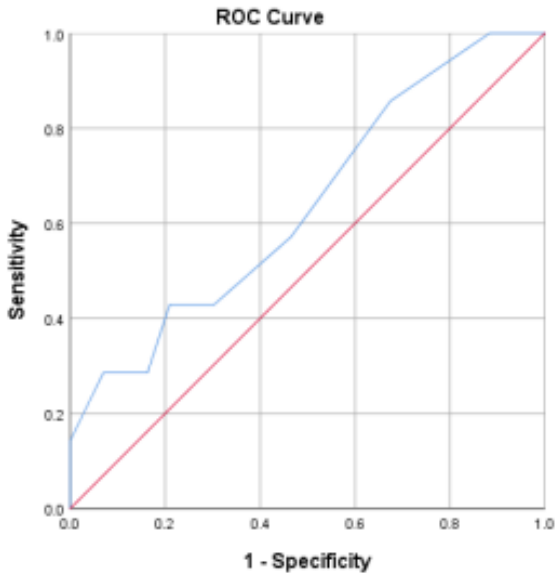


Table 3: Area under and coordinates of ROC curve to differentiate Class II from Class I MKG angle

	Area under the curve	Positive if less than or equal to	Sensitivity	Specificity
MKG angle	0.640	54.50	1.000	.953
		56.50	1.000	.907
		59.00	1.000	.884
		58.50	.857	.674

Table 4 Embodies the area under and coordinates of ROC curve to differentiate Class III from Class I MKG angle. The values of MKG angle more than 51.5° has 55.6% sensitivity and 36.6% specificity for differentia ting Class III from Class I group. (Graph 3)

Graph 3: Differentiation of Class III from Class I ROC curve.

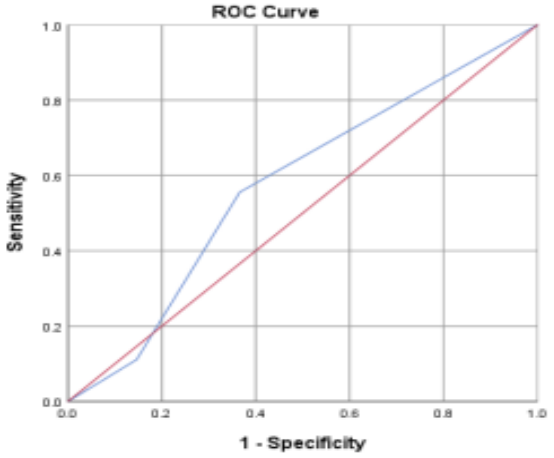


Table 4: Area under and coordinates of ROC curve to differentiate Class III from Class I MKG angle.

	Area under the curve	Positive if less than or equal to	Sensitivity	1 – Specificity
	0.575	-1.00	1.000	1.000
MKG angle		.50	.556	.366
		1.50	.111	.146
		3.00	.000	.000

Graph 4: Differentiation of Hypodivergent from Normo divergent ROC curve

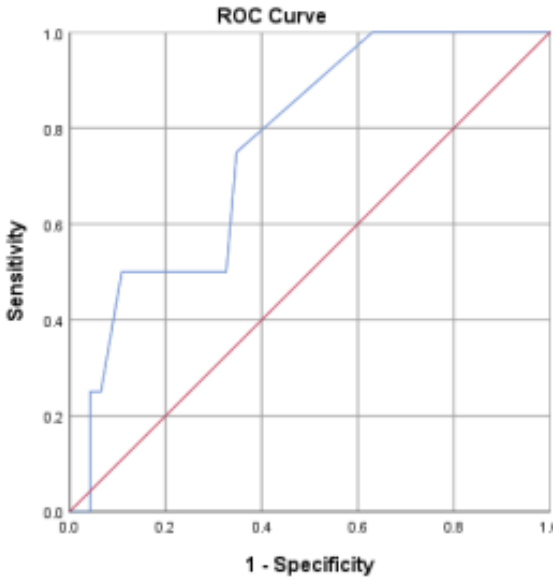


Table 5: Area under and coordinates of ROC curve to differentiate Hypodivergent from Normo divergent Dr angle

	Area under the curve	Positive if less than or equal to	Sensitivity	Specificity
DR angle	0.761	23.00	1.000	1.000
		26.00	1.000	.978
		28.50	0.973	.957
		29.50	0.910	.891

Cut off values were ascertained by receiver operating characteristics (ROC) curves to differentiate between Hypodivergent and Hyperdivergent from Normo divergent groups based on the DR angle. The sensitivity and specificity of DR angle was examined by ROC curves.

Table V: Represents the area under and coordinates of ROC curve to differentiate Hypodivergent from Normo divergent DR angle. This shows that a DR angle less than 28.5° has 97.3% sensitivity and 95.7% specificity

for differentiating Hypodivergent from Normo divergent group (Graph 4).

Table 6: Clearly defines area under and coordinates of ROC curve to differentiate Hyperdivergent from Normo divergent group. The receiver -operator curve shows that the DR angle more than 32.5° has 97% sensitivity and 88.5% specificity for differentiating Hyperdivergent from Normo divergent group. (Graph 5)

Graph 5: Differentiation of Hyperdivergent from Normo divergent ROC curve

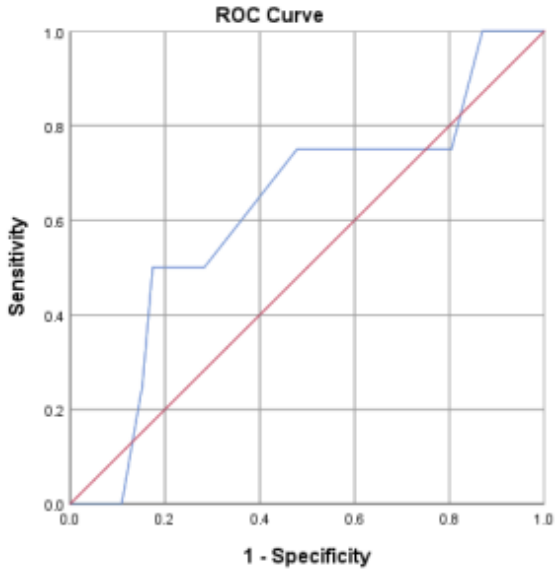


Table 6: Area under and coordinates of ROC curve to differentiate Hyperdivergent from Normo divergent Dr angle

	Area under the curve	Positive if less than or equal to	Sensitivity	Specificity
DR angle	0.622	28.50	1.000	.981
		29.50	1.000	.962
		30.50	1.000	.942
		31.50	1.000	.923
		32.50	.970	.885
		33.50	.933	.808

Discussion

Successful attainment of orthodontic diagnosis and planning of the treatment mechanics, and measurement of sagittal and vertical jaw relationship is critically important. For analyzing the lateral cephalograms both linear and angular measurements have been proposed to evaluate the sagittal and vertical jaw relationship. For establishing the sagittal jaw discrepancy, the ANB angle was used prevalently8.

ANB angle was altered by changes in the corresponding position of one or more of its 3 points, particularly Nasion point, (Charles M. Taylor) which is not a constant point, so that any variation in this point will in turn affect the amount of jaw discrepancy. Diverse factors affecting the ANB angle are 1) rotation of the jaws due to growth, 2) vertical growth in point A and point B, 3) vertical growth between Nasion and point B10.

Most familiar alternative was the Wits appraisal, it has difficulty in identifying the functional occlusal plane, particularly during the mixed dentition. Any changes in the Wits measurement all over treatment might be replicated in the functional occlusal plane rather than changes in the sagittal plane of the jaw. Beta angle exploits the point A and point B which can be modified by the orthodontic treatment and growth. Another method of measuring the anteroposterior jaw dysplasia is the YEN angle15, measures the angle between SM and MG, rotation of jaw due to growth or orthodontic treatment can mask the true jaw dysplasia. Added to this, W angle was constructed from the point S, M and G, it depends on midpoint of Sella turcica (point S), which is not a constant landmark proven by many studies.

The MKG angle5 relies on constant landmarks and not rest on the functional occlusal plane. It uses the three stable points KR, M and G. Unlike point A and Point B,

these points were unaffected by local remodelling secondary to dental movements. Growth vector of maxilla and mandible can be calculated by Point M and G correspondingly this itself states the stability of these points during active growth periods in maxilla and mandible. The point KR, the malar region of the maxilla and the forward part of the zygoma altered in concurrence with the adjoining maxillary complex and their respective manners of growth are comparable20.

In 1948, to evaluate the mandibular divergence pattern Frankfort horizontal (FH) plane was employed as the orientation line to establish the Y axis using the points Po Or and S-Gn on the cephalograms(down,1948)19. Inadequacy of Y axis was found by Schudy (1964), as they had to alter the Y-axis to account for varying location of Gn47. Same way, FMA angle was emphasized by Tweed by indulging the FH plane and mandibular plane (Go-Me) 56. FH plane was established in 1884 using the point Porion (Po) and Orbitale (Or), delineating the Po point could be misleading. Cecil C. Steiner18, he developed the mandibular plane angle to measure the vertical jaw difference by using the points Go, Gn, S and N. It has been shown that vertical orientation of the SN alters the features accompanying the points S and N. Linear metrics, such as Jarabak ratio, facial height ratio was established to examine the vertical development of an individual. Facial height ratio is the proportion of LAFH: TAFH, whereas Jarabak ratio is the proportion of PFH: AFH. More commonly, the anterior to posterior ratios were employed to assess the facial proportions then the divergence.

The Facial axis given by McNamara, which employed the points Ba, N, Ptm and Gn. Basion and Pterygomaxillary points were not much readily identified, that makes these points less consistent. Rizwan and Rohan in 2013 established the R angle, Nasion was an unstable point, any dissimilarity in this point will in turn disturb the volume of jaw discrepancy. DR angle was raised by employing the point C, point M and point G; the angle created at point C between CM and CG axis. The point C is the most promising marker in the posterior part of the face; however, the condyle continues to enlarge, it is less influenced by growth and transformation changes. It is an eminent landmark that makes easy to find and trustworthy. Growth increments occurring G-axis and C-axis was not statistically significant4.

It clearly shows that the changes happened at the point M and G were replicated only within the jaws. The present study conducted on 156 lateral cephalograms were clustered into Class I, Class II and Class III based on the their ANB, Wit's, Beta, W- angle and Yen angle. The mean value for MKG angle derived in Class I group was 54.82° ± 2.7°, in Class II skeletal pattern was 61.86° ± 3.73° and in Class III as 47.24° ± 4.09° which is consistent with the values obtained from the previous study.

Current study included 156 participants, and were grouped into Normo divergent, Hypodivergent and Hyperdivergent individuals based on Y-axis, facial axis, Jarabak ratio, Go Gn-Sn. The results obtained as follows, Normo divergent is 31.6°+3.5°, for Hyperdivergent as 33.15°+4.21°, and as Hypodivergent 28.67°+3.7°. These results are stable.

Conclusion

This study evaluated the reliability of MKG and DR angle for assessing the sagittal and vertical jaw relationship correspondingly.

Thus, this study concluded as follows,

➢ The MKG angle with Class I skeletal pattern group has the values 54.82° ± 2.7°, for Class II skeletal pattern

was 61.87° ± 3.73° and in Class III skeletal pattern 47.24° ± 4.09°.

➢ The DR angle in Class I skeletal pattern group was 31.60° ± 3.5°, Class II skeletal pattern was 33.15° ± 4.21° and in Class III skeletal pattern 28.67° ± 3.7°.

➢ MKG and DR angle can be used as an effective diagnostic tool.

The study depicts that MKG and DR angle could be efficiently used in the diagnosis of sagittal and vertical skeletal jaw discrepancies. They are the eminent marker for establishing the true skeletal deformities.

Limitations

This study was done in smaller population size and the sexual difference among them was not assessed, as the values might change for different sexes. And the study population confined to particular region, it might show racial differences. The entire study depends on the manual tracing and assessment, with the advent of technology digital methods for locating the landmarks would help us to depict more precise values.

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