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International Journal of Oral Health Dentistry

Journal homepage: www.ijohd.org

Original Research Article

The maxillary-mandibular planes angle (MM⁰) bisector: A new reference plane for anteroposterior measurement of dental bases

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ARTICLE INFO

Article history:

Received 01-02-2022

Accepted 06-03-2022

Available online 23-03-2022

Keywords:

Bisecting occlusal plane

Functional occlusal plane

Maxillomandibular planes angle

ABSTRACT

Introduction: Diagnosis of an important part of orthodontic treatment. Although many cephalometric analyses have been devised to determine the degree of anteroposterior skeletal discrepancies, effective treatment planning and assessment must be based on accurate measurement using stable and reproducible reference planes.¹

Aim: The purpose of study was to evaluate the clinical usefulness of maxillomandibular bisector, its reproducibility, and validity, and relationship to functional occlusal plane, bisecting occlusal plane.¹

Materials and Methods: Pre-treatment lateral cephalograms of 30 adult patients (age 18 or above) were selected. Various Angular & Linear measurement were recorded.

Result: Present study showed MM bisector plane, FOPPM is more reproducible and valid reference point than BOPMM, BOPPM.

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1. Introduction

The goal of orthodontic treatment is to improve the patient's life by enhancing dentofacial esthetics and function. Diagnosis of an important part of orthodontic treatment and the greatest thrust in this direction evolved with advent of radiographic cephalometry by Broadbent in 1931.^{1,2} Although many cephalometric analysis have been devised to determine the degree of anteroposterior skeletal discrepancies, effective treatment planning and assessment must be based on accurate measurement using stable and reproducible reference planes. Despite the popularity of the ANB angle,¹ Jacobson³ noted that this measurement does not always accurately relate the true anteroposterior relationship of the jaws.³ Jenkins⁴ and Harvold⁵ used the functional occlusal plane (FOP) as suitable reference plane

for anteroposterior jaw disharmony assessment, Jacobson A. (2003)³ suggested using the Wits appraisal to exclude the problems of a cranial base references which involves drawing perpendiculars from point A and B on the maxilla and mandible respectively, for the functional occlusal plane.³ The idea of an occlusal plane substitute, though arrived at independently, was originally suggested by Jenkins,⁴ who used the bisector of the FM angle. However, he related his plane to the cranial base for subsequent measurement and so incurred inaccuracies when the cranial base was abnormally related to the dental bases.⁴ The purpose of this study was to analyze the clinical usefulness of the MM bisector, looking at its reproducibility, its relationship to the other occlusal planes, the nature of its cant measured to the PM vertical, and finally to present mean values for A point with respect to B point measured to it, by using the Wits technique. Thayar TA (1990)⁶

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compared Wits values measured to three different occlusal planes, FOP, the bisecting occlusal plane (BOP), and the lower incisor occlusal plane (LIP), and found different values for each of the different planes and recommended that workers stay with the plane initially selected.⁵ The need still remains for the AP jaw measurement to be made close to the dental bases, but preferably to a plane that is easily defined at all times. A plane whose cant will not change with growth or, if it does, will change in harmony with dental base change and so will not distort the true relationship between A and B points. It is proposed that the bisector of the maxillary (palatal) mandibular planes angle be used for this purpose, the MM^o bisector. The plane is geometrically derived from the dental base planes, shown to be highly reproducible.

2. Aim and Objectives

To evaluate the reliability and validity of anteroposterior skeletal measurement using the maxillomandibular angles bisector, FOP and BOP in Distt. Solan population.

3. Materials and Methods

Pretreatment lateral cephalograms of 60 adult patients (age 18 or above) with dental Class I malocclusion were selected who reported to the Department of Orthodontics and Dentofacial Orthopedics, Bhojia Dental College and Hospital, Vill. Bhud, Baddi, Distt. Solan, H.P for fixed orthodontic treatment. The sample was divided into 2 groups, group I (males, N=30) and group II (females, N=30).

Table 1: Grouping of sample

Group I	Group II
Males (N=30)	Females (N=30)

3.1. Methodology

All the cephalograms were traced by the same operator manually. All the landmarks (Table 2 Figure 1) and planes (Table 3, Figure 2) were identified and marked. Various cephalometric points (Table 4, Figure 3) were marked to measure angular and linear measurements.

3.2. Statistical analysis

The values so obtained were subjected to SPSS software. Mean and standard deviations were calculated. The means of the parameters were analysed by comparing the two-group using student t test. Level of significance was set as ($p < 0.00$).

Table 2: Cephalometric Landmarks used in the study¹

Landmarks	Definitions
Sella	The geometric centre of the pituitary fossa.
Nasion	The most anterior point on the frontonasal suture in the mid saggital plane.
Orbitale	It is deepest point on the infraorbital margin.
Posterior nasal spine (PNS)	The posterior spine of the palatine bone constituting the hard palate.
Anterior nasal spine (ANS)	The most anterior point on anterior nasal spine.
Point A	Deepest bony point on contour of premaxilla below ANS.
Point B	Deepest bony point on contour of mandible above the pogonion.
Gonion	Most posterior inferior point of angle of mandible.
Menton	Most inferior point in the symphysis.
Pterygomaxillary fissure (PTM)	Formed anteriorly by retromolar tuberosity of maxilla and posterior by the anterior curve of pterygoid process of sphenoid bone.

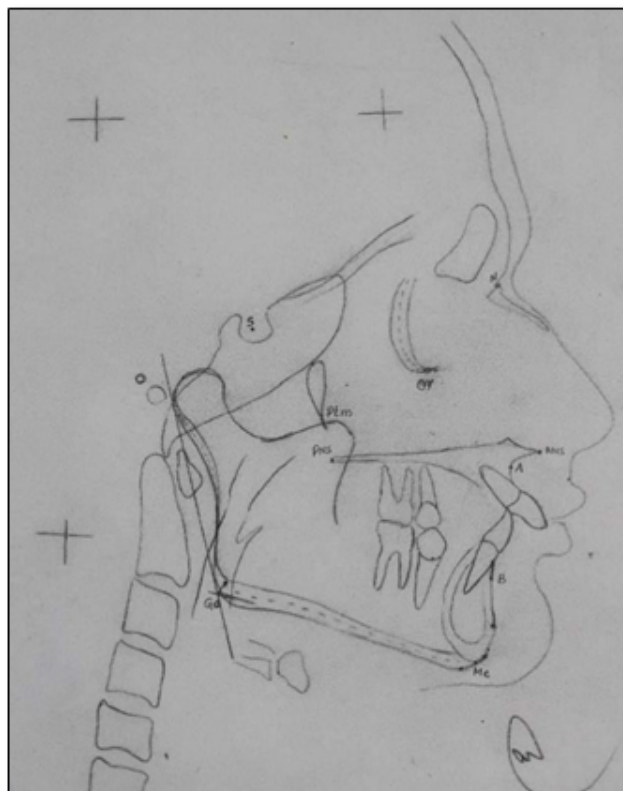


Fig. 1: Cephalometric landmarks used in the study

Table 3: Cephalometric planes used in the study¹

Planes	Definitions
Maxillary Plane	Line joining Anterior nasal spine to Posterior nasal spine (ANS-PNS)
Mandibular Plane	Line joining Menton (Me) to Gonion (Go).
Functional Occlusal Plane (FOP)	A plane bisecting the molar and premolar overbite, excluding the incisors in adult dentition.
Bisecting Occlusal Plane (BOP)	A plane bisecting molar and incisor overbite.
SN	Line joining Sella (s) to Nasion (N).
NA	Line joining Nasion point to point A.
NB	Line joining Nasion point to point B.

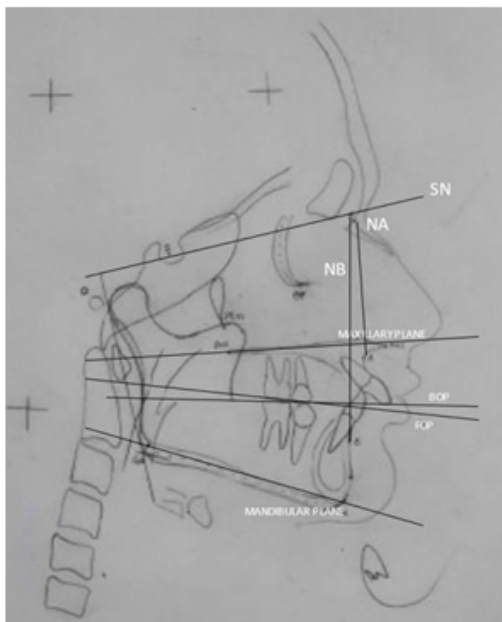


Fig. 2: Cephalometric planes used in the study

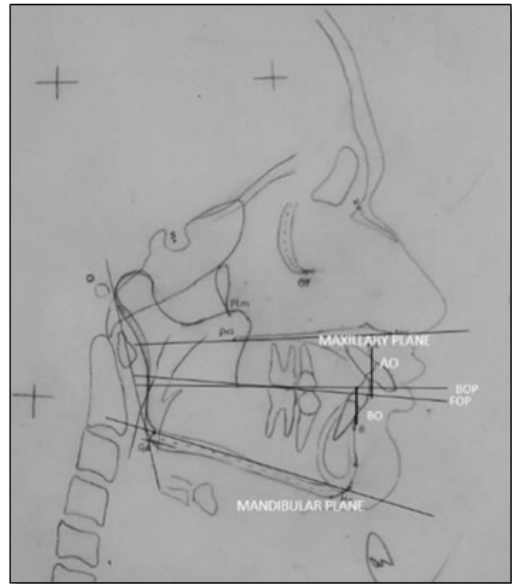


Fig. 3: Cephalometric points to measure linear and angular measurements

Table 5: Angular measurements

Parameter	Definition
ANB	Angle between Nasion-A point plane and Nasion-B point plane.
MM	The MM bisector which is constructed by bisecting the anterior angle formed by intersection of the maxillary and mandibular planes.
FOP-PM	Angle between the line bisecting the molars and premolar to pterygoid vertical plane.
BOP-PM	Angle between the line bisecting through overlap of permanent first molar and incisor to pterygoid vertical plane.
MM-PM	Angle between the line bisecting the maxillomandibular plane to pterygoid vertical plane.
FOP-MM	Angle between the line bisecting the molars and premolar to maxillomandibular plane.
BOP-MM	Angle between the line bisecting through overlap of permanent first molar and maxillomanibular plane.

Table 4: Cephalometric points used in the study

Points	Definitions
AO	Point A projected in perpendicular on functional occlusal plane.
BO	Point B projected in perpendicular on the functional occlusal plane.
Am	Point A projected in perpendicular on the MM bisector.
Bm	Point B projected in perpendicular on the MM bisector.
Ab	Point A projected in perpendicular on the bisecting occlusal plane.
Bb	Point B projected in perpendicular on the bisecting occlusal plane.

Table 6: Linear measurements

Parameters	Definition
AB-FOP	Distance between point A and point B perpendicular to FOP line
AB-BOP	Distance between point A and point B perpendicular to BOP line
AB-MM	Distance between point A and point B perpendicular to MM line.

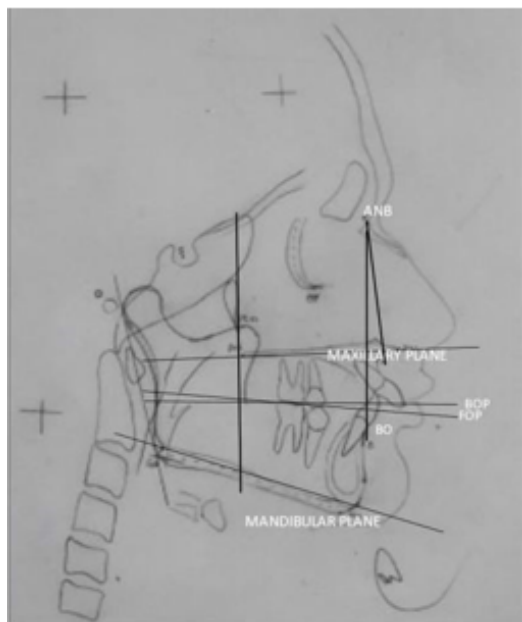


Fig. 4: Angular measurements

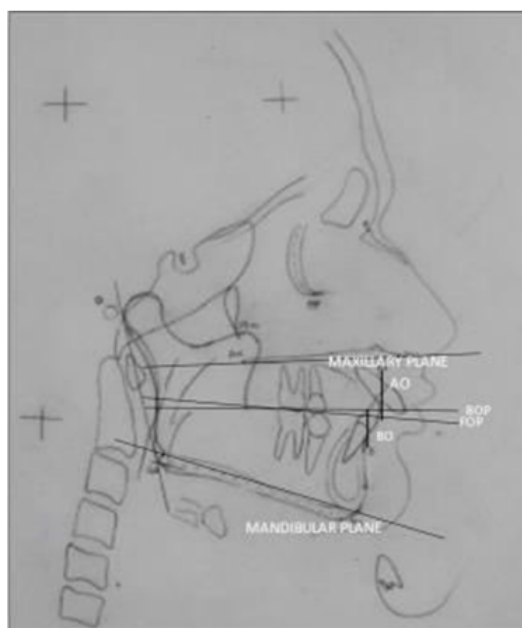


Fig. 5: Linear measurements

4. Results

60 pre-treatment lateral cephalograms of adult patients aged 18 or above with dental Class I malocclusion were selected. The sample was divided into 2 groups as Group I (Males, N=30) and Group II (Females, N=30). Various angular and linear measurements were recorded for both the groups. The values thus obtained were subjected to statistical analysis. The descriptive statistics and comparison for angular and

linear parameters for males and females were depicted in (Table 7).

The results shows that the mean value of ANB in male (3.43 ± 1.54) is decreased than in female (3.83 ± 1.64) and was found to be statistically non-significant ($p=0.35$). Maxillomandibular bisector (MM) mean value for the male (10.43 ± 3.22) is decreased than in female (11.90 ± 3.39) and was found to be statistically highly significant ($p=0.09^*$). Maxillomandibular bisector to PM vertical (MM-PM) in males (97.46 ± 4.51) is decreased than in females (97.60 ± 5.16) and was found to be statistically non-significant ($P=0.91$). Functional occlusion plane to PM vertical (FOP-PM) in male (90.86 ± 3.07) is decreased than in female (94.90 ± 4.02) and was found to be statistically non-significant ($p=0.00$). Bisecting occlusion plane to PM vertical (BOP-PM) in males (90.53 ± 6.53) is decreased than in females (91.30 ± 4.88) and was found to be statistically non-significant ($P=0.6$). Functional occlusal plane to maxillomandibular bisector (FOP-MM) in male (7.40 ± 3.17) is increased than in female (5.80 ± 2.85) and was found to be statistically significant ($p=0.04$). Bisecting occlusal plane to maxillomandibular bisector (BOP-MM) in male (8.93 ± 4.25) is decreased than in female (9.26 ± 3.06) and was found to be statistically significant ($P=0.72$). Among the linear measurements it was found that AB-FOP in male (2.83 ± 2.13) is increased than in females (2.23 ± 1.88) and was found to be statistically non-significant ($P=0.25$). AB-BOP in male (3.00 ± 1.80) mean value is equal and standard deviation is increased than in females (3.00 ± 2.13) and was found to be statistically non-significant ($P=1.00$). AB-MM in males (3.11 ± 2.49) is increase than in females (2.78 ± 2.39) and was found to be statistically non-significant ($p=0.59$).

5. Discussion

The goal of orthodontic treatment is to improve the patient's life by enhancing dentofacial esthetics and function. To achieve this goal proper diagnosis is necessary. Lateral cephalometric analysis has been devised to determine the degree of anteroposterior or vertical skeletal discrepancies. Its assessment must be based on accurate measurement using stable and reproducible reference planes. Very few attempts have been made to develop an analysis of anteroposterior jaw relationship to reduce these problems. Thus, the aim of the present study was to evaluate the reliability and validity of anteroposterior skeletal measurement using the maxillomandibular bisector angle (MM), FOP and BOP in Distt Solan population.

Pretreatment lateral cephalograms of 60 adult patients (age 18 or above) with dental Class I malocclusion were selected. The sample was divided into 2 groups as Group I (males, N=30) and Group II (females, N=30). Various angular and linear measurements were calculated.

Table 7: Descriptive statistics and comparison between males and females

Parameters	Gender	Mean (\pm SD)	T Value	F Value	P Value (2-Tailed)
ANB	Male	3.43 (\pm 1.54)	-.971	.055	0.35
	Female	3.83 (\pm 1.64)			
MM	Male	10.43(\pm 3.22)	-1.715	.061	0.09*
	Female	11.90(\pm 3.39)			
MM-PM	Male	97.46 (\pm 4.51)	-.106	.134	0.91
	Female	97.60 (\pm 5.16)			
FOP-PM	Male	90.86 (\pm 3.07)	-3.922	6.895	0.00*
	Female	94.90 (\pm 4.02)			
BOP-PM	Male	90.53 (\pm 6.53)	1.079	-.527	0.60
	Female	91.30(\pm 4.88)			
FOP-MM	Male	7.40 (\pm 3.17)	2.050	.356	0.04*
	Female	5.80 (\pm 2.85)			
BOP-MM	Male	8.93 (\pm 4.25)	.638	-.349	0.72
	Female	9.26 (\pm 3.06)			
AB-FOP	Male	2.83 (\pm 2.13)	1.153	.125	0.25
	Female	2.23 (\pm 1.88)			
AB-BOP	Male	3.00 (\pm 1.80)	.000	.738	1.00
	Female	3.00 (\pm 2.13)			
AB-MM	Male	3.11 (\pm 2.49)	.528,008	.008	0.59
	Female	2.78 (\pm 2.39)			

When the males and females were compared it was found that MM.

($P < 0.09$), FOP-PM ($P < 0.00$), FOP-MM ($P < 0.04$) were statistically significant. Whereas ANB ($P < 0.35$), AB-FOP ($P < 0.25$), AB-BOP ($P < 1.00$), AB-MM ($P < 0.59$), BOP-PM ($P < 0.60$), BOP-MM ($P < 0.72$) were found to be non-significant. The present study shows slight increase in the angle between the maxillomandibular bisector (MM) and the functional occlusal plane (FOP) which is statistically significant, similar to that found by Jarvinen S. (1985),⁷ Foley, Stirling(1997).⁸ This implies a change in the cant of the FOP. Since the accuracies of the anteroposterior measurements are directly affected by their reference planes, using the more reliable MM bisector should show the least amount of measurement error, whereas use of the FOP should show the greatest amount of error.⁸ Sherman SL, Woods HL⁹ found a study designed to test the reliability of the FOP and BOP and the MM Bisector showed the MM Bisector to be more reproducible as it showed two-thirds of the error seen with BOP and about half the error seen with FOP. Because the accuracies of the anteroposterior measurements are directly affected by their reference planes, using the more reliable MM bisector should show the least amount of measurement error, whereas use of the FOP should show the greatest amount of error. The study is similar to present study. Samir E Bishara (1983)¹⁰ found no significant differences between male and female subjects for ANB because ANB angle changes significantly with age, while the Wits appraisal indicates that the relationship between points A and B does not change significantly with age. This study is in concordance to our study.

Hall-Scott J. (1994)¹¹ found that the MM angle Bisector provides a valid, reliable method of anteroposterior jaw measurement that enhances the Wits' appraisal measured to occlusal planes. Because of the downward cant of this plane anteriorly, B is projected ahead of A for normal occlusion, resulting in a negative value. This study is in concordance to our study. Scott JH,¹¹ Ganiger RC (2012)¹ found that AB-MM is more reliable because the MM bisector is highest stable plane with the relation of cranial base. It is recommended that the orthodontist can use AB-MM parameter for judging the antero-posterior skeletal discrepancy with better accuracy and validity than its contemporary parameters. Whereas in the present study AB-MM is statistically non-significant. Urban H et al. (2008)¹² found that the anteroposterior relationship of the dental arch and jaw-base fail to match in at least one out of every three individuals and that linear measurement of anteroposterior jaw-base relationships is a more valid reflection of the dental arch relationship than angular measurements. In the present study the MM^o shows statistically significant result. Sherman's et al (1988)⁹ found that MM-PM angle did not show any significant difference between male and female group.

The maxillomandibular bisector angle measured to PM vertical showed that angle moved downward and backward with the age which reflects the direction and the amount of total growth rotation of the dental alveolar complex. Thus present study is similar to this study. Studies by Freeman,¹³ Taylor,¹⁴ and Jacobson³ reiterate that angle ANB is not a reliable basis for identifying unharmonious jaw relationships. Jacobson³ presented a Wits appraisal

based upon the relationships of points A and B relative to the occlusal plane which was not in concordance with our study. Bagga DK (2013)¹⁵ did a cephalometric study of various horizontal reference planes in natural head position and found that MM bisector was not that reliable horizontal reference plane. This result is concomitant with our study.

6. Conclusion

1. In the present study, MM, FOP-MM, FOP-PM are statistically significant whereas ANB, MM-PM, BOP-PM, BOP-MM, AB-FOP, AB-BOP, AB-MM are statistically non-significant.
2. The mean values of angular measurements is greater in females whereas linear measurements is greater in males.
3. The MM bisector provides a more reproducible and valid indicator of the skeletal anteroposterior relationships of the jaws, especially during treatment, than the Wits appraisals made with either the FOP or BOP and is a useful adjunct to the cephalometric assessment of a patient.

7. Source of Funding

None.

8. Conflict of Interest

The authors declare no conflict of interest.

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Cite this article: Aggarwal I, Akram W, Mittal S, Palkit T, Merry, Avasthi A. The maxillary-mandibular planes angle (MM^o) bisector: A new reference plane for anteroposterior measurement of dental bases. *Int J Oral Health Dent* 2022;8(1):41-46.