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Influence of cranial base parameters on the mandibule in class II division 1 malocclusion (Three dimensional cephalometric study)

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ABSTRACT

Aim: To evaluate the effect of cranial base parameters on mandibular parameters in class II division 1 malocclusion in three dimensions. **Materials and Methods**: The sample consists of 103 students age range between (18–24) years, 103 students (50 males and 53 females) having class II division 1malocclusion. Lateral and posteroanterior radiographs were taken for each subject. Cranial base measurement included (five angular and seven linear measurements). Mandibular measurement included (six angular and eleven linear measurements). Descriptive statistical analysis was used to describe the data using Pentium computer using SPSS program. **Results**: Cranial base flexures play a role in determination of lower jaw position which represented by significant effect of cranial base angles (N–S–Ba, N–S–Ar and S–Ba–N) on the angles (SNB, SN–Pog and SN–Id). The increase in the anterior and posterior cranial base lengths (S–N and S–Ba) will affect mandibular dimensions in class II division 1 malocclusion represented by significant effect on (Go–Me, Ar–Go, RW, N–Me , ANS–Me and S–GO). **Conclusion**: Total cranial base length increase (N–Ba) will have significant effect on all mandibular dimensions in class II division 1 malocclusion (Go–Me, Ar–Go, RW, N–Me, ANS–Me, S–Go, and Co–Gn). Significant effect of both anterior and posterior cranial base widths (GL–GL and Mas–Mas) on mandibular width measured at Condyle, Gonion and Antegonion points. Only (GL–GL) have effect on mandibular width (Lm–Lm).

Key Words: Influence, Cranial base, Class II division 1 malocclusion.

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INTRODUCTION

The aims of orthodontic diagnosis are to observe and evaluate the relationship of various part of facial skeleton and to study interrelation between them.[1]

However, the relation between cranial base flexure and malocclusion has been studied by many authors. One group contends that the cranial base flexure has no effect on the class of malocclusion or mandibular prognathism.[2–4]

Whereas others contend that the cranial base flexure is the factor.[5–8] According to Scott [9], three main factors influence facial prognathism:

1. Opening of cranial base angle (N–S–Ba).
2. The relative forward movements of components like maxilla and mandible to the cranium.
3. Amount of surface deposition along the facial profile between Nasion (N) and Menton (Me).

The assessment of class II malocclusion; especially the mandible, had more posterior position under the cranium which associated with more opening of flexure of the cranial base.[10]

The cranial base angle represents the fundamental determination of jaw relationship, but this may be compensated by different jaw relationship manifested by a change in angle ANB. The cranial base angle at age five years can be considered as an accurate prediction of eventual occlusal type of patient at age 15 year.[6]

The aims of study is to determine the effect of cranial base parameters on the

mandibular parameters in class II division 1 malocclusion.

MATERIALS AND METHODS

The samples were selected from Mosul University. A total of 2500 students were clinically examined and 224 students were selected, aged range from (18–25) years. The final size of sample is 103 which include 50 males and 53 females having class II division 1 malocclusion.

Criteria used to select Angle Class II division 1 Malocclusion Group:

1. Bilateral distal lower molar and canine relationships of at least one–half cup width.[11, 12]
2. Over jet more than 5 mm.[13]
3. Complete permanent dentition in both jaws excluding third molars.[14]
4. No massive proximal caries, no traumatized or fractured anterior teeth and no congenital missing or history of orthodontic treatment.

All radiographs were taken at the X–ray department of the College of Dentistry University of Mosul using cephalometric machine (cranex 3+ ceph by soredex orion corporation). The machine was set at 75 KV for lateral cephalometric radiograph and 80 KV for posteroanterior radiograph and 10 mA power with 2 second impulses.

Under standardized condition, two x–ray films were taken for each selected subject of this x–ray, one for lateral view and the other for frontal view. The subject is set in standing position with his head fixed by two ear rods laterally and a plastic nasal stopper on the bridge of the nose anteriorly, so the Frankfort horizontal plane is kept parallel to the floor. The subject is in centric occlusion during exposure.[15,16] Then the radiographs were traced and the measurements obtained include**:** cranial base angles (N–S–Ba, N–S–Ar, S–Ba–N) and dimensions, anterior and posterior cranial base widths (Gl–Gl, Mas–Mas), SNB, SN–Pog, SN–Id, S–Ar–Go (articular angle), Ar–Go–Me (gonial angle), SN–MP angles. in addition to the mandibular dimensions.

Duncan test was used to find the effect of cranial base parameters on the mandibular parameters.

RESULTS AND DISCUSSION

A significant effect was found of N–S–Ba (cranial base flexure) on the SNB and SN–Pog. This result indicates that cranial base flexure play a role in determining mandibular position in relation to cranial base in class II division 1 malocclusion. Tanabe *et al.*,[17] found that SNB was inversely related to the flexure of the cranial base. The result of present study is supported by findings by Andria *et al.*,[8], but it contradicts with Wilhelim *et al.*,[3] (Table 1).

Table (1) Effect of N–S–Ba on Angular Measurements of the Mandible

Angle	N–S–Ba (Mean ± SE) (°)				Significant
	≤100°	100–104°	105–109°	≥110°	
SNB	75.65 ± 0.49 a	75.65 ± 0.29 a	75.85 ± 0.36 b	75.03 ± 0.79 b	Significant
SN–Pog	78.75 ± 0.47 b	78.56 ± 0.30 ab	77.09 ± 0.61 a	77.42 ± 0.66 ab	Significant
SN–Id	78.40 ± 0.92 a	78.76 ± 0.51 a	77.09 ± 0.71 a	77.03 ± 0.46 a	Not Significant
S–Ar–Go	141.09 ± 1.11 a	141.02 ± 0.9 a	140.26 ± 1.29 a	142.8 ± 2.1 a	Not Significant
Ar–Go–Me	124.25 ± 1.25 a	126.45 ± 0.78 a	125.57 ± 1.28 a	126.38 ± 1.69 a	Not Significant
SN–MP	30.12 ± 1.42 a	32.08 ± 0.83 a	32.64 ± 1.3 a	31.73 ± 1.23 a	Not Significant

SE: Standard error; Different letters horizontally mean significant difference, SNB: Anteroposterior position of mandible. SN–Pog: Sella–Nasion–Pogonion angle. SN–Id: Anteroposterior position of alveolar part of premaxilla. S–Ar–Go: Articular angle. Ar–Go–Me: Gonial angl. .SN–MP: Angle between Sella–Nasion line and mandibular plane.

A significant effect of N–S–Ar (Saddle angle) was found on the SNB and S–Ar–Go. This result indicates that the increase in N–S–Ar in class II division 1 malocclusion may effect the basal position of the mandible in relation to anterior cranial base and affect articular angle. This result is supported by finding of some investigators.[17, 18] (Table 2)

Table (2) Effect of N–S –Ar on Angular Measurements of the Mandible

Angle	N–S–Ar (Mean ± SE) (°)				Significance
	≤120°	121–125°	126–130°	>130°	
SNB	76.07 ± .26 b	76.01 ± 0.32 b	75.38 ± 0.45 ab	74.3 ± 0.73 a	Significant
SN–Pog	77.94 ± 0.50 ab	78.83 ± 0.32 b	78.0 ± 0.45 ab	77.23 ± 0.72 a	Not Significant
SN–Id	77.75 ± 0.65 ab	79.19 ± 0.57 b	78.16 ± 0.66 ab	76.56 ± 0.94 a	Not Significant
S–Ar–Go	144.48 ± 1.1 b	142.78 ± 0.92 b	137.87 ± 1.04 a	136.93 ± 1.49 a	Significant
Ar–Go–Me	125.0 ± 1.06 a	125.36 ± 0.93 a	127.22 ± 1.05 a	126.53 ± 1.69 a	Not Significant
SN–MP	31.67 ± 1.24 a	30.66 ± 0.94 a	32.12 ± 1.18 a	34.1 ± 1.01 a	Not Significant

SE: Standard error; Different letters horizontally mean significant difference, SNB: Anteroposterior position of mandible. SN–Pog: Sella–Nasion–Pogonion angle. SN–Id: Anteroposterior position of alveolar part of premaxilla. S–Ar–Go: Articular angle. Ar–Go–Me: Gonial angl. .SN–MP: Angle between Sella–Nasion line and mandibular plane.

No significant effect of N–S–Co on any of mandibular angular parameters.

This result means that lateral cranial base flexure has no effect on mandibular position and form in class II division 1 malocclusion as noticed in the Table (3). This result may explain that mandibular condyle is located in lateral sagittal plane and not in median sagittal and also due error in determination of Condylion point during tracing is due to difficulty in localization of this point. This result is in agreement with Wilhelim *et al.*,[3]. It contradicts with the other researchers.[10, 19]

Table (3) Effect of N–S–Co on Angular Measurements of the Mandible

Angle	N–S–Co(Mean±SE) (°)					Significant
	≤120°	121–125°	126–130°	113–135°	>135°	
SNB	75.68 ± .35 a	75.66 ± .41 a	75.62 ± .47 a	75.77 ± .67 a	75.35 ±.69 a	Not Significant
SN–Pog	78.31 ± .34 a	78.32 ± .56 a	78.17 ± .47 a	78.04 ± .72 a	77.64 ± .64 a	Not Significant
SN–Id	79.15 ± .70 a	78.22 ± .74 a	77.58 ± .76 a	77.9 ± .81 a	77.82 ± .71 a	Not Significant
S–Ar–Go	143.93 ± 1.57 a	141.80 ± 1.11 ab	138.8 ±1.11 a	140.18 ± 1.93 ab	140.82 ± 1.19 ab	Not Significant
Ar–Go–Me	125.4 ± 1.61 a	126.02 ± .72 a	125.55 ± .93 a	126.0 ± 1.42 a	127.0. ± 1.7 a	Not Significant
SN–MP	32.34 ± 1.4 a	31.72 ± 1.1 a	32.12 ± 1.02 a	31.27 ± 1.26 a	31.32 ± 1.73 a	Not Significant

SE: Standard error; Different letters horizontally mean significant difference, SNB: Anteroposterior position of mandible. SN–Pog: Sella–Nasion–Pogonion angle. SN–Id: Anteroposterior position of alveolar part of premaxilla. S–Ar–Go: Articular angle. Ar–Go–Me: Gonial angl. .SN–MP: Angle between Sella–Nasion line and mandibular plane.

A significant effect S–Ba–N (posterior cranial base angle) was found on the SN–Pog and SN–Id. This means that effect of decrease of this angle will cause more retorted position of the mandible and alveolar process in relation to anterior cranial base. Andria *et al.*,[8] found that posterior cranial base angle had statistically significant effect on both the skeletal facial angle and the alveolar point reflecting a more posterior skeletal and alveolar position of the mandible and this supports the finding of present study.(Table 4)

Table (4) Effect of S–Ba–N on Angular Measurements of the Mandible

Angle	S–Ba–N (Mean ± SE) (°)			Significant
	<30°	30–32°	>32°	
SNB	75.45 ± 0.49 a	75.69 ± 0.39 a	75.64 ± 0.27 a	Not Significant
SN–Pog	77.09 ± 0.57 a	77.91 ± 0.38 ab	78.90 ± 0.30 b	Significant
SN–Id	76.79 ± 0.49 a	77.85 ± 0.54 ab	79.10 ± 0.59 b	Significant
S–Ar–Go	140.81 ± 1.4 a	141.98 ± 1.06 a	140.6 ± 0.89 a	Not Significant
Ar–Go–Me	126.04 ± 0.97 a	126.61 a	125.33 ± 0.81 a	Not Significant
SN–MP	32.60 ± 1.11 a	32.95 ± 0.98 a	30.61 ± 0.87 a	Not Significant

SE: Standard error; Different letters horizontally mean significant difference, SNB: Anteroposterior position of mandible. SN–Pog: Sella–Nasion–Pogonion angle. SN–Id: Anteroposterior position of alveolar part of premaxilla. S–Ar–Go: Articular angle. Ar–Go–Me: Gonial angl. .SN–MP: Angle between Sella–Nasion line and mandibular plane.

A significant effect of S–N (anterior cranial base length) was found on the Go–Me (mandibular body length), Ar–Go (ramus height), RW (ramus width), N–Me (anterior facial height), ANS–Me (lower anterior facial height) and S–Go (posterior facial height) as shown in Table (5). This means that the increase in (anterior cranial base length) will have effect on mandibular dimensions in class II division 1 malocclusion. This is in agreement with Kasai *et al.*,[20] who found that variation in anterior cranial base was associated with difference in anterior facial height, lower anterior facial height and ramal width. Beside that, a signification effect of S–Ba (posterior cranial base length) was found on the Go–Me (mandibular body length), Ar–Go (ramus length), RW (ramus width), N–Me (anterior facial height), ANS–Me (lower anterior facial height) and S–Go (posterior facial height). This means that the increase in S–Ba (posterior cranial base length) will have an effect on mandibular dimension in class II division 1malocclusionand this was cleared in Table (6) this may be explained as the glenoid fossa is located in the posterior cranial base; an elongated cranial base would bring the glenoid fossa backward and place the mandible in a retrusive position which makes the mandible to rotate slightly downward and backward. This will produce class II characteristics.[5,21] This result is in agreement with other researchers.[8, 22, 23]

A significant effect of N–Ba (total cranial base length) was found on all dimensions that determine form and position the mandible (Go–Me, Ar–Go, Co–Gn, Co–Go, RW, ANS–Me, N–Me, S–Ar and S–Go).

This mean that an increase in N–Ba (total cranial base length) which means that the elongation of cranial base will affect mandibular dimension and lead to mandible characteristics of class II division 1.This is in agreement with Kasai *et al.*,[20] and Andria *et al.*,[8] proposed that the increase in cranial base flexure will be compensated by the increase in cranial length (N–Ba) and this elongation in length (N–Ba) will place the Basion point and mandible post-

eriorly and vice versa. This will produce the characteristics of class II division 1maloccusion which support the finding of the present study and this is obvious in Table (7).

Table (5) Effect of S–N on Mandibular Dimensions

(mm)	S–N (Mean ± SE) (mm)				Significant
	≤ 70 mm	71–75 mm	76–80 mm	>80 mm	
Go–Me	78.0 ± 1.37 a	81.28 ± 0.90 ab	83.97 ± 0.83 b	86.62 ± 1.22 c	Significant
Ar–Go	45.19 ± 2.21 a	50.13 ± 1.19 ab	53.11 ± 1.03 b	55.37 ± 1.68 b	Significant
Co–Gn	122.96 ± 2.4 a	123.61 ± 1.3 a	126.19 ± 1.97 a	128.12 ± 2.78 a	Not Significant
RW	30.61 ± 0.68 a	31.43 ± 0.37 a	34.43 ± 0.47 b	34.25 ± 1.25 b	Significant
ANS–Me	74.0 ± 1.46 a	73.55 ± 1.03 a	76.58 ± 1.06 ab	80.75 ± 2.23 b	Significant
N–Me	120.88 ± 1.36 a	127.0 ± 1.2 b	129.18 ± 1.29 b	135.0 ± 2.8 c	Significant
S–Go	77.65 ± 1.43 a	81.17 ± 1.13 ab	85.86 ± 1.26 b	91.81 ± 1.42 c	Significant

SE: Standard error; Different letters horizontally mean significant difference. Go–Me: mandibular body length . Ar–Go: ramus height. Co–Gn: Gonion–Gnathion.RW: ramus width. ANS–Me: Anterior nasal spin–Menton. N–Me: anterior facial height. S–Go: posterior facial height.

Table (6) Effect of S–Ba on Mandibular Dimensions

(mm)	S–Ba (Mean ± SE) (mm)				Significant
	<48 mm	48–52 mm	53–57 mm	>57 mm	
Go–Me	80.41 ± 1.36 a	80.51 ± 0.99 a	84.36 ± 0.74 b	84.14 ± 1.98 b	Significant
Ar–Go	48.05 ± 2.05 a	49.70 ± 1.07 ab	53.06 ± 1.37 b	53.0 ± 2.01 b	Significant
Co–Gn	122.02 ± 2.61 a	124.29 ± 1.28 a	125.63 ± 1.5 a	127.14 ± 2.4 a	Not Significant
RW	31.23 ± 0.50 a	31.97 ± 0.42 a	33.36 ± 0.68 b	33.21 ± 0.63 b	Significant
ANS–Me	73.64 ± 1.55 a	73.66 ± 0.91 b	76.59 ± 1.25 ab	78.28 ± 2.12 b	Significant
N–Me	122.97 ± 1.93 a	125.21 ± 1.14 a	129.93 ± 1.39 b	134.42 ± 1.76 b	Significant
S–Go	75.85 ± 2.01 a	81.17 ± 0.84 b	86.27 ± 1.3 c	89.89 ± 1.45 c	Significant

SE: Standard error; Different letters horizontally mean significant difference. Go–Me: mandibular body length . Ar–Go: ramus height. Co–Gn: Gonion–Gnathion.RW: ramus width. ANS–Me: Anterior nasal spin–Menton. N–Me: anterior facial height. S–Go: posterior facial height.

Table (7) Effect of N–Ba on Mandibular Dimensions

(mm)	N–Ba (Mean ± SE) (mm)						Significant
	≤ 100 mm	101–105 mm	106–110 mm	111–115 mm	116–120 mm	>120 mm	
Go–Me	763.0 ± 1.01 a	81.52 ± 0.79 bc	81.28 ± 1.18 b	82.9 ± 1.36 bc	85.9 ± 1.08 c	84.5 ± 2.40 bc	Significant
Ar–Go	45.2 ± 2.19 a	46.28 ± 1.07 a	49.61 ± 1.67 ab	51.84 ± 1.59 b	57.10 ± 1.33 c	54.62 ± 1.97 bc	Significant
Co–Gn	120.55 ± 2.84 a	121.65 ± 1.93 a	122.56 ± 1.95 a	125.08 ± 1.76 ab	130.6 ± 1.41 b	127.25 ± 2.8 ab	Significant
RW	30.5 ± 0.73	30.47 ± 0.5	32.52 ± 0.69	32.68 ± 0.53	34.2 ± 0.6	39.5 ± 1.26	Significant
ANS–Me	72.2 ± 1.60 ab	70.34 ± 1.43 a	74.45 ± 1.23 abc	76.22 ± 1.38 bc	78.0 ± 1.1 c	82.62 ± 2.49 d	Significant
N–Me	119.25 ± 1.72 a	122.42 ± 1.07 ab	124.64 ± 1.66 b	131.72 ± 1.38 c	130.7 ± 1.55 c	137.62 ± 2.39 d	Significant
S–Go	75.5 ± 1.49 a	77.97 ± 1.45 ab	81.0 ± 1.89 bc	84.68 ± 1.29 cd	89.4 ± 1.15 de	89.81 ± 1.72 e	Significant

SE: Standard error; Different letters horizontally mean significant difference. Go–Me: mandibular body length . Ar–Go: ramus height. Co–Gn: Gonion–Gnathion.RW: ramus width. ANS–Me: Anterior nasal spin–Menton. N–Me: anterior facial height. S–Go: posterior facial height.

A significant effect of S–Ar (posterior cranial base length) was found on Ar–Go (ramus height) and Co–Gn (effective mandibular length) as shown in Table (8).

This means that the effect of increased posterior cranial bass length will cause posterior rotation of the mandible which will produce characteristics of class II division 1 malocclusion. This result is in agreement with Tanabe *et al.*, [17] and Anderson and Popovich.[19]

Table (8) Effect of S–Ar on Mandibular Dimensions

(mm)	S–Ar (Mean ± SE) (mm)				Significant
	≤35 mm	36–40 mm	41–45 mm	>45 mm	
Go–Me	81.70 ± 1.08 a	82.15 ± 0.89 a	82.39 ± 1.03 a	83.0 ± 2.91 a	Significant
Ar–Go	45.65 ± 1.25 a	52.75 ± 1.28 ab	52.29 ± 1.17 bc	49.42 ± 3.0 d	Significant
Co–Gn	119.5 ± 2.07 ab	123.22 ± 1.37 a	127.89 ± 1.18 d	127.42 ± 3.77 bc	Significant
RW	31.65 ± 0.59 a	32.63 ± 0.53 a	32.63 ± 0.46 a	32.71 ± 1.53 b	Not Significant
ANS–Me	75.25 ± 1.46 c	74.06 ± 1.27 c	76.52 ± 0.98 c	72.71 ± 2.5 b	Not Significant
N–Me	123.90 ± 1.44	127.43 ± 1.34	128.80 ± 1.38	131.71 ± 3.07	Not Significant
S–Go	79.0 ± 1.54 a	83.65 ± 1.49 a	84.47 ± 1.14 a	84.00 ± 2.92 b	Not Significant

SE: Standard error; Different letters horizontally mean significant difference. Go–Me: mandibular body length . Ar–Go: ramus height. Co–Gn: Gonion–Gnathion.RW: ramus width. ANS–Me: Anterior nasal spin–Menton. N–Me: anterior facial height. S–Go: posterior facial height.

Significant effect of GL–GL anterior cranial base width was found on the Co–Co, Go–Go, AG–AG, and Lm–Lm. This means that there is a harmony of growth pattern between anterior cranial base and mandible in transverse plane in class II division 1 malocclusion and this result is in agreement with Hayashi [23] and this showed in Table (9).

Table (9) Effect of GL–GL on Mandibular Width Dimensions

(mm)	Gl–Gl (Mean ± SE) (mm)				Significant
	≤100 mm	100–104 mm	105–109 mm	≥110 mm	
Co–Co	105.64 ± 0.54 a	108.98 ± 0.88 ab	110.13 ± 1.17 b	116.92 ± 1.37 c	Significant
Go–Go	100.76 ± 1.45 a	103.83 ± 0.87 ab	105.59 ± 1.86 b	113.07 ± 1.16 c	Significant
Ag—Ag	87.05 ± 1.07 a	87.75 ± 0.63 a	89.95 ± 1.32 a	94.0 ± 1.4 b	Significant
Lm–Lm	53.97 ± 0.84 a	54.28 ± 0.59 a	56.59 ± 0.76 b	58.0 ± 0.79 b	Significant

SE: Standard error; Different letters horizontally mean significant difference. Co–Co: Condylon–Condylon; Go–Go: Ag—Ag: Lm–Lm: mandibular width

Significant effect of Mas–Mas (posterior cranial base width) was found on the Co–Co, Go–Go and AG–AG. This result indicated that there was a harmony of growth pattern of posterior cranial width with mandibular skeletal width in class II division 1 malocclusion. No effect on dental width and this may be associated with factors like tongue equilibrium with other oral forces (Table 10). This is in agreement with Hayashi.[23]

Table (10) Effect of Mas–Mas on Mandibular Width Dimensions

(mm)	Mas–Mas (Mean ± SE) (mm)					Significant
	110–114 mm	115–119 mm	120–124 mm	125–129 mm	>129 mm	
Co–Co	104.37 ± 0.96 a	106.26 ± 0.81 a	111.16 ± 1.13 b	112.95 ± 1.18 bc	115.66 ± 1.38 c	Significant
Go–Go	99.87 ± 1.54 a	101.33 ± 1.15 a	107.19 ± 1.71 b	107.10 ± 1.24 b	111.66 ± 1.99 c	Significant
Ag–Ag	86.5 ± 0.89 a	86.71 ± 0.96 a	90.44 ± 0.95 b	90.41 ± 1.12 b	91.93 ± 1.59 b	Significant
Lm–Lm	54.18 ± 0.82 a	54.2 ± 0.65 a	56.63 ± 1.07 a	55.45 ± 0.80 a	56.33 ± 0.96 a	Not Significant

SE: Standard error; Different letters horizontally mean significant difference. Co–Co: Condylon– Condylon; Go–Go: Ag—Ag: Lm–Lm: mandibular width

CONCLUSION

Total cranial base length increase (N–Ba) will have significant effect on all mandibular dimensions in class II division 1 malocclusion (Go–Me, Ar–Go, RW, N–Me, ANS–Me, S–Go, and Co–Gn). Significant effect of increased posterior cranial base length (S–Ar) was found on ramus height (Ar–Go) and effective mandibular length (Co–Gn) in class II division 1 malocclusion.

Significant effect of increase posterolateral cranial base length (S–Co) on mandibular dimensions in class II division 1 malocclusion on (Go–Me, RW, N–Me and S–Go). Significant effect of both anterior and posterior cranial base widths (GL–GL and Mas–Mas) on mandibular width measured at Condyle, Gonion and Antegonion points. Only (GL–GL) have effect on mandibular width (Lm–Lm).

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