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The variation of the cranial base parameters in Class I, II and III skeletal relationships

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ABSTRACT

Aims: To detect the variation in cranial base parameters among the skeletal relationships of Class I, II and III for both sexes. **Materials and Methods:** The sample was consisted of 90 lateral cephalometric radiographs 30 for each class (Class I, II and III skeletal relationships of ANB angle 0–2, over 2 and less than 0 degree respectively). The radiographs were for Iraqi adolescents who live in Mosul City of age 15–18 years. The subjects were collected from the Department of Pedodontics, Orthodontics and Preventive dentistry, College of Dentistry, University of Mosul. The radiographs were traced to determine the ANB angle to group the sample into Class I, II and III skeletal relationships, the statistical analysis of cranial base lines (SN, SBa, SCo, SAr and SBa), and the cranial base angles (NSBa, SBaAr, SBaCo, SBaN) was carried out to find their variation among the three skeletal relationships. **Results:** Revealed that there was no significant difference at ($p < 0.05$) significant level between sexes. There were significantly increase in mean value of Class II in comparing to Class I and III skeletal relationships for both sexes in the cranial base parameters (lines SN, SBa, NBa, and angle NSBa) and insignificantly greater in the cranial base parameters (line SCo and angle SBaN). **Conclusion:** There were significantly differences among the Class I, II and III groups in the (SN, SBa, NBa and NSBa) parameters for males, while in females were in the (SN, SBa, NBa and NSBa) parameters. The sex variation was insignificant difference for all the parameters in the three skeletal groups.

Key Words: Cranial base length, cranial base angle.

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INTRODUCTION

The development of the cranial base is the early evidence of the skull formation. The cranial base is relatively stable during the growth. The spheno–occipital synchondrosis is the major contributor to growth of the cranial base, as it persists into early adulthood. This prolonged growth period allows for continued posterior expansion of the maxilla, the spheno–ethmoidal synchondrosis contributed in the anterior expansion of the cranial base which was ceased after seven years.[1]

The position of the maxilla is depend on the growth at the spheno–occipital and spheno–ethmoidal synchondroses.[2] Weinmann and Sicher[3] reported that the maxilla is hafted to the cranium at least partly by the frontomaxillary suture, the zygomaticomaxillary suture, zygomaticotemporal suture and the pterygopalatine suture. These sutures are all oblique and more or less parallel with each other; thus growth in these areas would serve to move the maxilla downward and forward or the cranium moves upward and backward as Graber[2] cited.

Growth of the cranial floor has a direct effect on the placement of the midface and mandible, as the anterior cranial fossa and cranial floor elongate the underlying space occupied by the elongating nasomaxillary complex and ramus increases correspondingly.[4, 5]

The cranial base dimensions affect the relationship of naso–maxillary complex and the mandible.[6, 7] Tanabe *et al*.,[8] reported that there was a certain relationship between the saddle angle (NSBa) and the variation of flexure of maxillofacial. The length and inclination of the posterior cranial base have influence on the position of the glenoid fossa. Bjork[4] and McNamara[9] observed that the change in cephalo-

metric values were associated with the change in the orientation of the cranial base without a concomitant change in the craniofacial skeleton.

The aims of this study were designed to assist the variations of the cranial base parameters in Class I, II and III skeletal relationships for both sexes.

MATERIALS AND METHODS

The sample consisted of 90 lateral cephlaometric radiographs for Iraqi adolescents of age 15–18 years who were attended for the Department of Pedodontics, Orthodontics and Preventive Dentistry, College of Dentistry, University of Mosul. The sample was grouped into three groups according to the ANB angle to: Class I group (ANB angle 0–2 degree), Class II group (ANB angle more than 2 degree) and Class III group (ANB angle less than 0 degree). Each of these groups were consisted of 15 subjects for each sex.

The method was conducted as follows:

1. Tracing all the lateral cephalometric radiographs especially the SNA, SNB and ANB angles and the cranial base lines (NS, NBa, SAr and SCo) and angles (NSBa, SBaN, NSCo and NSAr) (Figure 1).
2. Measurement of cranial base lines and angles for the three groups were recorded.

The results were analyzed by Descriptive analysis (which involve mean, standard deviation, minimum and maximum values), Student's t–test (at $p \leq 0.05$ significant level to find the sex variation), and Duncan's Multiple Range Test (at $p \leq 0.05$ significant level to reveal variation among the three skeletal groups).

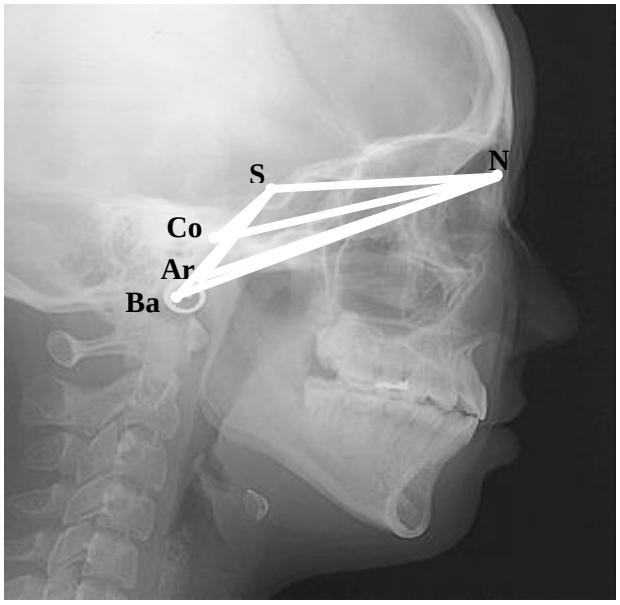

Figure (1): The cranial base parameters. Lines: SN, NBa, SAr, SCo; Angles: NSBa, SBaN, NSAr, NSCo.

RESULTS

The variation of the cranial base parameters between males and females for Class I, II and III skeletal relationships were shown in Tables (1–3). The mean value of these parameters were insignificantly higher in males than females at $p \leq 0.05$ significant level for the three skeletal relationships.

Duncan's Multiple Range Analysis for the cranial base parameters at $p \leq 0.05$ significant level among Class I, II, and III skeletal relationships for both sexes were presented in Tables(4, and 5) and Figures (2, and 3). Class II appeared significantly greater mean value in parameters (line SN, SBa and NBa, and NSBa angle) for both sexes. The parameters NSCo and NSAr angles significantly larger in Class II relationship than other skeletal relationships

for males. The cranial base parameters (line SCo and angle SBaN) were insignificantly greater in Class II than Class I and III skeletal relationships for both sexes. The parameter SAr line was insignificantly higher in Class II than Class I and III for males.

DISCUSSION

The insignificant greater mean value of the cranial base parameters (line SN, SBa, SCo, SAr and NBa, and angles NSBa, NSCo, NSAr and SBaN) in males than females for Class I, II and III skeletal relationships. this comes in accordance with Graber,[2] who reported that the gender variation indicates that the cranial differrentiation wass strongly genetically determined. Other researchers[10, 11] observed that the gender variation could be due to that the growth rate of males is faster and longer time than females. Lewis *et al*.,[12] and Axelsson[13] concluded that the cranial base elongates more in males than females. The insignificant gender variations in Class I matched the findings of the authors regarding the following parameters: NBa,[14] NSBa, NSCo,[15, 16] NSAr.[16] Others found that the mean value in males was approached the significant level in the cranial base line SN.[17, 18] Researchers found the gender variation in Class I occlusion was significantly larger in the following cranial base parameters: NS,[17, 18] SBa, SAr[18, 19] and Co line, angles (NSCo and NSAr).[18] In contrast, it was demonstrated that the cranial base angle NSBa was greater in females than males for Class I occlusion.[20, 21]

Table (1): The variations of the cranial base parameters between male and female in Class I skeletal relationship

Parameter	Sex	Sample Number	Mean ± SD	Minimum Value	Maximum Value	t–value	Significance
Linear*							
SN	M	15	76.3±1.6	72	79	1.43	Not significant
	F	15	75.8±1.8	71.5	78.5		
SBa	M	15	52.6±1.4	47	54	1.24	Not significant
	F	15	51.9±1.5	47.5	54		
SCo	M	15	24.8±1.2	20.5	27.5	1.61	Not significant
	F	15	23.6±1.4	20	27		
SAr	M	15	29.4±1.3	25.5	33	1.12	Not significant
	F	15	27.8±1.8	24.5	31		
NBa	M	15	116.4±2.2	112	120.5	1.86	Not significant
	F	15	114.7±2.3	111.5	118.5		
Angular**							
NSBa	M	15	122.3±1.4	118.5	125	1.65	Not significant
	F	15	120.8±2.2	116	123.5		
NSCo	M	15	112.1±2.4	108.5	125	1.42	Not significant
	F	15	110.8±1.8	110	116		
NSAr	M	15	117.6±1.9	113	121	1.38	Not significant
	F	15	115.2±2.1	111.5	118.5		
SBaN	M	15	36.4±1.4	33.5	39	1.26	Not significant
	F	15	34.2±1.8	30.5	37		

SD: Standard deviation; M: Males; F: Females.

* Linear measurements in millimeters; ** Angular measurements in degrees.

Table (2): The variations of the cranial base parameters between male and female in Class II skeletal relationship

Parameter	Sex	Sample Number	Mean± SD	Minimum Value	Maximum Value	t–value	Significance
Linear*							
SN	M	15	80.6±1.9	79	86.5	1.65	Not significant
	F	15	79.2±2.1	78	83		
SBa	M	15	54.4±1.4	51	58	1.22	Not significant
	F	15	54.7±1.2	48	55.5		
SCo	M	15	25.2±1.6	23	30	1.38	Not significant
	F	15	24.8±1.8	21.5	27.5		
SAr	M	15	31.5±1.1	28	34.5	1.03	Not significant
	F	15	29.6±1.2	27.5	33.5		
NBa	M	15	120.1±2.2	116	123.5	1.14	Not significant
	F	15	118.3±1.8	115	121.5		
Angular**							
NSBa	M	15	125.4±1.5	122	128	1.28	Not significant
	F	15	123.6±1.6	119.5	127		
NSCo	M	15	112.8±2.1	110	117	1.36	Not significant
	F	15	111.4±2.3	109.5	114		
NSAr	M	15	119.9±1.8	105	120.5	1.43	Not significant
	F	15	116.8±2.2	113	119.5		
SBaN	M	15	35.5±1.9	37.5	42	1.55	Not significant
	F	15	37.6±1.2	35.5	39.5		

SD: Standard deviation; M: Males; F: Females.
* Linear measurements in millimeters; ** Angular measurements in degrees.

Table (3): The variations of the cranial base parameters between male and female in Class III skeletal relationship

Parameter	Sex	Sample Number	Mean±SD	Minimum Value	Maximum Value	t–value	Significance
Linear*							
SN	M	15	77.5±1.6	71.5	76	1.36	Not significant
	F	15	70.6±1.2	72.5	76.5		
SBa	M	15	47.5±1.5	44	50	1.62	Not significant
	F	15	46.2±1.3	44	48.5		
SCo	M	15	21.2±1.4	19	23.5	1.48	Not significant
	F	15	20.8±1.5	17.5	23		
SAr	M	15	27.6±1.6	21.5	27	1.12	Not significant
	F	15	22.8±1.7	19	25		
NBa	M	15	111.9±1.9	108.5	114	1.66	Not significant
	F	15	109.4±2.1	107	112.5		
Angular**							
NSBa	M	15	117.8±1.9	115.5	120	1.24	Not significant
	F	15	115.6±2.1	112	118.5		
NSCo	M	15	108.4±1.7	105.5	110.5	1.18	Not significant
	F	15	106.5±1.5	104	109		
NSAr	M	15	113.1±1.8	110	115.5	1.34	Not significant
	F	15	110.7±1.6	108	112.5		
SBaN	M	15	34.6±1.8	29	34	1.62	Not significant
	F	15	29.5±1.5	27	31.5		

SD: Standard deviation; M: Males; F: Females.
* Linear measurements in millimeters; ** Angular measurements in degrees.

Table (4): The variation of cranial base parameters among Class I, II and III skeletal relationships for males

Parameters	Class I		Class II		Class III		F–value
	No.	Mean ± SD	No.	Mean ± SD	No.	Mean ± SD	
Linear*							
SN	15	77.8 ± 1.6 ^{B}	15	80.6 ± 1.9 ^{C}	15	73.2 ± 1.6 ^{A}	9.81
SBa	15	52.6 ± 1.4 ^{B}	15	54.4 ± 1.4 ^{C}	15	47.5 ± 1.5 ^{A}	9.49
SCo	15	24.8 ± 1.2 ^{A}	15	25.2 ± 1.6 ^{AB}	15	21.2 ± 1.4 ^{A}	4.26
SAr	15	29.4 ± 1.3 ^{A}	15	31.5 ± 1.1 ^{AB}	15	27.6 ± 1.6 ^{A}	4.53
NBa	15	116.4 ± 2.2 ^{B}	15	120.1 ± 2.2 ^{C}	15	111.9 ± 1.9 ^{A}	10.22
Angular**							
NSBa	15	122.3 ± 1.4 ^{B}	15	125.4 ± 1.5 ^{C}	15	117.8 ± 1.9 ^{A}	9.76
NSCo	15	112.1 ± 2.4 ^{AB}	15	112.8 ± 2.1 ^{C}	15	108.4 ± 1.7 ^{A}	9.24
NSAr	15	117.6 ± 1.3 ^{AB}	15	119.9 ± 1.8 ^{C}	15	113.1 ± 1.8 ^{A}	9.10
SBaN	15	34.4 ± 1.4 ^{AB}	15	35.5 ± 1.9 ^{AB}	15	31.6 ± 1.8 ^{A}	4.65

No.: Number; SD: Standard deviation.
Different letters mean significant difference ($p \leq 0.05$).
* Linear measurements in millimeters; ** Angular measurements in degrees.

Table (5): The variation of cranial base parameters among Class I, II and III skeletal relationships for females

Parameters	Class I		Class II		Class III		F–value
	No.	Mean ± SD	No.	Mean ± SD	No.	Mean ± SD	
Linear*							
SN	15	75.8 ± 1.8 ^{B}	15	79.2 ± 2.1 ^{C}	15	70.5 ± 1.6 ^{A}	10.31
SBa	15	51.9 ± 1.5 ^{B}	15	54.7 ± 1.2 ^{C}	15	46.2 ± 1.3 ^{A}	9.86
SCo	15	23.6 ± 1.4 ^{A}	15	24.8 ± 1.8 ^{AB}	15	20.8 ± 1.5 ^{A}	4.86
SAr	15	27.8 ± 1.8 ^{AB}	15	29.6 ± 1.2 ^{B}	15	22.8 ± 1.7 ^{A}	4.80
NBa	15	114.7 ± 2.3 ^{B}	15	118.3 ± 1.8 ^{C}	15	109.4 ± 2.1 ^{A}	10.42
Angular**							
NSBa	15	120.8 ± 2.2 ^{B}	15	123.6 ± 1.5 ^{C}	15	115.6 ± 2.1 ^{A}	11.21
NSCo	15	110.8 ± 1.8 ^{AB}	15	111.4 ± 2.3 ^{B}	15	106.5 ± 1.5 ^{A}	10.76
NSAr	15	115.2 ± 1.6 ^{AB}	15	116.8 ± 2.2 ^{AB}	15	110.7 ± 1.6 ^{A}	10.68
SBaN	15	34.2 ± 1.8 ^{AB}	15	37.6 ± 1.2 ^{C}	15	29.5 ± 1.5 ^{A}	10.36

No.: Number; SD: Standard deviation.
Different letters mean significant difference ($p \leq 0.05$).
* Linear measurements in millimeters; ** Angular measurements in degrees.

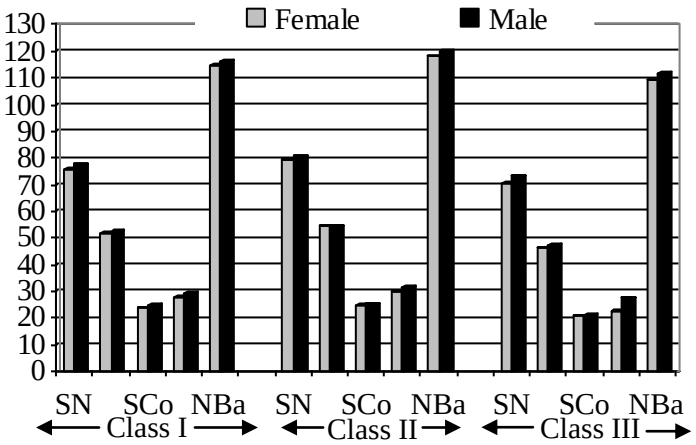

Figure (2): Comparison of the linear cranial base parameters between males and females

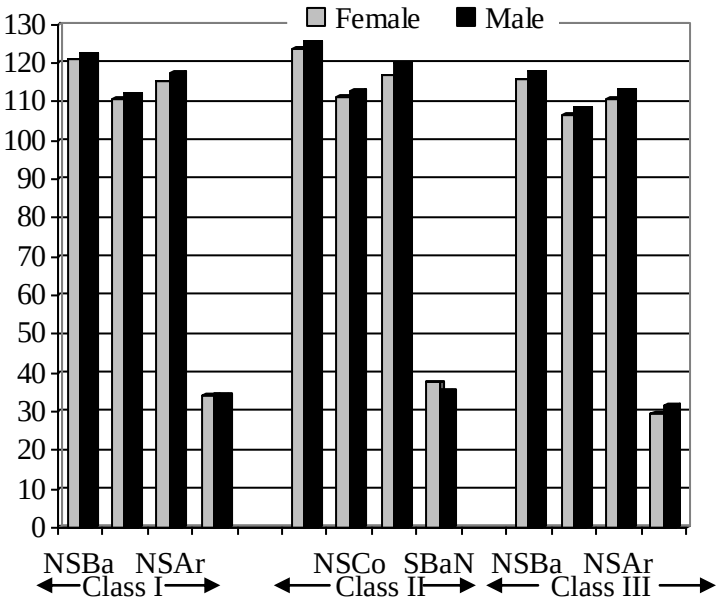

Figure (3): Comparison of angular cranial base parameters between males and females

No significant gender variation of the cranial base parameters were demonstrated in Class II relationship coincide the studies concerning NSBa and NSCo angles,[15, 21,22] NSAr;[18] where as the cranial base parameters (NSBa, NSCo, SN, SBa, SCo, SAr and NBa) were not matching the findings of Al–Sultan,[18] Gasgoos[23] concerning NSBa, SN, NBa and SBa; and Al–Hamadany[24] regarding SN line.

No significant gender variation of the cranial base parameters disclosed in Class III occlusion; this was agreed regarding the NSAr angle and was not matching concerning the SN and SAr lines.[25]

The significant increase in the mean value of cranial base lines (SN, SBa and NBa) and angle NSBa in Class II skeletal relationships for both sexes than in Class I and III skeletal relationships. This could be due to the more growth in the cranial base in Class II relationship, which develop large and protruded maxillary complex. These come in accordance with the conclusion of Keer and Adam,[26] who stated that the cranial base lengths are corresponded strongly with maxillary lengths. Anderson and Popovich[27] observed that Class II tendency in group with large cranial base angles. According to other studies,[28, 29] the facial prognathism was due to opening of the cranial base angle (NSBa). The large cranial base flexure (NSBa) angle was associated with Class II than Class I relationships.[30, 31]

The significant large of the linear parameters (SN, SBa) come in accordance with other studies.[18, 32–34] The line NBa is in agreement with other researchers.[14, 18, 34]

The insignificant greater mean value of the cranial base line (SCo and SAr) in Class II for both sexes are not matching the findings of other studies.[7, 18, 34]

The significant large cranial base angles (SCo, SAr) in Class II than Class I for males and insignificant for females were matching the results of other researchers[18,34] concerning males and disagreed with that concerning females. The insignificant greater cranial base angle (SBaN) in Class II for males and significantly higher for females was in accordance with the findings of Johannsdottir *et al*.[19] regarding females, and Lau and Hagg[35] regarding males.

The significant higher mean value of the cranial base parameters (lines: SN, SBa and NBa; and angle NSBa) and the insignificant greater mean value of the cranial base (line: SCo and SAr; and angles: NSCo, NSAr and SBaN) in Class I more than Class III for both sexes indicate that Class I group represented the average dimension among Class II and Class III skelet-

al relations. This comes with the conclusions of other researchers,[6, 36] who reported that the cranial base dimensions affect the relationship of the naso–maxillary complex and the mandible. Klocke *et al*.[37] stated that the relationship between cranial base flexure and the skeletal pattern of the jaws seems to be established before the age 5 years. The lowest mean value of the cranial base parameters in Class III subjects than in Class I and II skeletal relation was matching the results of Bjork,[3] who demonstrated that Class III occlusion due to shortening and angular bending of the cranial base. Nagahara *et al*.,[38] reported that the anterior cranial base length (SN) in Class III occlusion tend to be small. Battagel[39] found that the cranial base is smaller in subjects with Class III occlusion and associated with smaller cranial base angle (BaSN) and more anteriorly positioned of articular point (Ar). These results were in accordance with Said[25] concerning the angle NSAr, and in contrast with the findings of other researchers[40, 41] concerning the SAr line. They reported that line SAr was larger in Class III, and Said[25] found that the lines SAr and SN were insignificantly smaller in Class III occlusion.

CONCLUSION

This study demonstrated that there were strongly growth pattern variation among Class I, II and III skeletal relationships concerning the cranial base parameters (lines SN and SBa, and angle NSBa), and relatively concerning the parameters (lines SAr and SCo, and angles NSAr and NSCo). Moreover, the study does not show significant differences in the cranial base parameters between genders.

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