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Correlating cranial base morphology in adults having skeletal class II malocclusion

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Abstract

Introduction: Anteroposterior relationship of the jaw base is affected by many factors, one of which is cranial base morphology. Cranial base has always been of significant interest in anthropology and evolution due to its marked effect on the development of adjacent regions including the brain, neck and craniofacial skeleton. Maxilla and mandible are attached to anterior and posterior parts of cranial base respectively, therefore any change in shape and size of cranial base would influence the position of both upper and lower jaws and their relationship to cranial base.

Aim: To correlate the cranial base morphology in adults having skeletal Class II malocclusion.

Materials and Method: 180 pre-treatments lateral cephalograms (90 males and 90 females) of subjects with the age group between 18-35 years were taken. They were divided into Class I, Class II Div. 1 and Class II Div. 2 subjects based on Overjet, ANB angle, Wits appraisal and molar relation. Various linear and angular

parameters were traced on radiographs to determine for variation.

Results: Cranial base angle (NSBa) and anterior cranial base length (SN) shows significant difference between both the groups. It is increased in Class II group as compared to Class I group. SNB angle and effective mandibular length (Cd-Gn) was significantly decreased in Class II Div 1 and Class II Div 2 as compared to Class I group. A significant correlation of cranial base angle (NSBa) with SNB is observed between all the three groups.

Conclusion: Cranial base angle (NSBa, SeSBa) increased in Class II Div. 1 and Class II Div. 2 group of subjects suggestive of posteriorly positioned mandible. Decreased SNB angle depicts mandible to be posteriorly positioned as compared to subjects with Class I malocclusion subject.

Keywords: Cranial base angle, lateral cephalogram, sagittal malocclusion, cranial base

Introduction

Cranial base has always been subject of interest in anthropology and evolution due to its marked effect on the development of adjacent regions including the brain, neck and craniofacial skeleton. Bjork was the first one to demonstrate the relationship between cranial base morphology to maxillomandibular jaw base morphology with use of cephalometric radiographs.[1]

Cranial base is a midline structure forms the floor of cranial vault and extends from foramen caecum anteriorly to foramen magnum posteriorly. It is uneven in shape with saddle shaped depression in the sphenoid bone at the center known as Sella turcica which houses pituitary gland dividing it into anterior and posterior parts being called anterior and posterior cranial bases respectively. Upper jaw is attached to anterior cranial base and lower jaw is attached to posterior cranial base.[2]

Cranial base flexes at Sella turcica in mid sagittal plane during developmental process forming an angle between them called saddle angle or cranial base angle. This cranial base flexion is attributed to faster growth of brain.[3] This can be justified in cranial base angle (N-S-Ba) which measures 142º at birth reduces to 130º at 5 years of age. Not much change is observed thereafter. However, any changes in this angle may lead to alteration in sagittal skeletal relationship of upper and lower jaws to each other relative to cranial base. This in turn may influence skeletal pattern and type of malocclusion.[2]

Malocclusion with sagittal skeletal discrepancy may not only be caused by abnormal form, size and position of cranial base. Maxilla, mandible and various interrelated factors like heredity, function and environment also have an effect on growth and development of maxillofacial bones.[4] Moreover, maxilla and mandible are attached to anterior and posterior parts of cranial base respectively, therefore any change in shape and size of cranial base would influence the position of both maxilla and mandible jaws and their relationship to cranial base.[2]

Many studies have investigated the correlation between cranial base morphology and malocclusion but the results are variable. As one of the factors affecting malocclusion, cranial base remains still a matter of debate. Therefore, this study was carried out to correlate cranial base morphology between Class I and Class II malocclusion.

Materials and Method

Pre-treatment lateral cephalograms of 180 subjects with the age group of 18-35 years were obtained from the Department of Orthodontics and Dentofacial Orthopaedics, Government Dental College and Hospital, Ahmedabad. They were divided into Class I, Class II

Div. 1 and Class II Div. 2 group based on ANB angle, Wits, molar relation and overjet.

Inclusion criteria

• No history of previous orthodontic treatment.

• Age group of the selected subjects in the range of 18-35 years.

Exclusion criteria

• Patients with craniofacial deformities.

• Cleft lip and palate.

• Mandibular deviation.

• Retained deciduous and/or missing permanent teeth except third molar.

All lateral cephalograms were taken with Vatech PHT 30 LFO smart machine with a film to focus distance of 150 cm and a film to median plane distance of 15 cm and FH plane parallel to the floor. The lateral cephalograms were traced with a standard technique using 2H 0.5 mm lead pencil on acetate tracing paper. Various reference points, planes and angles depicting skeletal jaw base and cranial base parameters were drawn and recorded for evaluation.

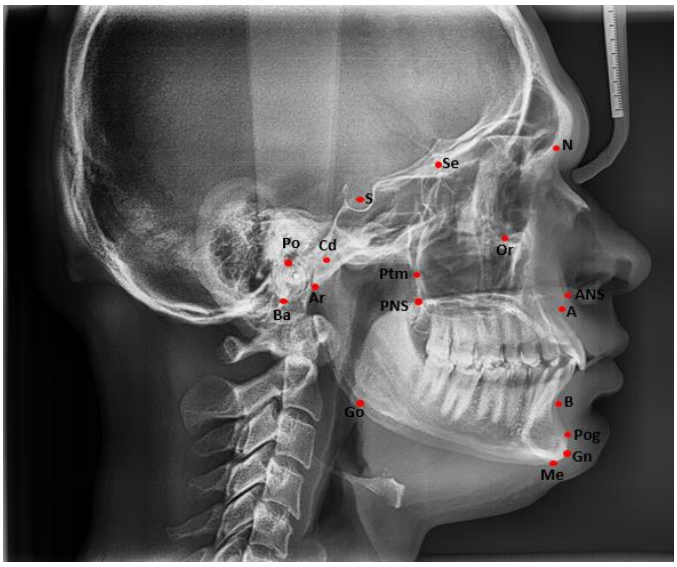

Fig 1: Reference points.

Reference points

Nasion (N), Sella (S), Sphenoidale (Se), Orbitale (Or), Basion (Ba), Porion (Po), Anterior nasal spine (ANS), Posterior nasal spine (PNS), Point A, Point B, Gonion (Go), Gnathion (Gn), Articulare (Ar), Condylion (Cd), Pogonion (Pog), Pterygomaxillary fissure (Ptm), Menton (Me)

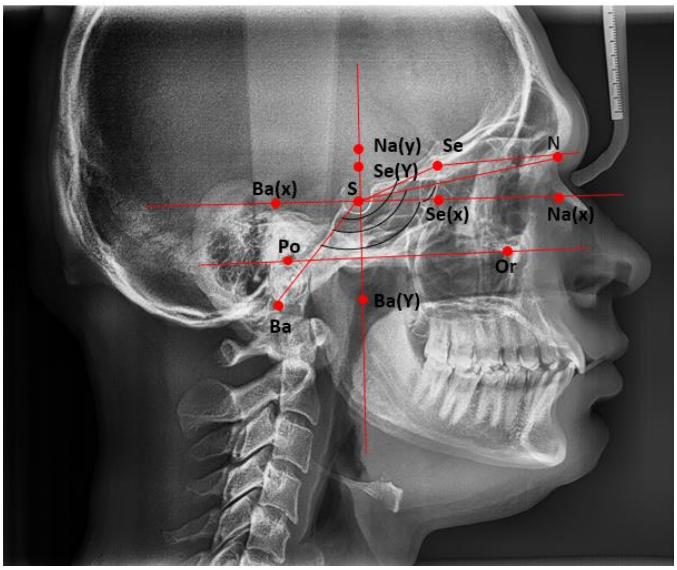

Fig 2: Linear and angular cranial base measurements.

Table 1: Various linear and angular cranial base parameters.

S-N:	Linear distance from the sella to nasion. This shows anterior cranial base length
S-Se:	Linear distance from the sella to sphenoidale
Se-N:	Linear distance from the sphenoidale to nasion
S-Ba:	Linear distance from the sella to basion. This shows posterior cranial base length
NSBa:	Angle between N-S and S-Ba line
SeSBa:	Angle between Se-S and S-Ba line
FH-SN:	Angle between FH plane and SN plane (x-axis and SN plane)
FH-SBa:	Angle between FH plan and SBa line (x-axis and SBa)
FH-SSe:	Angle between FH plane and SSe line (x-axis and SSe)
Na(x):	Point Na is marked perpendicular on x axis,

	and linear distance measured from Sella to point N
Na(y):	Point Na is marked perpendicular on y axis, and linear distance measured from Sella to point Na
Se(x):	Point Se is marked perpendicular on x axis, and linear distance measured from Sella to point Se
Se(y):	Point Se is marked perpendicular on y axis, and linear distance measured from Sella to point Se
Ba(x):	Point Ba is marked perpendicular on x axis, and linear distance measured from Sella to point Ba
Ba(y):	Point Ba is marked perpendicular on y axis, and linear distance measured from Sella to point Ba

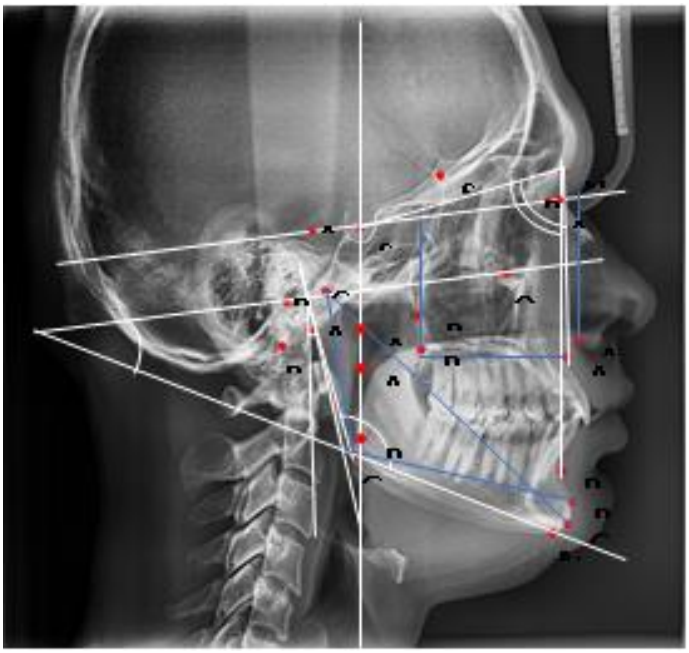

Fig 3: Linear and angular Jaw base measurements

Table 2: Various linear and angular jaw base parameters

SNA	Angle between the S-N and the N-A lines
SNB:	Angle between the S-N and the N-B lines.
Mandibular plane angle:	Angle between FH plane and Go-Me
Ramus inclination:	The angle between the Frankfort horizontal plane [FH] and the line connecting articulare (Ar) and gonion (Go)
Gonial angle:	Angle between Ar-Go and Go-Me
A' -Ptm':	Linear distance from point A to pterygomaxillary fissure (Ptm)
Anterior maxillary height (A Mx H):	Vertical distance from anterior nasal spine to its perpendicular intersection on the horizontal plane (X-axis)
Posterior maxillary height (P Mx H):	Vertical distance from posterior nasal spine to its perpendicular intersection on the horizontal plane (X-axis)
Cd-Gn:	Linear distance from condylion to gnathion
Go-Pog:	Linear distance from gonion to pogonion
Cd-Go:	Linear distance from condylion to gonion
A(x):	Point A is marked perpendicular on x axis, and linear distance measured from Sella to point A
A(y):	Point A is marked perpendicular on y axis, and linear distance measured from Sella to point A

B(x):	Point B is marked perpendicular on x axis, and linear distance measured from Sella to point B
B(y):	Point B is marked perpendicular on y axis, and linear distance measured from Sella to point B
Ar(x):	Point Ar is marked perpendicular on x axis, and linear distance measured from Sella to point Ar
Ar(y):	Point Ar is marked perpendicular on y axis, and linear distance measured from Sella to point Ar

Statistical analysis

The independent t test was used to do intergroup comparison and Pearson's correlation was used to analyse correlation between cranial and jaw base parameters.

Results

Table 3: Comparison of cranial base variables between Class I and Class II Div. 1 malocclusion

Cranial base variables	Class I (Mean±SD)	Class II Div. 1 (Mean±SD)	p value
NSBa(º)	128.7±0.54	131.26±1.36	0.000*
SeSBa(º)	150.34±1.1	150.49±5.70	1
FH-SN(º)	8.68±1.76	8.24±0.35	0.2
FH-SeS(º)	27.04±0.54	26.26±1.18	0.1
SN (mm)	69.86±2.21	71.56±2.82	0.01*
Sse (mm)	30.18±0.82	28.68±0.16	0.08
SeN (mm)	46.39±1.60	49.44±4.78	0.001*
Na(x)(mm)	71.81±4.92	73.98±1.58	0.023*
Na(y)(mm)	-10.01±2.05	-11.21±0.65	0.1
Se(x) (mm)	25.98±0.07	26.38±1.20	0.07
Se(y) (mm)	-16.18±2.33	-16.64±0.30	0.28
FH-SBa(º)	125.08±2.5	126.08±0.63	1
S-Ba (mm)	45.015±3.7	46.65±4.03	0.08
Ba(x) (mm)	-25.83±.07	-28.85±3.83	0.000*
Ba(y) (mm)	37.04±0.86	39.59±2.61	0.07

Table 4: Comparison of cranial base variables between Class I and Class II Div. 2 malocclusion

Cranial base variables	Class I (Mean±SD)	Class II Div 2 (Mean±SD)	p value
NSBa(º)	128.7±0.54	130.35±0.21	0.0001*
SeSBa(º)	150.34±1.1	150.94±1.11	0.11
FH-SN(º)	8.68±1.76	7.92±0.27	0.1
FH-SeS(º)	27.04±0.54	26.51±1.11	0.2
SN (mm)	69.86±2.21	71.11±1.06	0.002*
Sse (mm)	30.18±0.82	27.38±0.07	0.07
SeN (mm)	46.39±1.60	48.76±2.82	0.015*
Na(x) (mm)	71.81±4.92	74.31±1.53	0.0001*
Na(y) (mm)	-10.01±2.05	-10.26±0.40	0.2
Se(x) (mm)	25.98±0.07	26.08±0.16	0.2
Se(y) (mm)	-16.18±2.33	-16.71±0.49	0.1
FH-SBa(º)	125.08±2.85	126.65±0.49	0.2
S-Ba (mm)	45.015±3.27	45.33±3.49	0.37
Ba(x) (mm)	-25.83±.07	-28.04±3.69	0.001*
Ba(y) (mm)	37.04±0.86	38.41±0.61	0.06

Table 5: Comparison of maxillomandibular variables between Class I and Class II Div. 1 malocclusion

Maxillo mandibular variables	Class I (Mean±SD)	Class II Div. 1 (Mean±SD)	p value
SNA(º)	82.1±1.09	82.6±1.11	0.369
SNB(º)	79.2±1.13	75.7±1.79	0.0001*
Mandibular	24.9±0.53	26.3±3.29	0.08

plane angle(º)			
Ramus inclination(º)	7.8±0.68	6.6±0.56	0.45
Gonial angle(º)	123.0±2.43	124.4±5.81	0.56
A'-Ptm' (mm)	53.6±5.06	57.4±3.64	0.004*
AMxH (mm)	54.6±6.52	54.7±5.25	0.12
PMxH (mm)	44.1±2.66	45.0±7.42	0.08
Cd-Gn(mm)	112.7±5.53	109.4±6.9	0.04*
Go-Pog (mm)	74.3±2.89	73.7±4.52	0.57
Cd-Go (mm)	60.7±2.27	59.1±7.67	0.269
A(x) (mm)	68.2±1.03	69.7±0.37	0.001*
A(y) (mm)	47.0±3.23	48.1±7.28	0.1
B(x) (mm)	62.9±1.90	57.2±0.89	0.0001*
B(y) (mm)	81.1±3.15	85.0±11.4	0.301
Ar(x) (mm)	-19.2±3.28	-21.0±2.02	0.07
Ar(y) (mm)	30.5±1.76	31.0±1.34	0.181

Table 6: Comparison of maxillomandibular variables between Class I and Class II Div. 2 malocclusion

Maxillo mandibular variables	Class I (Mean±SD)	Class II Div. 2 (Mean±SD)	p value
SNA(º)	82.1±1.09	82.02±1.11	0.369
SNB(º)	79.2±1.13	76.73±1.79	0.000*
Mandibular plane angle(º)	24.9±0.53	23.33±3.29	0.02*
Ramus inclination(º)	7.8±0.68	6.9±0.56	0.09
Gonial angle(º)	123.0±2.4	122.41±5.8	0.54
A'-Ptm' (mm)	53.6±5.06	56.48±3.64	0.003*
AMxH (mm)	54.6±6.52	55.3±5.25	0.2
PMxH (mm)	44.1±2.66	44.5±7.40	0.269
Cd-Gn (mm)	112.7±5.53	111.4±6.79	0.03*
Go-Pog (mm)	74.3±2.89	73.9±4.54	0.53
Cd-Go (mm)	60.7±2.27	60.1±7.67	0.26
A(x) (mm)	68.2±1.03	70.7±0.37	0.000*
A(y) (mm)	47.0±3.23	47.3±7.28	0.1
B(x) (mm)	62.9±1.90	58.8±0.89	0.000*
B(y) (mm)	81.1±3.15	83.2±11.4	0.07
Ar(x) (mm)	-19.2±3.28	-20.8±2.02	0.06
Ar(y) (mm)	30.5±1.7	31.2±1.34	0.182

Table 7: Correlation of angular and linear cranial base parameters with maxillary jaw base parameters

Parameters	Class I	Class II Div. 1	Class II Div. 2
NSBa-SNA	0.16(p=0.08)	-0.46 (p=0.002*)	-0.50 (p=0.002*)
SBaFH-SNA	0.20 (p=0.28)	-0.18 (p=0.3)	0.13 (p=0.52)
SN-SNA	-0.06 (p=0.75)	-0.05 (p=0.25)	-0.14 (p=0.1)
SBa-SNA	0.05 (p=0.79)	0.02 (p=0.91)	0.08 (p=0.63)

Table 8: Correlation of angular and linear cranial base parameters with mandibular jaw base parameters

Parameters	Class I	Class II Div 1	Class II Div 2
NSBA-SNB	-0.54 p=0.002*)	-0.48 (p=0.003*)	-0.47 (p=0.003*)
NSBA-MPA	0.18 (p=0.34)	-0.06 (p=0.75)	-0.10 (p=0.59)
NSBA-Gonial angle	0.24 (p=0.20)	-0.13 (p=0.52)	0.06 (p=0.75)
NSBA-CdGn	0.04 (p=0.4)	-0.31 (p=0.04*)	-0.33 (p=0.03*)

SBAFH-SNB	0.35 (p=0.05)	-0.09 (p=0.4)	0.13 (p=0.52)
SBAFH-MPA	0.01 (p=0.59)	0.17 (p=0.32)	0.17 (p=0.37)
SBAFH-CdGn	0.04 (p=0.3)	0.01 (p=0.95)	-0.06 (p=0.75)
SBAFH-Gonial angle	0.04 (p=0.83)	0.02 (p=0.91)	0.36 (p=0.05)
SN-SNB	-0.05 (p=0.79)	-0.14 (p=0.06)	-0.20 (p=0.07)
SN- MPA	0.27 (p=0.13)	0.03 (p=0.87)	-0.07 (p=0.71)
SN-Gonial angle	0.05 (p=0.79)	-0.28 (p=0.13)	0.05 (p=0.79)
SN-CdGn	0.19 (p=0.36)	0.14 (p=0.46)	0.17 (p=0.37)
SBA-SNB	0.02 (p=0.91)	-0.01 (p=0.59)	-0.12 (p=0.52)
SBA-MPA	-0.01 (p=0.95)	-0.09 (p=0.63)	-0.01 (p=0.95)
SBA-Gonial angle	-0.23 (p=0.24)	-0.06 (p=0.75)	0.09 (p=0.63)
SBA-CdGn	0.6 (p=0.0001 *)	0.59 (p=0.0001 *)	0.6 (p=0.0002*)

Discussion

On comparison of cranial base parameters between Class I and Class II Div. 1 (Table III), NSBa (cranial base angle), SN (length of anterior cranial base), SeN, Nasion and Basion projected on X axis shows statistically significant difference between Class I and Class II Div 1 malocclusion (p=0.0001, 0.01, 0.001, 0.023, 0.0001 respectively) being larger in Class II Div 1 malocclusion (Table III). Similar variation is observed between Class I and Class II Div 2 malocclusion subjects (Table IV), (p=0.0001, 0.002, 0.015, 0.0001, and 0.001 respectively). These findings were in accordance with the study carried out by Kerr et al.[5], Sayin et al.[6], Agrawal et al.[7], Wilhelm et al.[8], Hopkin et al.[9] and Wallis et al.[10] who observed statistically significant difference of these parameters between these groups. Other angular and linear parameters like SeSBa, FH-SN, FH-SeS, SSe, Se(x), projection of nasion, sphenoidale and basion on y axis [Na(y), Se(y) and Ba(y) respectively], FH-SBa and posterior cranial base length (SBa) showed no significant differences between Class I and Class II Div 1 and Class II Div 2 malocclusion (Table III and IV). These findings are in accordance with the study conducted by Wilhelm et al.[8], Breh et al.[11] and Mortazavi et al.[12] who observed statistically non-significant difference of these parameters between these groups.

On comparison of jaw base parameters, it was found that angular parameter SNB and linear parameters like maxillary base length (A'-ptm'), effective mandibular length (Cd-Gn) and projection of point A and B on x axis [A(x) and B(x)] showed statistically significant difference between Class I and Class II Div 1 and Class II Div 2 malocclusion (Table V and VI) (p=0.0001, 0.004, 0.04, 0.001, 0.0001, 0.0002, 0.003, 0.03, 0.0001, 0.0002 and 0.02 respectively). Mandibular plane angle shows significant difference (p=0.02) on comparison between Class I and Class II Div 2 malocclusion. These findings are in accordance with the study conducted by Dhopatkar et al.[2], Sayin et al.[6], Chin et al.[13], Raja et al.[14], Awad et al.[15], Ahmed et al.[16], Kerr et al.[5], Rothstein et al.[17] Agrawal et al.[7] and Brezniak et al.[18] who observed the statistically significant difference of these parameters between these groups.

On correlating linear and angular cranial base parameters with maxillary jaw base parameters in Class I, Class II Div 1 and Class II Div 2 group (Table VII) it was found that cranial base angle (NSBa) showed significant negative correlation with angle SNA in Class II Div 1 and Class II Div 2 (r=-0.46 and -0.50 respectively) group.

On correlating linear and angular cranial base parameters with mandibular jaw base parameters in Class I, Class II Div 1 and Class II Div 2 group (Table VIII) it was found that Cranial base angle (NSBa) showed significant negative correlation to SNB (placement of mandible related to cranial base) in Class I, Class II Div 1 and Class II Div 2 (r=-0.54, -0.48 and -0.47 respectively) subjects. These findings are in accordance with the study conducted by Dhopatkar et al.[2], Raja et al.[14], Awad et al.[15] and Ahmed et al.[16] who obtained negative correlation of NSBa with SNB in Class I and Class II group.

Cranial base angle shows significant negative correlation to effective mandibular length (Cd-Gn) in Class II Div 1 and Class II Div 2 (r=-0.31 and -0.33 respectively) malocclusion. These findings are in accordance with the study conducted by Awad et al.[15] who obtained negative correlation of NSBa with CdGn in Class II Div 1 (r=-0.293) group. Whereas posterior cranial base length (SBa) shows positive correlation to effective mandibular length (Cd-Gn) in all three groups (r=0.6, 0.59 and 0.6 respectively). This is in accordance with the study conducted by Raja et al.[14], Awad et al.[15] and Ahmed et al.[16] who obtained positive correlation of SBa with CdGn in Class I and Class II group.

Conclusion

The present study concluded that

- Cranial base morphology in adults vary in Class I, Class II Div 1 and Class II Div 2 malocclusion.
- Cranial base angle (NSBa, SeSBa) increased in Class II Div 1 and Class II Div 2 group of subjects suggestive of posteriorly positioned mandible. This can be strengthened by decreased SNB showing mandible to be posteriorly positioned as compared to cranial base.
- Cranial base length and maxillary base length are significantly increased in Class II Div 1 and Class II Div 2 group of subjects.
- Thus, from this study we can conclude that cranial base angle may not be the only sole factor determining the malocclusion. Maxillomandibular variables may contribute to Class II malocclusion.

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