Beta angle in a sample of Iraqi adults with Class I skeletal and dental relations and its correlation with other craniofacial measurements

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ABSTRACT

Background: This study aimed to determine the value of Beta angle for a sample of Iraqi adults with class I skeletal and dental relations and to verify the existence of sexual dimorphism and to find out the relation between this angle and other craniofacial measurements.

Materials and Methods: Sixty dental students (23 males and 37 females) with an age ranged between 20-31 years old and having class I skeletal and dental relations were chosen for this study. Each student was subjected to clinical examination and digital true lateral cephalometric radiograph. The radiographs were analyzed using AutoCAD 2007 computer program to measure the angular and linear variables. Descriptive statistics were obtained for the measurements for both genders and total sample; independent samples t-test was performed to evaluate the gender difference and Pearson's correlation coefficient test used to detect the relation between the Beta angle and other measurements.

Results and Conclusions: The value of Beta angle in this study was 32.63°± 2.57°. When the Beta angle is less than 27°, the case is class II and when it is more than 38°, the case is class III. There is no genders difference regarding the Beta angle and this angle correlated significantly and positively with the mandibular length and articular angle and negatively with ANB and saddle angles.

Key words: Sagittal jaw relation, Beta angle. (J Bagh Coll Dentistry 2013; 25(4):145-150).

INTRODUCTION

Freeman [(1)] stated that, even before Edward H. Angle introduced his classification of malocclusion to the profession in the early 1900's, the anteroposterior relation of mandible to maxilla was a most important diagnostic criterion. This relationship can be determined from clinical observation to some degree, but it can be much more accurately evaluated from a lateral radiograph. Broadbent's [(2)] introduction of his cephalometer in 1931 made such films available, although they were used primarily for research and growth studies until the late 1940's.

From 1947 till 2009, many methods [(3-39)] had been developed to assess the anteroposterior (sagittal) jaw relationship. For every method, there are many advantages and disadvantages, but still the ANB angle [(7)] is the most popular one.

In 2004, Baik and Ververidou [(37)] established a new cephalometric measurement, named the Beta angle, to assess the sagittal jaw relationship with accuracy and reproducibility. In this angle, three skeletal landmarks- point A, point B, and the apparent axis of the condyle- were used to measure an angle that indicated the severity and the type of skeletal dysplasia in the sagittal dimension. They found that subjects with a Beta angle between 27° and 35° had a Class I skeletal pattern, a Beta angle less than 27° indicated a Class II skeletal pattern, a Beta angle greater than 35° indicated a Class III skeletal pattern and there was no statistically significant difference between mean Beta angle values of males and females.

Kamalamma [(40)] carried out a lateral cephalometric study in the natural head position on Indian adults to determine the norms for Beta angle and Wits appraisal and also to correlate Beta angle with the Wits appraisal and ANB angle. The results indicated that there was no significant difference in the norms for males and females. Beta angle showed a negative linear correlation with ANB angle and Wits appraisal.

This study aimed to determine the value of Beta angle for a sample of Iraqi adults with class I skeletal and dental relations and to verify the existence of sexual dimorphism and to find out the relation between this angle and other craniofacial measurements.

MATERIALS AND METHODS

Sample

Out of 80 clinically examined under and postgraduate students in the College of Dentistry, University of Baghdad with an age ranged between 20-31 years, 60 students (23 males and 37 females) were selected having normal occlusion, full permanent dentition regardless the third molars, and ANB angle equals to 2°±2° and MP-SN angle equals to 32°±5° [(7)].

Methods

Each individual was examined clinically and subjected to the digital true lateral cephalometric radiograph using the Planmeca ProMax X-ray unit. The individual was positioned within the

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cephalostat with the sagittal plane of the head vertical, the Frankfort plane horizontal, and the teeth were in centric occlusion. Every lateral cephalometric radiograph was analyzed by AutoCAD program 2007 to calculate the angular and linear measurements. Once the picture was imported to the AutoCAD program, it will appear in the master sheet on which the points and planes were determined, and then the measurements were obtained. The angles were measured directly as they were not affected by magnification while the linear measurements were divided by scale (the ruler in the nasal rod) for each picture to overcome the magnification.

Cephalometric Landmarks, Lines, and Measurements

Cephalometric Landmarks

1. Point S (Sella): The midpoint of the hypophysial fossa [41].
2. Point N (Nasion): The most anterior point on the nasofrontal suture in the median plane [41].
3. Point A (Subspinale): The deepest midline point on the premaxilla between the Anterior Nasal Spine and Prosthion [6].
4. Point B (Supramentale): The deepest midline point on the mandible between Infradentale and Pogonion [6].
5. Point Me (Menton): The lowest point on the symphyseal shadow of the mandible seen on a lateral cephalogram [42].
6. Point Go (Gonion): A point on the curvature of the angle of the mandible located by bisecting the angle formed by the lines tangent to the posterior ramus and inferior border of the mandible [42].
7. Point C: The center of the condyle [37].
8. Point ANS (Anterior Nasal Spine): It is the tip of the bony anterior nasal spine in the median plane [41].
9. Point PNS (Posterior Nasal Spine): This is a constructed radiological point, the intersection of a continuation of the anterior wall of the pterygopalatine fossa and the floor of the nose. It marks the dorsal limit of the maxilla [41].
10. Point Ar (Articulare): The point of intersection of the external dorsal contour of the mandibular condyle and the temporal bone [4].

Cephalometric Lines

1. Sella-Nasion (SN) line: It is the anteroposterior extent of anterior cranial base [41].
2. Mandibular plane (MP): Formed by a line joining Gonion and Menton [42].
3. N- A line: Formed by a line joining Nasion and point A [6].
4. N- B line: Formed by a line joining Nasion and point B [6].
5. C-B line: A line connecting the center of the condyle C with B point [37].
6. A-B line: A line connecting A and B points [6].
7. A line from point A perpendicular to the C-B line [37].
8. Sella- Articulare (S-Ar) line: A line from Sella to Articulare [41].
9. Palatal plane (PP): A line joining between anterior nasal spine and posterior nasal spine [41].
10. Articulare- Gonion (Ar- Go) line: A line joining between Articulare and Gonion [41].

Cephalometric Measurements

1. ANB angle: The angle between lines N-A and N-B. It represents the difference between SNA and SNB angles or it may be measured directly as the angle ANB [7].
2. Beta angle: It is the angle between the line from point A perpendicular to the C-B line and the A-B line [37].
3. SN plane- Mandibular plane angle (SN-MP): The angle between the S-N plane and the mandibular plane [41].
4. Gonial angle (Ar-Go-Me): The angle between the posterior border of the ramus and the mandibular plane [41].
5. Saddle angle (N-S-Ar): The angle between the anterior and the posterior cranial base. This angle formed at the point of intersection of the S-N plane and the S-Ar plane [41].
6. Articular angle (S-Ar-Go): This angle formed at the point of intersection of the S-Ar plane and the Ar-Go plane [41].
7. Basal plane angle (PP-MP): This defines the angle of inclination of the mandible to the maxillary base [41]
8. S-N: A distance from Sella to Nasion [41].
9. S-Ar: A distance from Sella to Articulare [41].
10. Maxillary length: It represents the distance from Anterior Nasal Spine to Posterior Nasal Spine [43].
11. Mandibular length: It represents the distance from Gonion to Menton [43].
12. Ramus length: The distance between Ar and Go [41].
13. Total anterior facial height (AFH): It's measured from N to Me [41].
14. Upper anterior facial height (UFH): It's measured from N to ANS [42].
15. Lower anterior facial height (LFH): It's measured from ANS to Me [42].
16. Posterior facial height (PFH): It's measured from S to Go [41].

Statistical Analyses

All the data of the sample were subjected to computerized statistical analysis using SPSS version 15 (2006) computer program. The statistical analysis included:

1. Descriptive Statistics: Means, standard deviations, standard errors, minimum, maximum and statistical tables.
2. Inferential Statistics: Independent-samples t-test for the comparison between both genders and Pearson's correlation coefficient test to detect the relation between the Beta angle and other measurements.

In the statistical evaluation, the following levels of significance are used:

Non-significant	NS	$P > 0.05$
Significant	*	$0.05 \geq P > 0.01$
Highly significant	**	$0.01 \geq P > 0.001$
Very highly significant	***	$P \leq 0.001$

RESULTS AND DISCUSSION

In this study, the normal value of the Beta angle had been determined for a sample of Iraqi adults with class I dental and skeletal relations with its relation to different craniofacial measurements.

In Iraq, two studies had been done using this angle as a measurement that determine the features of class II and III [44,45] depending on the value of Baik and Ververidou [37]. The variables will be discussed under two headings:

1- Descriptive statistics and gender difference

a. Angular measurements

The results showed that all of the angular measurements except MP-SN angle and saddle angle were larger in males than females with a non-significant difference. Saddle angle was larger significantly in females than males; this comes in agreement with Yassir [46] and this was considered normal as the saddle angle increased with the decreased of ANB angle [47].

The mean value of SN-MP was smaller significantly in males than females indicating that the males had a tendency towards forward rotation.

The value of Beta angle was slightly higher than Baik and Ververidou [37] and Kamalamma [40] due to the age factor in the first as they conducted their study on subjects had age between 9 and 15 years old and the head position during taking the radiograph in the second. There was non-significant genders difference and this comes in agreement with Baik and Ververidou [37] and Kamalamma [40].

b. Linear measurements

The results indicated that all the linear measurements were significantly larger in males than females. This may follow the general rule that females are slightly smaller than males in all dimensions [48].

2. Relation between Beta angle and other measurements

The results showed that Beta angle correlated significantly in negative direction with ANB and saddle angles. This comes in agreement with Kamalamma [40], while it correlated directly and significantly with the S-Ar-Go angle.

Beta angle also correlated directly and significantly with the mandibular length in so as the mandibular length increased, the Beta angle increased and this becomes obvious in Class II and III jaws relation [44,45].

On the other hand, the other linear and angular measurements had no significant correlation with Beta angle.

REFERENCES

1. Freeman RS. Adjusting A-N-B angles to reflect the effect of maxillary position. Angle Orthod 1981; 51(2): 162-71. (IVSL)
2. Broadbent BH. A new X-ray technique and its application to orthodontia. Angle Orthod 1931; 1(2): 45-66, and Angle Orthod 1981; 51(2): 93-114.
3. Wylie WL. The assessment of anteroposterior dysplasia. Angle Orthod 1947; 17(3, 4): 97-109.
4. Björk A. The face in profile. An anthropological X-ray investigation on Swedish children and conscripts. Svensk tandläkare-Tidskrift 1947; 40(5B Suppl): 1-180.
5. Ballard CF. Some bases for aetiology and diagnosis in orthodontics. Dental Rec 1948; 68(6): 133-45.
6. Downs WB. Variations in facial relationship: their significance in treatment and prognosis. Am J Orthod 1948; 34(10): 812-40.
7. Riedel RA. The relation of maxillary structures to cranium in malocclusion and in normal occlusion. Angle Orthod 1952; 22(3): 142-5. (IVSL)
8. Steiner CC. Cephalometrics for you and me. Am J Orthod 1953; 39(10): 729-55.
9. Freeman RS. A radiographic method of analysis of the structures of the lower face to each other and to the occlusal plane of the teeth. Am J Orthod 1953; 39(1): 56-57.
10. Donovan RW. Recent research for diagnosis. Am J Orthod 1954; 40(8): 591-609.
11. Jenkins DH. Analysis of orthodontic deformity employing lateral cephalometric radiography. Am J Orthod 1955; 41(6): 442-52.
12. Mills JRE. The application and importance of cephalometry in orthodontic treatment. The Orthodontist 1970; 2: 32-47.
13. Beatty EJ. A modified technique for evaluating apical base relationships. Am J Orthod 1975; 68(3): 303-15.
14. Jacobson A. The "Wits" appraisal of jaw disharmony. Am J Orthod 1975; 67(2): 125-38, and Am J Orthod Dentofac Orthop 2003; 124(5): 470-9.

15. Houston WJB. Assessment of the skeletal pattern from the occlusion of the incisor teeth: a critical review. Br J Orthod 1975; 2(3): 167-69.
16. Demisch A, Gebauer U, Zila W. Comparison of three cephalometric measurements of sagittal jaw relationship. Angle ANB, "Wits" appraisal and AB/occlusal angle. Trans Eur Ortho Soc 1977: 269-80.
17. Johnson JS. A new approach to cephalometric analysis of the dental base relationship. Angle Orthod 1978; 48(1): 23-32. (IVSL)
18. Kim YH, Vietas JJ. Anteroposterior dysplasia indicator: an adjunct to cephalometric differential diagnosis. Am J Orthod 1978; 73(6): 619-33.
19. Bhatia SN, Akpabio TA. A correlation study of two methods of assessing skeletal pattern. Br J Orthod 1979; 6(4): 187-93.
20. Jarvinen S. A comparison of two angular and two linear measurements used to establish sagittal apical base relationship. Eur J Orthod 1981; 3(2): 131-4.
21. Brown M. Eight methods of analysing a cephalogram to establish anteroposterior skeletal discrepancy. Br J Orthod 1981; 8(3): 139-46.
22. Jarvinen S. The JYD angle: a modified method of establishing sagittal apical base relationship. Eur J Orthod 1982; 4(4): 243-9
23. Richardson M. Measurement of dental base relationship. Eur J Orthod 1982; 4(4): 251-6.
24. Williams S, Leighton BC, Nielsen JH. Linear evaluation of the development sagittal jaw relationship. Am J Orthod 1985; 88(3): 235-41.
25. Calvao CAAN, Madeira MC. Comparative study between Wits Appraisal and I Line. Angle Orthod 1985; 55(3): 181-9.
26. Chang HP. Assessment of anteroposterior jaw relationship. Am J Orthod Dentofac Orthop 1987; 92(2): 117-22.
27. Hussels W, Nanda RS. Clinical application of a method to correct angle ANB for geometrical effects. Am J Orthod Dentofac Orthop 1987; 92(6): 506-10.
28. Cooke MS, Wei SHY. An improved method for the assessment of the sagittal skeletal pattern and its correlation to previous methods. Eur J Orthod 1988; 10(1): 122-7.
29. Sarhan OA. A new cephalometric parameter to aid in dental base relationship analysis. Angle Orthod 1990; 60(1): 59-64. (IVSL)
30. Oktay H. A comparison of ANB, Wits, AF-BF, and APDI measurements. Am J Orthod Dentofac Orthop 1991; 99(2): 122-8.
31. Viazis AD. Comprehensive assessment of anteroposterior jaw relationships. J Clinic Orthod 1992; 26(10): 673-30.
32. Hall-Scott J. The maxillary-mandibular planes angle (MM°) bisector: A new reference plane for anteroposterior measurement of the dental bases. Am J Orthod Dentofac Orthop 1994; 105(6):583-91.
33. Nanda RS, Merrill RM. Cephalometric assessment of sagittal relationship. Am J Orthod Dentofac Orthop 1994; 105(4): 328-44
34. Yang SD, Suhr CH. F-H to AB plane angle (FABA) for assessment of anteroposterior jaw relationships. Angle Orthod 1995; 65(3): 223-32. (IVSL)
35. Foley TF, Stirling DL, Hall-Scott J. The reliability of three sagittal reference planes in the assessment of Class II treatment. Am J Orthod Dentofac Orthop 1997; 112(3): 320-9
36. Polk CE, Buchanan D. A new index for evaluating horizontal skeletal discrepancies and predicting treatment outcomes. Am J Orthod Dentofac Orthop 2003; 124(6): 663-9.
37. Baik CY, Ververidou M. A new approach of assessing sagittal discrepancies: The Beta angle. Am J Orthod Dentofacial Orthop 2004; 126(1):100-5.
38. Neela PK, Mascarenhas R, Husain A. A new sagittal dysplasia indicator: The YEN angle. World J Orthod 2009; 10(2):147–151.
39. Noar JH, Al-Asady A, Moseley HC. A simple method of assessing anteroposterior skeletal pattern from a lateral cephalogram. J Clin Orthod 2009; 43(7): 449-52.
40. Kamalamma. Evaluation and correlation of beta angle and Wits Appraisal in various skeletal malocclusion groups among patients visiting government dental college, Bangalore. A master thesis. Department of Orthodontics and Dentofacial Orthopedics. Rajiv Gandhi University of health sciences, Bangalore, 2009.
41. Rakosi T. An atlas and manual of cephalometric radiography. 2nd ed. London: Wolfe medical publications Ltd.; 1982.
42. Jacobson A. Radiographic cephalometry from basics to videoimaging. 1st ed. Chicago: Quintessence publishing Co.; 1995.
43. Dhopatkar A, Bhatia S, Rock P. An investigation into the relationship between the cranial base angle and malocclusion. Angle Orthod 2002; 72(5): 456-63.
44. Al- Lehaibi WK. The characteristic features of skeletal class III in Iraqi adult orthodontic patients. A master thesis, Department of Orthodontics, University of Baghdad, 2010.
45. Toma RR. The morphology and texture of Iraqi skeletal class II young adults (cephalometric study). A master thesis, Department of Orthodontics, University of Baghdad, 2011.
46. Yassir YA. Saddle angle and its relationship with maxillary and mandibular lengths. Iraqi Orthod J 2009; 5(1): 14-6.
47. Nelson-Moon ZL. Craniofacial growth, the cellular basis of tooth movement and anchorage. In Mitchell L. An introduction to orthodontics. 3rd ed. Oxford: Oxford university press; 2007. p. 36.
48. Woods GA. Changes in width dimensions between certain teeth and facial points during human growth. Am J Orthod 1950; 36(9): 676-700.

Table 1: Descriptive statistics and genders difference

Variables	Genders	Descriptive statistics					Genders difference	
		Mean	S.D.	S.E.	Min.	Max.	t-test	p-value
ANB°	Males	2.61	1.47	0.31	0	4	0.70	0.48 (NS)
	Females	2.35	1.32	0.22	0	4		
	Total	2.45	1.37	0.18	0	4		
N-S-Ar°	Males	122.04	4.30	0.90	112	134	-2.90	0.01 **
	Females	126.14	5.84	0.96	114	137		
	Total	124.57	5.63	0.73	112	137		
S-Ar-Go°	Males	143.13	5.45	1.14	133	156	0.40	0.69 (NS)
	Females	142.49	6.52	1.07	126	156		
	Total	142.73	6.09	0.79	126	156		
Gonial angle°	Males	125.22	5.61	1.17	116	140	0.89	0.38 (NS)
	Females	124.11	4.04	0.66	117	138		
	Total	124.53	4.69	0.61	116	140		
SN-MP°	Males	30.65	2.74	0.57	27	37	-2.62	0.01 **
	Females	32.62	2.89	0.48	27	37		
	Total	31.87	2.97	0.38	27	37		
PP-MP°	Males	23.35	3.45	0.72	17	30	0.14	0.89 (NS)
	Females	23.22	3.50	0.57	15	29		
	Total	23.27	3.45	0.45	15	30		
Beta°	Males	33.17	2.71	0.56	27	38	1.29	0.20 (NS)
	Females	32.30	2.46	0.40	28	38		
	Total	32.63	2.57	0.33	27	38		
S-N (mm)	Males	70.45	2.52	0.52	65.7	77.05	6.27	0.000 ***
	Females	66.83	1.94	0.32	62.3	70.2		
	Total	68.22	2.79	0.36	62.3	77.05		
S-Ar (mm)	Males	36.35	2.52	0.53	31.2	42.02	5.74	0.000 ***
	Females	32.16	2.88	0.47	23.9	38.84		
	Total	33.77	3.41	0.44	23.9	42.02		
Ar-Go (mm)	Males	50.74	4.73	0.99	38.71	57.22	5.63	0.000 ***
	Females	44.69	3.57	0.59	38.8	54.09		
	Total	47.01	4.99	0.64	38.71	57.22		
ANS-PNS (mm)	Males	57.01	4.06	0.85	50.74	68.86	6.02	0.000 ***
	Females	52.28	2.01	0.33	45.4	55.2		
	Total	54.09	3.74	0.48	45.4	68.86		
Go-Me (mm)	Males	74.03	3.68	0.77	65.6	80.02	4.68	0.000 ***
	Females	69.28	3.90	0.64	57.2	77.9		
	Total	71.10	4.45	0.57	57.2	80.02		
UAFH (mm)	Males	53.19	2.80	0.58	45.31	59.02	3.69	0.000 ***
	Females	50.62	2.52	0.41	44.9	55.5		
	Total	51.60	2.89	0.37	44.9	59.02		
LAFH (mm)	Males	69.61	4.07	0.85	60.11	78.18	7.53	0.000 ***
	Females	62.05	3.59	0.59	54.1	69.03		
	Total	64.95	5.27	0.68	54.1	78.18		
TAFH (mm)	Males	121.10	4.58	0.95	114.48	132.02	8.93	0.000 ***
	Females	111.11	3.97	0.65	101.4	118.7		
	Total	114.94	6.44	0.83	101.4	132.02		
PFH (mm)	Males	82.74	4.94	1.03	74.9	92	8.75	0.000 ***
	Females	72.79	3.83	0.63	64.5	80.8		
	Total	76.61	6.47	0.84	64.5	92		

Males =23, Females =37, Total sample =60, d.f. = 58

Table 2: Relation between Beta angle and other variables

Variables	Relation	Beta°
		Total
ANB°	r	-0.44
	p-value	0.000 ***
N-S-Ar°	r	-0.34
	p-value	0.01 **
S-Ar-Go°	r	0.30
	p-value	0.02 *
Gonial angle°	r	-0.04
	p-value	0.77 (NS)
SN-MP°	r	-0.05
	p-value	0.71 (NS)
PP-MP°	r	0.01
	p-value	0.93 (NS)
S-N (mm)	r	-0.06
	p-value	0.63 (NS)
S-Ar (mm)	r	-0.15
	p-value	0.26 (NS)
Ar-Go (mm)	r	0.20
	p-value	0.13 (NS)
ANS-PNS (mm)	r	0.06
	p-value	0.63 (NS)
Go-Me (mm)	r	0.26
	p-value	0.04 *
UAFH (mm)	r	0.02
	p-value	0.91 (NS)
LAFH (mm)	r	0.14
	p-value	0.29 (NS)
TAFH (mm)	r	0.14
	p-value	0.28 (NS)
PFH (mm)	r	0.14
	p-value	0.30 (NS)

Table 3. The values of Beta angle in different studies.

Author(s)	Baik and Ververidou [37]			Kamalamma [40]			Present study		
Year	2004			2009			2013		
Age (yr)	9-15			18-25			20-31		
Sex	Male	Female	Total	Male	Female	Total	Male	Female	Total
Mean	30.9	31.1	31.1	32.33	31.41	31.8	33.17	32.30	32.63
S.D.			2	3.73	3.46	3.57	2.71	2.46	2.57
Min.			27			28	27	28	27
Max.			35			35	38	38	38