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Correlating cranial base morphology in adults having skeletal class III malocclusion

[1]Dr. Hemangi Raiththa, PG Student, Department of Orthodontics and Dentofacial Orthopaedics, Government Dental College and Hospital, Ahmedabad, Gujarat, India.

[2]Dr. Falguni Mehta, HOD and Professor, Department of Orthodontics and Dentofacial Orthopaedics, Government Dental College and Hospital, Ahmedabad, Gujarat, India.

[3]Dr. Renuka Patel, Professor, Department of Orthodontics and Dentofacial Orthopaedics, Government Dental College and Hospital, Ahmedabad, Gujarat, India.

[4]Dr. Megha Goswami, Assistant Professor, Department of Orthodontics and Dentofacial Orthopaedics, Government Dental College and Hospital, Ahmedabad, Gujarat, India.

Corresponding Author: Dr. Hemangi Raiththa, PG Student, Department of Orthodontics and Dentofacial Orthopaedics, Government Dental College and Hospital, Ahmedabad, Gujarat, India.

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Abstract

Introduction: Cranial base plays an important role in craniofacial growth. Maxilla is attached to anterior cranial base and mandible is attached to posterior cranial base. Therefore, any change in angle between anterior and posterior cranial base (cranial base angle) and cranial base length may lead to alteration in position of maxilla and/or mandible causing malocclusion. Class III malocclusion may occur due to decrease in cranial base angle and/or cranial base length, placing mandible more anteriorly as compared to normal.

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

Objectives: 1. To compare cranial base parameters between Class I (control group) and Class III malocclusion. 2. To compare maxillomandibular parameters between Class I and Class III malocclusion. 3. To correlate cranial base parameters to various maxillomandibular parameters responsible for sagittal discrepancies.

Materials and Method: Pre-treatment lateral cephalogram of 120 subjects with the age group of 18-35 years were taken. They were equally divided into Class I (30 males and 30 females) and Class III (30 males and 30 females) subjects based on ANB angle, Wits appraisal, molar relation and overjet. The radiographs

were traced manually and various parameters were measured.

Results: Cranial base angle (NSBa) and anterior cranial base length (SN) showed significant difference between Class I and Class III group. It was decreased in Class III group as compared to Class I group. Angle SNB, effective mandibular length and mandibular body length was significantly increased in Class III group as compared to Class I group. Also, there was significant correlation of cranial base angle (NSBa) with SNB in both the groups.

Conclusion: Increased SNB angle suggests mandible to be anteriorly positioned as compared to subjects with Class I group. Decreased cranial base angle will lead to anterior displacement of condyle and mandible and will lead to Class III malocclusion.

Keywords: Saddle angle, lateral cephalogram, maxillomandibular relationship, cranial base

Introduction

Cranial base has always been the subjects of various studies. It has major importance in orthodontics because its growth and development influence the growth of the maxilla and mandible and consequently in the development of anteroposterior relationship of the jaws. In 1863 Thomas Henry Huxley introduced the importance of cranial base in his book "Evidence as to Man's Place in nature"[1].

The cranial base represents a central and complex bone structure of the skull and forms the floor of the cranial vault on which the brain lies. It plays a key role in craniofacial growth and development, assisting to unite different patterns of growth which includes brain, nasal cavity, oral cavity and pharynx.

Importance of cranial base as a causative factor is strongly recognized. Main function of cranial base is to protect and support brain and provide platform for facial growth as it forms connection between cranial and facial parts of the skull and can affect development of both face and cranium hence growth at cranial base can strongly influence position of maxilla and mandible[2].

The objective of orthodontic treatment is to provide a pleasing esthetic profile, establishing structural balance and functional harmony of the face. Achieving these desired objectives depends on the proper planning of orthodontic treatment. Orthodontic treatment plan in turn requires a proper diagnosis of malocclusion. So, for that one needs to know the etiology of malocclusion.

Anteroposterior relationship of the jaw base is affected by many factors, one of which is cranial base morphology. Cranial base plays an important role in craniofacial growth because maxilla is attached to the anterior cranial base and mandible is attached to the posterior cranial base. Any changes in cranial base will influence the angle which is formed between anterior and posterior cranial base which is called as cranial base angle (saddle angle), it will lead to alteration in position of the jaws, which in turn will influence the relationship of the jaws to each other and with the cranium[3]. Closing of an angle (cranial base angle) will place the mandible more anteriorly and may produce skeletal Class III malocclusion.

Thus, correlation is shown to exist between cranial base morphology and sagittal relationship of the jaws. Therefore, this study was aimed correlate cranial base morphology and maxillomandibular components in Class III malocclusion. This could be helpful to understand etiology and various parameters affecting malocclusion for it to be corrected.

Materials and Method

This cross-sectional study was carried out in Department of Orthodontics and Dentofacial Orthopaedics, Government Dental College and Hospital, Ahmedabad. Pre-treatment lateral cephalograms of 120 subjects with the age group of 18-35 years were obtained. Patients with history of previous orthodontic treatment, cleft lip and palate, retained deciduous teeth, craniofacial deformities and missing permanent teeth were excluded.

These subjects were divided into Class I (30 males and 30 females) and Class III (30 males and 30 females) group based on ANB angle, Wits, molar relation and overjet.

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. 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.

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), Manton (Me)

Table 1: 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

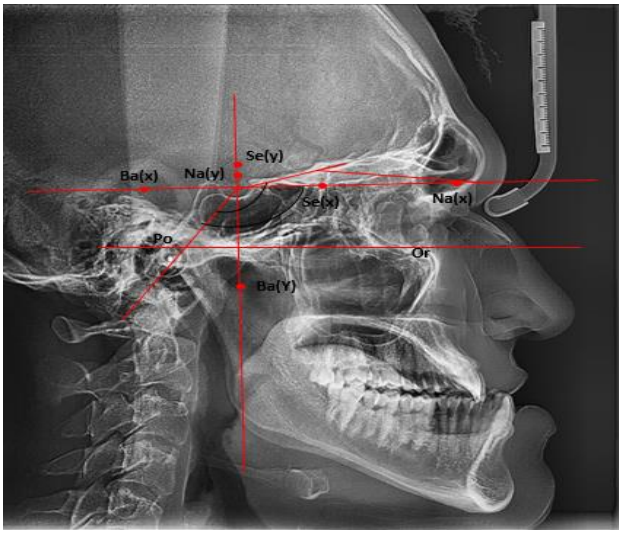

Fig 1: Cranial base parameters

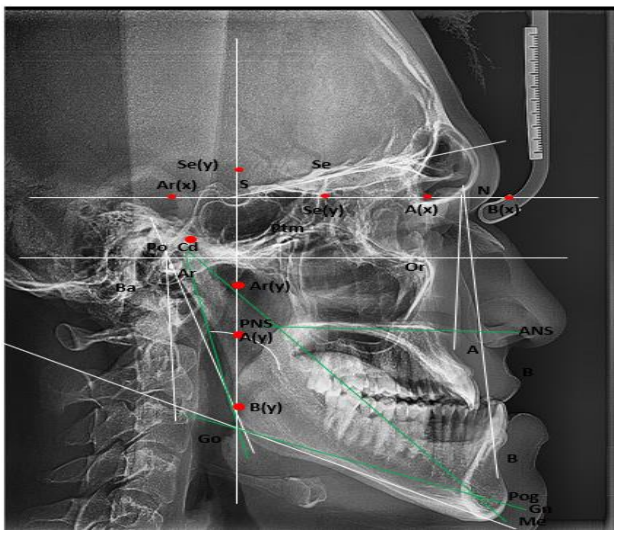

Fig 2: Jaw base parameters

Table 2: 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

Statistical analysis was done. The independent t test was used for intergroup comparison and Pearson's correlation was used to analyze correlation between cranial and jaw base parameters.

Results

Table 3: Comparison of cranial base variables between Class I and Class III malocclusion

Cranial base variables	Class I (Mean±SD)	Class III (Mean±SD)	p value
NSBa(º)	128.7±0.54	120.58±2.99	0.004*
SeSBa(º)	150.34±1.71	149.26±1.41	0.025*
FH-SN(º)	8.68±1.76	8.93±0.40	0.24
FH-SeS(º)	27.04±0.54	19.11±3.13	0.0001*
SN (mm)	69.86±2.21	67.78±3.74	0.0001*
Sse (mm)	30.18±0.82	31.245±0.86	0.2
SeN (mm)	46.39±1.60	44.98±3.56	0.08
Na(x) (mm)	71.81±4.92	70.86±3.16	0.6
Na(y) (mm)	-10.01±2.05	-9.8±1.55	0.8
Se(x) (mm)	25.98±0.07	26.465±0.94	0.7
Se(y) (mm)	-16.18±2.33	-15.03±0.09	0.06
FH-SBa(º)	125.08±2.85	122.015±1.67	0.0001*
S-Ba (mm)	45.015±3.27	45.005±1.25	0.1
Ba(x) (mm)	-25.83±.07	-24.75±0.35	0.0001*
Ba(y) (mm)	37.04±0.86	36.595±3.62	0.1

Table 4: Comparison of maxillomandibular variables between Class I and Class III malocclusion

Maxillo mandibular variables	Class I (Mean±SD)	Class III (Mean±SD)	p value
SNA(º)	82.16±1.09	81.06±0.98	0.06
SNB(º)	79.26±1.13	85.93±0.84	0.0001*
Mandibular plane angle(º)	24.97±0.53	24.81±5.25	0.6
Ramus inclination(º)	7.84±0.68	9.44±0.82	0.0001*
Gonial angle(º)	123.08±2.43	124.26±0.14	0.08
A'-Ptm' (mm)	53.68±5.06	52.23±4.48	0.62
AMxH (mm)	54.645±6.52	56.89±3.91	0.08
PMxH (mm)	44.11±2.66	45.46±1.74	0.06
Cd-Gn (mm)	112.71±5.53	118.66±4.29	0.0009*
Go-Pog (mm)	74.31±2.89	77.63±7.63	0.04*
Cd-Go (mm)	60.74±2.27	61.78±3.70	0.015*

A(x) (mm)	68.23±1.03	67.3±0.84	0.1
A(y) (mm)	47.04±3.23	47.21±0.68	0.992
B(x) (mm)	62.91±1.90	65.03±1.93	0.0001*
B(y) (mm)	81.13±3.15	83.41±4.97	0.03*
Ar(x) (mm)	-19.28±3.28	-17.93±0.14	0.03*
Ar(y) (mm)	30.555±1.76	29.44±0.58	0.14

Table 5: Correlation of angular and linear cranial base parameters with maxillary jaw base parameters

PARAMETERS	CLASS I	CLASS III
NSBa-SNA	0.16(p=0.08)	-0.21(p=0.06)
SBaFH-SNA	0.20 (p=0.28)	-0.07 (p=0.71)
SN-SNA	-0.06 (p=0.75)	0.03 (p=0.87)
SBa-SNA	0.05 (p=0.79)	0.4 (p=0.04*)

Table 6: Correlation of angular and linear cranial base parameters with mandibular jaw base parameters

Parameters	Class I	Class III
NSBA-SNB	-0.54(p=0.002*)	0.42(p=0.004*)
NSBA- MPA	0.18 (p=0.34)	-0.18 (p=0.34)
NSBA-Gonial angle	0.24 (p=0.20)	-0.04 (p=0.83)
NSBA-CdGn	0.04 (p=0.4)	-0.38 (p=0.02*)
SBAFH-SNB	0.35 (p=0.05)	-0.18 (p=0.34)
SBAFH-MPA	0.01 (p=0.59)	-0.03 (p=0.87)
SBAFH-CdGn	0.04 (p=0.3)	-0.40 (p=0.03*)
SBAFH-Gonial angle	0.04 (p=0.83)	0.04 (p=0.1)
SN-SNB	-0.05 (p=0.79)	0.10(p=0.59)
SN- MPA	0.27 (p=0.13)	0.05 (p=0.79)
SN-Gonial angle	0.05 (p=0.79)	-0.22 (p=0.21)
SN-CdGn	0.19 (p=0.36)	0.08 (p=0.3)
SBA-SNB	0.02 (p=0.91)	0.31 (p=0.04*)
SBA-MPA	-0.01 (p=0.95)	-0.10 (p=0.95)
SBA-Gonial angle	-0.23 (p=0.24)	-0.12 (p=0.52)
SBA-CdGn	0.6 (p=0.0001*)	0.48(p=0.006*)

Discussion

On comparison of cranial base parameters between Class I and Class III malocclusion (Table III), cranial base angle (NSBa), SeSBa, FHSeS, anterior cranial base length (SN), FHSBa and projection of basion on x axis [Ba(x)] showed statistically significant difference between these two groups (p=0.004, 0.025, 0.0001, 0.0001, 0.0001 and 0.0001 respectively). From these observations it is deducted that cranial base angle and anterior cranial base length are the influencing factor in

determining Class III malocclusion. These findings are in accordance with the study conducted by Proff et al.4, Agrawal et al.5 and Sanggarnjanavanich et al.6, Kerr et al.7, Chang et al.8, Fateh Ulla et al.9 and Agrawal et al.5 who observed statistically significant difference of these parameters between these two groups. Other angular and linear parameters like FH-SN, SSe, SeN, projection of nasion and sphenoidale on x axis [Na(x) and Se(x)], projection of nasion, sphenoidale and basion on y axis [Na(y), Se(y) and Ba(y)] and posterior cranial base length (SBa) showed statistically non-significant difference between these two groups.

On comparison of jaw base parameters between Class I and Class III group (Table IV), it was found that angular and linear parameters like SNB, ramus inclination, effective mandibular length (Cd-Gn), mandibular body length (Go-Pog), Cd-Go, projection of point B and articulare on x axis [B(x) and Ar(x)] and projection of point B on y axis [B(y)] showed statistically significant difference between these two groups (p=0.0001, 0.0001, 0.0009, 0.04, 0.015, 0.0001, 0.03 and 0.03 respectively). These findings are in accordance with the study conducted by Kerr et al.[7], Chin et al.[10], Agrawal et al.[5], Awad et al.[11] and Sanggarnjanavanich et al.[6], Marwan Mouakeh[12], Reyes et al.[13], Guyer et al.[14] and Gasgoos et al.[15] who observed the statistically significant difference between Class I and Class III malocclusion in their study.

On correlating linear and angular cranial base parameters with mandibular jaw base parameters in Class I and Class III group (Table VI) it was found that Cranial base angle NSBa shows significant negative correlation with SNB in Class I and Class III malocclusion (p=0.002 and 0.004 respectively). These findings are in accordance with the study conducted by Dhopatkar et al.[3], Raja et al.[16], Awad et al.[11] and Ahmed et al.[17] who obtained negative correlation of NSBa with SNB in Class I and Class III groups. On correlating linear and angular cranial base parameters with maxillary jaw base parameters in Class I and Class III group (Table V) it was found that posterior cranial base length (SBa) shows significant positive correlation with SNA in Class III subjects(p=0.04).

Cranial base angle shows significant negative correlation to mandibular length (Cd-Gn) in Class III malocclusion (p=0.02). These findings are in accordance with the study conducted by Awad et al.[11] who obtained negative correlation of NSBa with CdGn in Class III group. Posterior cranial base angle (SBaFH) is correlated negatively to effective mandibular length (Cd-Gn) in Class III malocclusion (p=0.03). These findings are in accordance with the study conducted by Chin et al.[10] who obtained negative correlation of SBaFH with CdGn in Class III group. Whereas posterior cranial base length (SBa) shows positive correlation to effective mandibular length (Cd-Gn) in both the groups (p=0.0001 and 0.006). This is in accordance with the study conducted by Raja et al.[16], Awad et al.[11] and Ahmed et al.[17] who obtained same findings.

Conclusion

The present study concluded that

- Cranial base and maxillomandibular parameters shows distinct variations in different sagittal malocclusion.
- Cranial base flexure may be responsible for anterior displacement of condyle and mandible. This is evident from decreased cranial base angle. However, increased mandibular plane angle, increased ramal length and increased mandibular body length also accounts for Class III malocclusion.

- Cranial base length and maxillary base length are significantly decreased in Class III malocclusion.
- Mandibular morphology is the strongest contributor to Class III malocclusion and this can be confirmed with increased linear parameters like Cd-Gn, Go-Pog, Cd-Go and B(x).

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