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Original Article

Comparing the range of μ and β angles in 6-17-year-old children of Isfahan with normal occlusion

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ABSTRACT

Background: Linear and angular measurements such as A point, nasion, B point (ANB) angle and Wits appraisal index are not accurate enough to evaluate sagittal relationship of the jaws. The aim of this study was to evaluate and compare the range of μ and β angles in 6-17-year-old children of Isfahan, having normal occlusion.

Materials and Methods: This was an analytical descriptive study. For this study, 235 cephalometric radiographs of patients who didn't receive orthodontics treatments and based on 13 indexes had normal occlusion, were selected. After tracing of cephalograms, ANB angle, Wits appraisal index, μ angle (resulted from the intersection of AB line and perpendicular line from point A to mandibular plane) and β angle (resulted from the intersection of AB line and perpendicular line from point A on CB line) were measured. Data was analyzed by *t*-test, ANOVA and Pierson-Spearman correlation coefficient ($P < 0.05$).

Results: Mean value of μ and β angles were 17.34 ± 3.47 and 31.7 ± 3.31 and ranged from 8-27 to 21.5-39 respectively. According to *t*-test, there was a significant difference between two sex groups for μ angle ($P = 0.02$); however, it was not significant for β angle. According to Spearman correlation coefficient, there was no significant difference between age and μ angle; however, β angle was directly and significantly related to age ($r = 0.435$). There was significant and reverse relationship between μ and β angles with ANB angle and Wits appraisal index.

Conclusion: μ and β angles are reliable and can be used to evaluate the anterior-posterior relationship of the jaws.

Key Words: A point, nasion, B point angle, normal occlusion, wits appraisal index, β angle, μ angle

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INTRODUCTION

In order to receive an accurate diagnosis and treatment planning, many researchers have used different criteria to determine the anterior-posterior relationship of the jaws.[1] Although molar relationship has been used in angel classification, it is clear that canine and molar relationship indicates the anterior-posterior relationship of the jaws when teeth are placed in the accurate position on the dental arch. Using plaster models for classification of malocclusion or determination of the jaws relationship, without lateral cephalometric radiograph is not reliable, particularly for patients who have defective dental structures.[2] Cephalometric analysis is conducted through template method and linear-angular measurement. Every analysis considers specific landmarks and plans to define their linear-angular relationship.[3] Currently, several types of intracranial plans have been used as reference lines to determine discrepancy of the jaws. The most popular measurement of discrepancy of the jaws in anterior-posterior dimension is A point, nasion,

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B point (ANB) angle, which indicates the relationship of apical base of maxilla to mandible.[4] ANB angle is the angle between point A and B and nasion.[5] Based on the geometric studies (studies conducted geometrically rather than statistically), following factors are able to change ANB angle, without any effect on the anterior-posterior relationship of apical bases:[1,6,7]

1. Rotation of the jaws around anterior cranial base.[8]
2. Rotation of the occlusal plane around anterior cranial base, with or without jaws rotation.[7]
3. Position of nasion in the sagittal and vertical dimension[9] and the length of anterior cranial base (S-N).[7]
4. Facial height.[1]
5. Rotation of S-N plan.[6,10]

Thus, regarding the geometric studies, ANB angle cannot always indicate anterior-posterior relationship of the jaws accurately.[11]

Wits appraisal index was offered by Jacobson to overcome the deficiencies of ANB angle. This index is a linear measurement, which is the distance between two perpendicular lines from points A to B to functional occlusal plane.[12] Geometric studies have shown that the value of Wits appraisal index may be influenced by alteration of functional occlusal plane and vertical distance of points A and B as well as sagittal alteration of points A and B.[11,13]

Some researchers have offered linear and angular measurements based on palatal plane. Although this plane is constant, with increasing of age, it has variable gradient, so it is difficult to determine normal average.[14]

As these indexes are influenced by anatomic landmarks and dental occlusion and regarding to probability of effect of these landmarks on accuracy of evaluations, it is necessary to access an independent index.

Recently, μ and β angles have been introduced, which are not dependent on cranial landmarks or dental occlusion. Therefore, they are reliable indexes in cases that previous indexes such as ANB angle and Wits appraisal may not be used.[15,16]

μ angle is a novel method of measurement of skeletal discrepancy between the maxilla and mandible in sagittal plan. This angle uses three anatomic landmarks: Point A, point B and mandibular plan:

Point A: Is the deepest point on the midline of the maxilla, which moves from base to alveolar process.[5]

Point B: Is the most anterior part of base of the mandible and the most posterior point of the outer contour of mandibular alveolar process in midline.[5]

Mandibular plan: Is tangential line on the lower border of the mandible.[5]

μ angle is the angle between AB line and perpendicular line from A to mandibular plan [Figure 1].

β angle also uses three anatomic landmarks: Point A, point B and condylar axis:

Point C (Condylion): Is the most posterior-superior point on condylar head of the mandible (In the present study, C is considered as the center of the condyle).

β angle is the angle between AB line and perpendicular line from point A to CB line [Figure 2].

Considering ethnical, sexual and growth differences, it is necessary to evaluate normal cephalometric

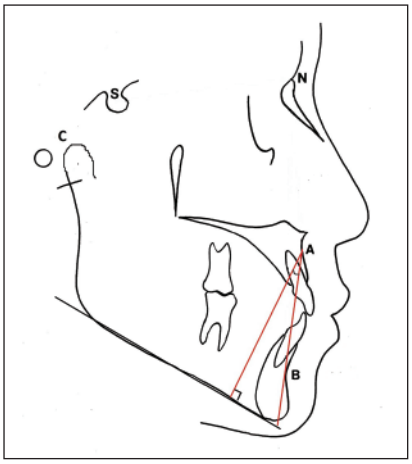

Figure 1: μ angle

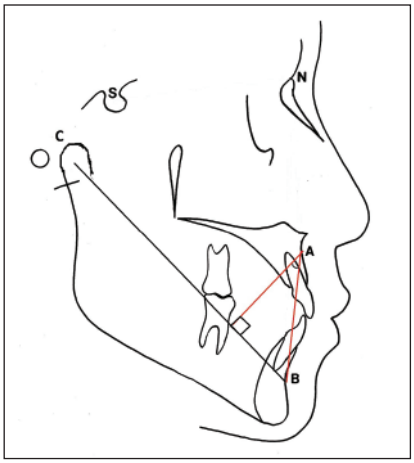

Figure 2: β angle

average of every population. The aim of this study was to evaluate and to compare the range of μ and β angles of 6-17-year-old children of Isfahan who have normal occlusion.

MATERIALS AND METHODS

This is a descriptive — analytical study. In order to conduct this study, archive documents of orthodontic department of Isfahan dental school were used. A total of 235 cephalometric radiographs of children, who had no history of orthodontic treatment and also based on 13 following criteria categorized as normal occlusion, were selected:

1. Symmetric face.
2. Having the whole teeth regarding to age (lack of primary tooth was acceptable if there was adequate space).
3. Normal tooth form, position and size.
4. Class I molar relationship for permanent tooth (Class I molar relationship or end to end relationship during mixed dentition or flush terminal plane relationship of second primary teeth [E] in cases of incomplete growth of permanent first molar).
5. Class I canine relationship.
6. Proper overbite up to 3 mm and over jet up to 2 mm.
7. Slight or no space between teeth.
8. Slight or no dental rotation.
9. Slight or no dental crowding.
10. No posterior cross bite.
11. No history of previous orthodontic treatment.
12. No history of orthognathic surgery.
13. No congenital disorder.

After selection of cephalometric radiographs, all of them were traced again. Acetate tracing paper (Dentaurum, Germany) was used for tracing and cephalometric protractor (3 M Unitek, Corporation, Monrovia, California, USA) with accuracy of 1° was used for measurement. ANB angle, Wits appraisal index, μ and β angles were measured. During measurement, 16 subjects were excluded due to clear inconsistency between ANB angle and Wits appraisal index. Furthermore, 17 subjects were excluded due to failure of determination of condylar center position in order to measure β angle. Three subjects were excluded due to superimposition of right and left mandibular plan and consequently failure of determination of μ angle. Finally, 199 subjects (112 females and 87 males) participated in this study.

The analyses were processed by SPSS (11.5 Chicago, IL and USA). Correlations of μ and β angles with ANB angle and Wits appraisal index were determined using Pearson correlation coefficient. T-test was used to determine the relationship between gender and μ and β angles and ANOVA was used to evaluate the relationship between age groups and μ and β angles ($P < 0.05$).

RESULTS

Out of 199 patients 43.7% were males and 56.3% were females. Patients were categorized into five age groups [Table 1].

Mean and standard deviation of μ and β angles are illustrated in Table 2.

According to *t*-test, there was a significant difference between the mean of μ angle and gender. However, there was no significant difference between other angles and gender [Table 3]. There was significant differences between the mean of μ angle and 14-17-year-old age group ($P = 0.01$) while the mean of β angle showed a significant difference in age groups of 8-10-year-old ($P = 0.02$) and 14-17-year-old ($P = 0.02$).

According to spearmen correlation coefficient there was no significant relationship between μ angle and age ($P = 0.054$) ($r = 0.138$), while there was a direct,

Table 1: Frequency of 6-17-year-old children of Isfahan with normal occlusion based on age group

Groups	Age	Girl	Boy	Percent
		Number	Number	
1	6-8	18	16	17.1
2	8-10	20	18	19.1
3	10-12	29	20	24.6
4	12-14	26	9	17.6
5	14-17	19	24	21.6
Total	6-17	112	87	100

Table 2: Mean and standard deviation of ANB angle, Wits appraisal, μ and β angles in 6-17-year-old children of Isfahan with normal occlusion

Index	Number	Mean	Standard deviation	Minimum	Maximum
ANB	199	3.29	1.7	–1.00	7.00
Wits	197*	–1.26	1.85	–5.50	2.50
M	197*	17.34	3.74	8.00	27.00
β	197*	31.70	3.31	21.50	39.00

*In measurement of wits appraisal and β and μ angles, 2 persons from our sample were excited because their age was not enough, so because of lack of growth their measurement were not been correct. ANB: A point, nasion, B point

Table 3: Comparison mean and standard deviation of ANB angle, Wits appraisal, μ and β angles in 6-17-year-old children of Isfahan with normal occlusion based on sex

Index	Sex	Number	Mean	SD	Minimum	Maximum	*P* value
ANB	Male	87	3.9	1.86	–1.00	7.00	0.124
	Female	112	3.45	1.63	00.0	7.00	
Wits	Male	85	–1.31	2.11	–5.50	2.50	0.741
	Female	112	–1.22	1.64	–5.00	2.00	
μ	Male	85	16.63	3.70	8.00	25.00	0.021
	Female	112	17.87	3.69	10.00	27.00	
β	Male	85	31.50	3.35	24.00	39.00	0.468
	Female	112	31.85	3.29	21.00	39.00	

ANB: A point, nasion, B point; SD: Standard deviation

significant relationship between β angle and age (r = 0.435).

The relationship between values of μ and β angles and ANB angle are presented on Diagrams 1 and 2 and the relationship between these angles with Wits appraisal index is presented on Diagrams 3 and 4.

DISCUSSION

Accurate measurement of anterior-posterior relationship of the jaws has a major importance in orthodontic treatment plan. The well-known criterion to investigate the anterior-posterior relationship of the jaws is ANB angle. However, this angle is affected by several factors.[11] A common alternative is Wits appraisal index, which is not dependent on cranial landmarks or jaws rotation; however, accurate diagnosis of functional occlusal plane is difficult and it may occur after orthodontic treatments due to alteration of functional occlusal plane rather than alteration of sagittal relationship of the jaws.[11,13]

In order to compensate the deficiency of ANB angle and Wits appraisal index, Baik and Ververidou suggested β angle.[16] The researchers claimed that β angle not only is independent of cranial landmarks and functional occlusal plane, but also it seems that clockwise or counter-clockwise rotation of the jaws has slight influence on this angle. Another advantage of β angle is that it can be applied in serial evaluation of orthodontics treatment plan and shows changes in sagittal relationship of the jaws related to growth and orthodontic or orthognathic interference. In addition, it can be used as accurate criteria in orthognathic surgery for patients with anterior-posterior and vertical skeletal disorder. However, major disadvantage of this angle is determination of condylar center, which is not always easy.[16] This issue has been similarly experienced in the present study, which 17 subjects were excluded due to lack of clarity of condylar area. In order to obtain accurate measurement of β angle, cephalometric radiographs must have high quality, so that the clinician can easily trace posterior border

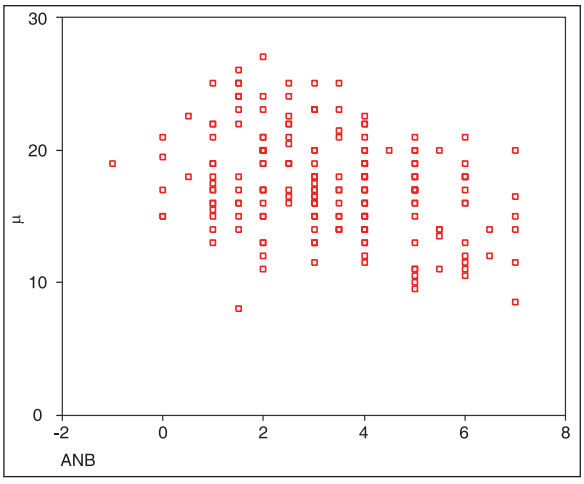

Diagram 1: Relationship of μ angle with A point, nasion, B point angle

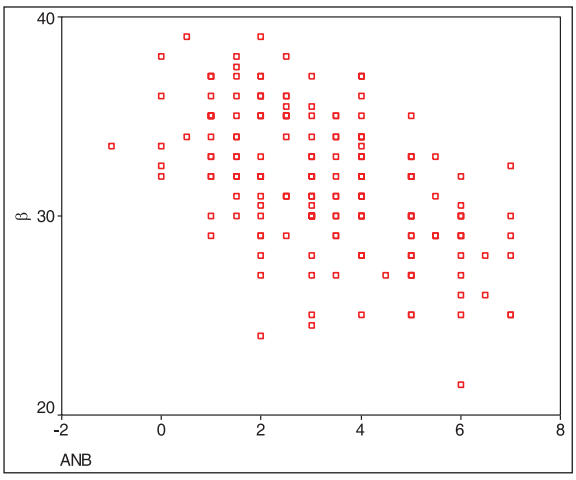

Diagram 2: Relationship of β angle with A point, nasion, B point angle

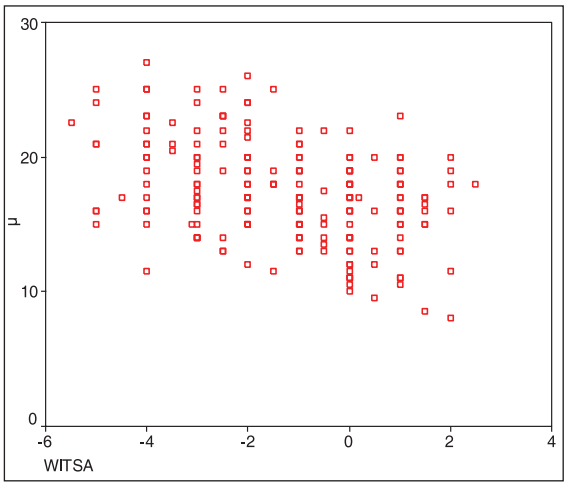

Diagram 3: Relationship of μ angle with Wits appraisal index

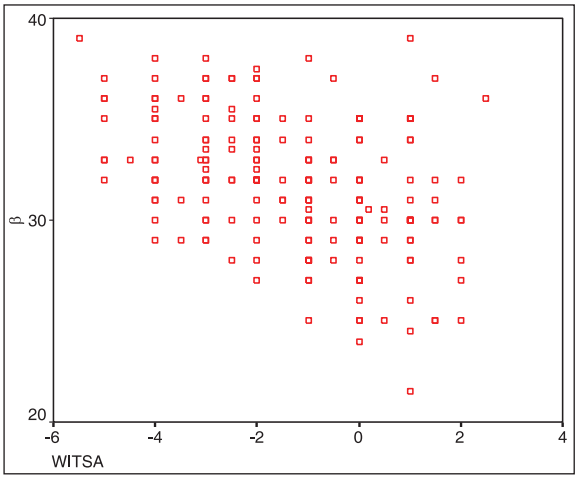

Diagram 4: Relationship of β angle with Wits appraisal index

of ramus and determine condylar head position. The advantage of using the center of condyle rather than condylion point is that accurate tracing of condylar contour is not usually easy. As it is illustrate in Figure 2, if real condylar center is point C, but clinician locates it in a circle with a radius of 2 mm, β angle is affected less than 1°, which makes its application more acceptable.

In the present study, the range of β angle was 21.5-39 while Fattahi *et al*. and Baik and Ververidou showed the range of β angle 27.5-43.5 and 27-35 respectively.[15,16] The difference between these studies is probably due to different sample size, inclusion criteria and demographic features of patients. The mean of β angle was 31.7 ± 3.3° in the current study, which is consistent with the results of Fattahi *et al*. (35.5 ± 3.1)[15] and Biak and Ververidou (31.1 ± 2).[16]

Fattahi *et al*. suggested μ angle, which is superior to β angle because the determination of mandibular plane is easier and the quality of radiograph does not influence this plane.[15] However, mandibular plane may be defective in some lateral cephalograms due to weak radiographic technique. Therefore, three samples were excluded in the present study.

One of the advantages of μ angle is that the rotation of the lower jaw from temporomandibular joint area or the rotation of mandibular body does not really influence the μ angle as A and B points change their position. However, if mandibular plane changes without displacement of A and B points, the angle will be failed.

In the present study, the range of μ angle was 8-27, while Fattahi *et al*. showed 11-29.[15] The mean value of μ angle was 17.34 ± 3.74, which is consistent with the results of Fattahi *et al*. (20 ± 3.9).[15]

According to spearman correlation coefficient there was direct significant, but weak relationship between β angle and age (r = 0.435). As β angle increases with the increase of age, it can be suggested that β angle is consistent with cephalocaudal gradient of the growth curve.

Pearson correlation coefficient revealed that there was reverse significant relationship between ANB angle and β angle (r = –0.520) and also μ angle (r = –0.329). As an increase in β angle and μ angle indicated a tendency to Class III and a decrease in ANB angle indicates the same tendency, these angles reinforce each other in the classification of the malocclusion. This is also true for Class II malocclusion.

There was also weak and reverse significant relationship between Wits appraisal index and μ angle (r = –0.412) and β angle (r = –0.427). As increase of these angles and a decrease of Wits appraisal index (more negative) indicate tendency to C1ass III, both of them reinforce each other in the classification of the malocclusion. This is also true for C1ass II malocclusion. Biak and Ververidou suggested that there is a significant relationship between ANB angle and Wits appraisal index and β angle.[16]

According to the present study, there was a direct significant relationship between β angle and μ angle (r = 0.621). Therefore, it can be said that these two angles have consistent validity and can be well used in the determination of anterior-posterior malocclusion.

In fact, all linear and angular measurement in lateral radiographies has specific advantages and disadvantages, thus none of the methods can be used merely as an accurate method for diagnosis and treatment plan in orthodontics. Although μ angle and β angle are able to diagnosis the anterior-posterior relationship of the jaws and bone disorder, previous cephalometric measurements should not be ignored. Based on the findings of the current study, further studies on the sensitivity and specificity of μ angle and β angle in three types of malocclusion and also comparison of these angles with other method of measuring jaw relationship such as the angle of convexity and facial angle are recommended.

CONCLUSION

Considering that μ angle and β angle do not have the disadvantages of previous measurements such as ANB angle and Wits appraisal index for evaluation of anterior-posterior relationship of the jaws, they may be an accurate method for diagnosis of jaw disorders and treatment plan.

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