10.5005/jp-journals-10024-1182
ORIGINAL RESEARCH

Maxillomandibular Plane Angle Bisector (MM) Adjunctive to Occlusal Plane to evaluate Anteroposterior Measurement of Dental Base

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ABSTRACT

Aim: This study was undertaken to analyze the clinical usefulness of the maxillomandibular bisector, its reproducibility, its validity and its relationship to the functional occlusal plane, the bisecting occlusal plane and the nature of its cant.

Materials and methods: Thirty pretreatment lateral cephalograms, each of adolescents (above 18 years of age) and children (10-12 years), seeking orthodontic treatment were randomly selected and the Wits technique of anteroposterior measurement was used to compare A-B values measured to the new plane with those measured to the functional occlusal plane (FOP) and to the traditional or bisecting occlusal plane (BOP).

Results: Present study showed that MM bisector plane is more reproducible and valid reference plane, than the FOP and BOP.

Conclusion: A new plane, geometrically derived from the dental base planes, has been tested as an occlusal plane substitute for the measurement of anteroposterior jaw relationships. It lies close to but at an angle and inferior to the traditional occlusal planes and is highly reproducible at all times.

Clinical significance: Maxillomandibular planes angle bisector may be a useful adjunct for the cephalometric assessment of sagittal relationship of the patient.

Keywords: Point A, point B, Bisecting occlusal plane, Functional occlusal plane, Maxillomandibular planes angle.

How to cite this article: Ganiger CR, Nayak USK, Cariappa KU, Ahammed ARY. Maxillomandibular Plane Angle Bisector (MM) Adjunctive to Occlusal Plane to evaluate Anteroposterior Measurement of Dental Base. J Contemp Dent Pract 2012; 13(4):539-544.

Source of support: Nil

Conflict of interest: None declared

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 in 1931 by Broadbent.[1] 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[2] angle, Jacobson noted that this measurement does not always accurately relate the true anteroposterior relationship of the jaws.

Very few attempts have been made to develop an analysis of anteroposterior jaw relationship to reduce these problems.[3] Jenkins and Harvold[4,5] used the functional occlusal plane (FOP) as suitable reference plane for anteroposterior jaw disharmony assessment, Jacobson[2] suggested using the Wits appraisal to exclude the problems of a cranial base references which involves drawing perpendiculars form point A and B on the maxilla and mandible respectively, for the functional occlusal plane. However, there are several shortcomings to the Wits analysis, since the functional occlusal plane is difficult to identify and reproduce in missing teeth, malpositioned teeth, dental restorations, molar overlap and third molars or young patients with a pronounced curve of spee. The functional occlusal plane has also been shown to rotate in a random fashion during growth.[5]

OBJECTIVE

The purpose of this investigation was to evaluate the reliability and validity of anterioposterior skeletal measurement using the maxillomandibular angles bisector, FOP and BOP.

MATERIALS AND METHODS

Thirty pretreatment lateral cephalograms each of adolescents (above 18 years of age) and children (10-12 years) seeking orthodontic treatment in Department of Orthodontics at AB Shetty Memorial Institute of Dental Sciences were randomly selected.

Each film was hand traced by a single operator onto acetate tracing paper with 2H pencil locating the following anatomical landmarks (Fig. 1). Cross-examination was performed by the same examiner in order to eliminate examiner bias. The following planes were drawn SN, NA, NB, maxillary plane (ANS-PNS) mandibular plane (Go-Me) functional occlusal plane, bisecting occlusal plane and Enlow's vertical plane (SE-Ptm; Fig. 2). The maxillo-mandibular plane angle bisector was constructed and angular and linear measurements were performed.

Cephalometric Measurements were Made using following Points and Planes

Following points were constructed for the purpose of the study (Fig. 3).

Ao: Point A projected in perpendicular fashion onto the functional occlusal plane.

Bo: Point B projected in perpendicular fashion onto the functional occlusal plane.

Am: Point A projected in perpendicular fashion onto the MM bisector.

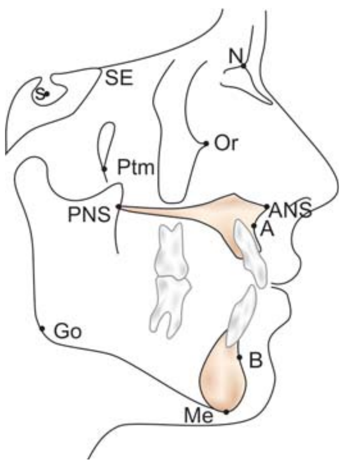

Fig. 1: Anatomical landmarks

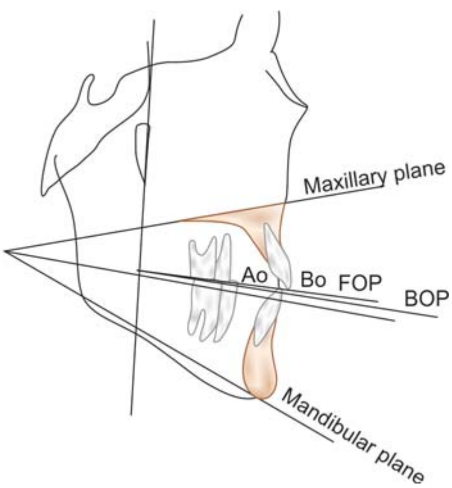

Fig. 2: Cephalometric planes used maxillary plane, mandibular plane, functional occlusal plane (FOP), bisecting occlusal plane (BOP), A^0 : point A, B^0 : point B.

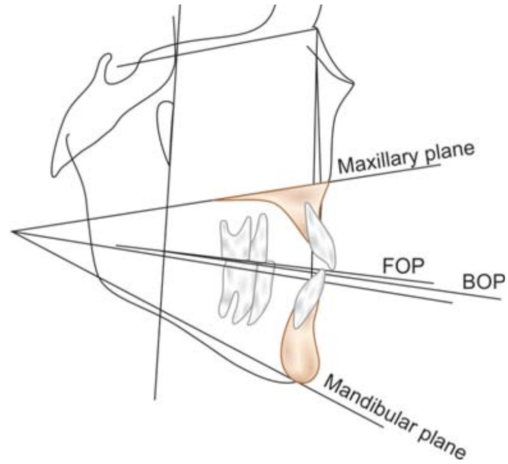

Fig. 3: Linear and angular measurement

Bm: Point B projected in perpendicular fashion onto the MM bisector.

Ab: Point A projected in perpendicular fashion onto the bisecting occlusal plane.

Bb: Point B projected in perpendicular fashion onto the bisecting occlusal plane.

Angular Measurements

With a large protractor measuring to 0.5°, the following angular measurements were made:

1. ANB angle and maxillomandibular bisector plane angle.
2. The angulations of FOP and BOP and the maxillo mandibular bisector plane angle to the PM vertical plane.
3. The angulations of FOP and BOP to the maxillo mandibular bisector plane angle.

Linear Measurements

With a steel ruler divided into 0.5 mm, the relationship of point A to point B was measured to each occlusal plane and to maxillomandibular bisector plane angle with the Wits technique.

RESULTS

The angular and linear measurements between adults and children are shown in Table 1. The standard error of the study was done using double determination test for various cephalometric measures for males (Table 2) and females (Table 3). The errors ranged from 0.89 to 1.12. There is less error when using bisecting occlusal plane and maxillomandibular bisector compared with FOP 0.89 to 0.74

The Error in Linear Measurement

All of the errors, except FOP Wits measurement, are in normal range; these errors ranged from 0.30 to 0.85.

Table 1: Comparison between adults and children

Groups		*N*	*Mean*	*Std. deviation*	*T*
SNA	Adults	30	83.067	2.067	0.3020
	Children	30	82.833	3.687	p = 0.763 NS
SNB	Adults	30	77.433	9.460	0.4690
	Children	30	76.567	3.598	p = 0.641 NS
ANB	Adults	30	2.433	1.960	6.5010
	Children	30	6.467	2.776	p = 0.001 VHS
MM	Adults	30	23.433	4.091	2.0900
	Children	30	25.767	4.546	p = 0.041 Sig
MM-PM	Adults	30	95.033	3.023	2.4940
	Children	30	98.067	5.936	p = 0.015 Sig
FOP-PM	Adults	30	91.9000	4.2292	1.7780
	Children	30	93.8333	4.1943	p = 0.081 NS
BOP-PM	Adults	30	90.3000	3.2605	1.5390
	Children	30	92.5667	7.3798	p = 0.129 NS
FOP-MM	Adults	30	6.5667	2.1284	7.3440
	Children	30	2.8667	1.7564	p = 0.001 VHS
BOP-MM	Adults	30	6.3333	2.0398	0.7840
	Children	30	5.9333	1.9106	p = 0.436 NS
AB-FOP	Adults	30	3.333E-02	1.9911	3.0350
	Children	30	2.1333	3.1142	p = 0.004 VHS
AB-BOP	Adults	30	0.8333	2.1509	4.2450
	Children	30	2.7333	4.0678	p = 0.001 VHS
AB-MM	Adults	30	–4.0000	2.16556	7.2000E-02
	Children	30	–3.96667	1.29943	p = 0.943 NS

NS: Nonsignificant; Sig: Significant; VHS: Very highly significant

Table 2: Comparison between male adults and male children

Group male		*N*	*Mean*	*Std. deviation*	*T*
SNA	Adults	15	83.0667	2.4919	0.8710
	Children	15	82.0000	4.0356	p = 0.391 NS
SNB	Adults	15	73.9333	12.4296	0.5130
	Children	15	75.667	4.0649	p = 0.612 NS
ANB	Adults	15	2.7333	1.3870	3.7050
	Children	15	6.333	3.4983	p = 0.001 VHS
MM	Adults	15	25.1333	3.9797	0.5810
	Children	15	25.9333	3.5550	p = 0.566 NS
MM-PM	Adults	15	95.0667	3.6541	1.3860
	Children	15	97.2000	4.7087	p = 0.177 NS
FOP-PM	Adults	15	92.4667	4.6270	1.3350
	Children	15	94.4667	3.5024	p = 0.193 NS
BOP-PM	Adults	15	90.4000	3.542	0.4210
	Children	15	91.267	7.136	p = 0.677 NS
FOP-MM	Adults	15	5.733	1.907	5.7250
	Children	15	2.667	0.816	p = 0.001 VHS
BOP-MM	Adults	15	6.3333	1.175	0.3260
	Children	15	6.1333	2.006	p = 0.747 NS
AB-FOP	Adults	15	0.533	1.885	1.2200
	Children	15	1.933	4.026	p = 0.233 NS
AB-BOP	Adults	15	6.667E-02	2.404	1.7960
	Children	15	2.667	5.066	p = 0.083 NS
AB-MM	Adults	15	–4.26667	1.48645	0.23000
	Children	15	–4.13333	1.68466	p = 0.84 NS

NS: Nonsignificant; VHS: Very highly significant

Comparison between Adults and Children

Angular Measurements

1. *ANB angle:* The mean value for the adults (2.433) and standard deviation (1.960), for children the mean value is 6.467 and standard deviation (2.776); on statistical comparison they show very significant difference.
2. *Maxillomandibular bisector:* The mean value for adults (23.433) and standard deviation of (4.091), for children the mean value is (25.767) and standard

Table 3: Comparison between female adults and female children

Group female		N	Mean	Std. deviation	T
SNA	Adults	15	83.0667	1.6242	0.6440
	Children	15	83.6667	3.2219	p = 0.525 NS
SNB	Adults	15	79.9350	3.1560	1.0580
	Children	15	77.4667	3.2450	p = 0.193 NS
ANB	Adults	15	2.1333	2.4162	5.6060
	Children	15	6.6000	1.9198	p = 0.001 VHS
MM	Adults	15	21.7333	3.5550	2.2900
	Children	15	25.6000	5.4876	p = 0.03 Sig
MM-PM	Adults	15	95.0000	2.3604	2.0580
	Children	15	98.9333	7.0150	p = 0.049 Sig
FOP-PM	Adults	15	91.3333	3.8668	1.1690
	Children	15	93.2000	4.8285	p = 0.252 NS
BOP-PM	Adults	15	90.200	3.075	1.7260
	Children	15	93.867	7.633	p = 0.095 NS
FOP-MM	Adults	15	7.400	2.063	5.3350
	Children	15	3.067	2.374	p = 0.001 VHS
BOP-MM	Adults	15	6.333	2.690	0.7190
	Children	15	5.733	1.792	p = 0.478 NS
AB-FOP	Adults	15	0.467	2.031	3.5440
	Children	15	2.333	2.289	p = 0.01 VHS
AB-BOP	Adults	15	–1.333	1.893	4.6250
	Children	15	2.800	2.933	p = 0.001 VHS
AB-MM	Adults	15	–3.73333	2.71153	9.2000E-02
	Children	15	–3.80000	0.77460	p = 0.928 NS

NS: Nonsignificant; Sig: Significant; VHS: Very highly significant

deviation (4.556); on comparison, they shows the significant difference.

3. FOP, BOP and maxillomandibular planes angle measured to PM vertical plane.
   a. *Maxillomandibular bisector to PM vertical:* The mean value for adults is (95.033) and standard deviation (3.023). The mean value for children (98.067) and standard deviation (5.936).
   b. *Functional occlusal plane to PM vertical:* The mean value for adults is (91.900) and standard deviation (4.2292) and mean value for children is (93.833) standard deviation is (4.1943).
   c. *Bisecting occlusal plane to PM vertical:* The mean value for adults is (90.300) and standard deviation (3.2605) and the mean value for the children is (92.560) and standard deviation is (7.3798).

   When compared all the three planes to PM vertical, there is definite change in cant of functional occlusal plane to PM vertical than compared to bisecting occlusal plane and maxillomandibular bisector but it is not very significant.
4. Bisecting occlusal plane and functional occlusal planes angle measured to maxillomandibular bisector.
   a. *Functional occlusal plane to maxillomandibular bisector:* The mean value for the adults is (6.5667) in standard deviation (2.1284) the mean value for children is (2.8607) and standard deviation is (1.7564).
   b. *Bisecting occlusal plane to maxillomandibular bisector:* The mean value for adults is (6.333) and standard deviation is (2.0398) and the mean value of children is (5.933) standard deviation is (1.9106).

   On comparison, there is significant difference between the FOP and maxillomandibular bisector than compared to BOP to maxillomandibular bisector.

Linear Measurements

a. *A and B values to FOP:* The mean value for adults is (3.333) and standard deviation is (1.9911), the mean value for children is (2.133) and standard deviation is (3.2242).
b. *A and B value measured to BOP:* The mean value for adults is (0.8333) and standard deviation is (2.1509) and mean value for children is (2.7333) and standard deviation is (4.0075).
c. *A and B value measured to maxillomandibular bisector:* The mean value for the adults is (4.000), standard deviation is (2.1055) and children (3.9907), standard deviation (1.299); there is very significantal value of A and B to FOP when compared A and B values to BOP and maxillomandibular bisector.

Comparison between Male Adults and Children

Angular Measurements

The values which are statistically significant are ANB angle and FOP to maxillomandibular bisector. The other values are not significant.

Linear Measurements

On comparison between male adults and children, none of values showed any significant variation.

Comparison between Female Adults and Children

Angular Measurement

The value which are statistically significant are ANB angle, maxillomandibular bisector angle and maxillomandibular bisector to PM vertical plane and FOP to maxillomandibular bisector angle.

Linear Measurement

On comparison between female adult and children. The A and B to FOP shows very significant variations than A and B values compared to BOP and maxillomandibular bisector.

DISCUSSION

An accurate AP measurement of jaw relationships is critically important in orthodontic treatment planning. The most popular parameter for assessing the sagittal jaw relationship remains the ANB angle, but it can be affected by various factors and can be misleading. A popular alternative that the Wits appraisal does not depend on cranial landmarks or rotation of the jaws but still has problem of correctly identifying the functional occlusal plane, which can sometime be impossible. Furthermore, changes of Wits measurement throughout orthodontic treatment might also reflect change in FOP, rather than pure sagittal changes of the relationship of the jaw.[2,3]

This study was undertaken to analyze the clinical usefulness of the maxillomandibular bisector, its reproducibility, its validity and its relationship to the FOP, the BOP and the nature of its cant.

The SNA, SNB and subsequently ANB angle does not accurately describe the sagittal maxillary and mandibular apical base relationship and this was attributed to normal variations in the spatial position both sella and nasion[2]and this changes with age,[6] the Wits analysis is an adjunct to the ANB angle and is not meant to be considered alone as defining the sagittal relationship.[7-9]

Vertical growth rotations are part of jaw development in growing children and thus measurement of anterior, posterior relationship, with the Wits technique, should be made to a plane that rotates with jaws.[10,11]

In the present study, it was found that the maxillary mandibular plane angle did not show any significant differences when compared between children and adults and also between male and female as shown by Sherman et al.[12]

The presence study, shows slight increase in the angle between the maxillomandibular bisector and the functional occlusal plane which is statistically very highly significant, similar to that found by Jarvinen.[14] This implies a change in the cant of the FOP and the Wits value using FOP showing greater difference than the normal.

When compared using Wits appraisal, the BOP Wits value had a higher relationship to dental measures than the FOP.[13,14] The rotation of the reference plane tends to mask the true value of linear changes between two distinct points when measurement is made to it during rotation.[15,16]

Lei Zhou et al[17] found that the anteroposterior relationship of the dental arch and jaw-base fail to match in atleast 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 Wits value measured to BOP the showed a class II tendency in the children and it increased with the age (becomes more positive) which suggests a slight increase in the maxillary base and decrease in mandibular base than compared to adults. 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.

Point A and B move the same amount and direction as their dental basis and so their true anterior-posterior relationship was effectively measured when using this plane. Since, the maxillomandibular bisector lies beneath the functional occlusal plane, therefore, B is projected ahead of point A for normal occlusion, resulting in a negative value. In females, children showed slightly increased mean value, i.e. (–3.800) than compared to adults (–3.733), whereas in males, adults showed slightly increased value (–4.266) than children (–4.133).

CONCLUSION

Following conclusions were drawn from the present study:

1. The maxillomandibular bisector is a more reproducible reference plane compared with BOP or FOP.
2. The maxillomandibular bisector for reference plane shows slight change, when compared with BOP and FOP but the Wits value measured shows nothing significant when compare to FOP and BOP.
3. Lying at an angle and inferior to the other occlusal planes, measurement to the maxillomandibular bisector is not obscured by the outline of the teeth. However, readings to it are of a negative value for skeletal because of downward cant of the planes interiorly.

4. Mean values for the Wits assessment made to maxillomandibular bisector is adults male more (4.2666) than adults female – 3.7333 and children male (4.1333); children female (3.800).
5. The anterioposterior measurement made in conjunction with as skull base reference, such as the ANB angle.

We do not suggest that clinicians should totally disregard any previously established cephalometric measurements rather, maxillomandibular bisector angle plane, enriches the current cephalometric tools availability to the clinician and enables better diagnosis and treatment planning for patient.

Since, this study was conducted using lateral cephalograms which provides only a two-dimensional vision of the morphological features, a study that can permit three-dimensional vision like three-dimensional CT reconstruction provided a better understanding of features.

CLINICAL SIGNIFICANCE

The maxillomandibular plane angle bisector was found to be a more reproducible and valid reference plane, than the FOP and BOP. Maxillomandibular planes angle bisector may be a useful adjunct for the cephalometric assessment of sagittal relationship of the patient.

REFERENCES

1. Broadent BH. A new X-ray technique and its application to orthodontics. Angle Orthod 1931;1:45-66.
2. Jacobson A. The Wits appraisal of jaw disharmony. Am J Orthod and Dentofac Orthod 2003;124:470-79.
3. Aranha CA, Galvao N, Madeira MC. Comparative study between Wits appraisal and I-line. Am J Orthod and Dentofac Orthop 1985;55:181-89.
4. Jenkins DH. Analysis or orthodontic deformity employing lateral cephalometric radiography. Am J Orthod and Dentofac Orthop 1955;41:442-52.
5. Harvold EP. Some biologic aspects of orthodontic treatment in the transitional dentition. Am J Orthod and Dentofac Orthop 1963;49:1-14.
6. Bishara SE, Fahl JA, Peterson LC. Longitudinal changes in the ANB angle and Wits appraisal: Clinical implications. Am J Orthod and Dentofac Orthop 1983;84:133-39.
7. Jacobson A. Update on the ‘Wits’ appraisal. Angle Orthod 1988;58:205-19.
8. Chan MD. An evaluation of the ‘Wits’ appraisal using pre and post-treatment cephalometric values san Diego: University of Southern California School of Dentistry, Thesis 1985.
9. Rotberg S, Fried N, Kane J, Shapiro E. Predicting the ‘Wits’ appraisal from the ANB angle. Am J Orthod and Dentofac Orthop 1980;77:636-42.
10. Roth R. The Wits appraisal – its skeletal and dentoalveolar background. Eur J Orthod 1982;4:21-28.
11. Rushton A, Cohen AM, Linney AD. The relationship and reproducibility of angle ANB and the Wits appraisal. Br J Orthod 1991;18:225-31.
12. Sherman SL, Woods M, Nanda RS. The longitudinal effects of growth on the Wits appraisal. Am J Orthod and Dentofac Orthop 1988;93:429-36.
13. Foley TF, et al. The reliability of three sagittal reference planes in the assessment of the class II treatment. Am J Orthod and Dentofac Orthop 1997;112:320-29.
14. Jarvinen S. Analysis of ANB angle a statistical appraisal. Am J Orthod and Dentofac Orthop 1985;87:144-46.
15. Schudy FF. The rotation of the mandible resulting from growth: Its implications in orthodontic treatment. Angle Orthod 1965:35:36-50.
16. Creekmore TD. Inhibition or stimulation of vertical growth of the facial complex. Angle Orthod 1967;37:285-97.
17. Lei Zhou, Chung-Wai Mok, Urban Hagg, Colman McGrath, Margareta Bendeus, John Wu. Anteroposterior dental arch and jaw-base relationships in a population sample. Angle Orthod 2008;78:1023-29.

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