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Original Research Article

Correlation between the cranial base, mandible, and hyoid bone in Class II skeletal individuals- A cephalometric study

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ABSTRACT

Aim: The aim of this study was to assess the relationship between the cranial base, mandible, and hyoid bone in Class II skeletal individuals.

Materials and Methods: The retrospective study included lateral cephalograms of 40 Skeletal Class II subjects divided into maxillary prognathism (n=20) and mandibular retrognathism(n=20) based on Burstone's N⊥A and N⊥B values. The angular measurements using 10 variables were used to determine the relationship between the cranial base, mandible, and hyoid bone in Class II subjects. Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. An Independent t-test was used to compare the two groups and a p-value less than 0.05 was considered statistically significant. Post-Hoc Bonferroni was applied to examine any changes among any two groups that were found to differ statistically.

Results: NSAr, C3HyD, SArHy, and NSHy angles were measured in both groups. NSAr and NSHy angles showed significance between the two groups of skeletal class II whose p-value <0.05 whereas C3HyD and SArHy angles did not show any significance.

Conclusion: The condylar position was anterior in maxillary prognathism compared to mandibular retrognathism of Skeletal Class II. The hyoid bone was positioned forward and upward in maxillary prognathism individuals and downward and backward in mandibular retrognathism individuals belonging to skeletal class II.

1. Introduction

Understanding skeletal deformities that contribute to malocclusion is of paramount importance in the field of orthodontics and dentofacial orthopaedics. The clinical diagnosis has a considerable impact on the treatment and orthodontic mechanics used. It is therefore crucial to identify the factors contributing to the etiology of skeletal discrepancies.

Björk established a correlation between the morphology of the cranial base and the relationship between the jaw base using cephalometric radiographs.[1] The cranial base establishes the limit of the skull and facial skeleton. The mandible is connected to the posterior cranial base, whereas the nasomaxillary complex is connected to the anterior cranial base. Therefore, the structure and form of the anterior cranial base have a significant role in determining the position of the maxilla.[2]

However, in the relationship to the mandible, any alteration in the posterior cranial base will impact the glenoid fossa's displacement, which in turn will directly impact the mandibular position.[2] Therefore, there is a strong relationship between the alteration in the cranial base and the sagittal malposition of the jaws. The mandibular position

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depends on the length and direction of the condyle's growth as well as the displacement of the mandibular body caused by the sutural growth of the cranial base.[2]

The hyoid bone and its relation to facial patterns and probable influence, has garnered a great deal of attention during the last two decades.[3] The hyoid bone is an anatomical structure that relates the position of the head with the neck. The hyoid bone is attached to the cranial base and the mandible with various muscular attachments. This bone is crucial for carrying out some physiological functions such as breathing, speaking, and swallowing. Alteration in the position of the hyoid bone in relation to the mandible has been described by Gobeille and Bowman[4] and Cuozzo and Bowman.[5] This may be due to the muscular and ligamentous attachments of the hyoid bone, thereby acting as a functional interface between the cranium, cervical spine, and mandible. Thus, any alterations in the hyoid bone may provide significant functional ramifications. The results of the aforementioned studies suggest that the positional alteration of the hyoid bone is closely related to malocclusion. Jarvinen linked SNA and NSAr and found them to be related to facial patterns.[5,6] He found large NSAr angles were related to relatively small SNA angles, while small NSAr angles were connected with large SNA angles. In 1984 he also found the NSAr angle varied significantly between Class II and Class III malocclusions, with significantly higher NSAr angular values in Class III malocclusion.[7]

Researchers have demonstrated that changes in the mandibular position are related to the changes in the hyoid bone and that the position of the hyoid bone responds to changes in the anteroposterior position of the head.[8]

The aim of this study was to assess the relationship between the cranial base, mandible, and hyoid bone in Class II skeletal individuals with maxillary prognathism and mandibular retrognathism.

2. Materials and Methods

The retrospective study included lateral cephalograms of 40 Skeletal Class II subjects divided into maxillary prognathism (n=20) and mandibular retrognathism(n=20) based on Burstone's N⊥A and N⊥B values. All the subjects for the study were selected from patients who reported to the Department of Orthodontics seeking orthodontic treatment during the years 2020 to 2022. The data were taken from the archives of the Department of Orthodontics and Dentofacial Orthopaedics, at the A.B Shetty Memorial Institute of Dental Sciences in Mangalore. Clearance for the study was obtained from the Institutional Ethics Committee (Cert.no: ABSM/EC67/2021).

Lateral cephalogram records of individuals between the age group 15-30, individuals with healthy periodontium, and who had a full set of dentitions upto second molars in both arches were included in the study. Individuals with previous orthodontic or surgical treatment, habits like mouth breathing, tongue thrusting, etc., and history of trauma, pathologies and facial asymmetries were excluded from the study.

The following cephalometric landmarks were used: [Figure 1]

1. Nasion (N): The deepest point on the frontonasal suture.
2. Sella (S): The midpoint of the shadow of the pituitary fossa (Sella turcica).
3. Articulare (Ar): An intersection points of the posterior margin of the mandible and the basilar border of the occipital bone.
4. Point D: A lateral cephalogram shows this location as the center of the mandibular symphysis.
5. Hyoidale (Hy): The most superior, anterior point on the body of the hyoid bone.[9]
6. C3: The point at the most inferior anterior position on the third cervical vertebra.[9]

2.1. Angular measurements taken in the study

Saddle angle (NSAr): Lines connecting Nasion to Sella and Sella to Articulare form this angle. It represents the cranial base flexure. [Figure 2]

Hyoidale angle (C3HyD): A line connecting C3 to Hyoidale and from Hyoidale to Point D forms an angle. One can read the hyoidale angle as the superior angle formed by the two planes. [Figure 3]

SArHy angle: A line joining Sella and Articulare and a line joining Articulare and Hyoidale forms this angle. [Figure 4]

NSHy angle: A line joining Nasion to Sella and Sella to Hyoidale forms this angle. [Figure 5]

For calibration, a pilot test was conducted selecting 20 lateral head films in which the cephalometric tracing was performed. The same radiographs were measured once again by the operator after two weeks to verify coincidence, and that there were no errors thus achieving intra-operator reliability. Two weeks later, the same radiographs were traced by the professor to verify that there were no errors.

2.2. Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. An Independent t-test was used to compare the two groups and a p-value less than 0.05 was considered statistically significant. Post-Hoc Bonferroni was applied to examine any changes among any two groups that were found to differ statistically.

3. Results

Comparison of NSAr, C3HyD, SArHy, and NSHy angle between maxillary prognathism and mandibular retrognathism in skeletal class II.

3.1. Saddle angle (NSAr)

The mean saddle angle measured in the maxillary prognathism group was found to be 120.78° ±5.33, whereas it was found to be 124.75° ±4.80 in the mandibular retrognathic group. The study revealed a statistically significant difference between the two groups in the skeletal class II pattern ($p < 0.05$). (Table 1) (Graph 1)

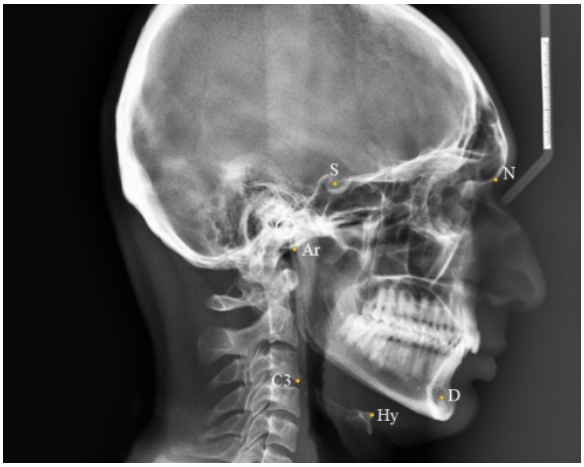


Fig. 1:

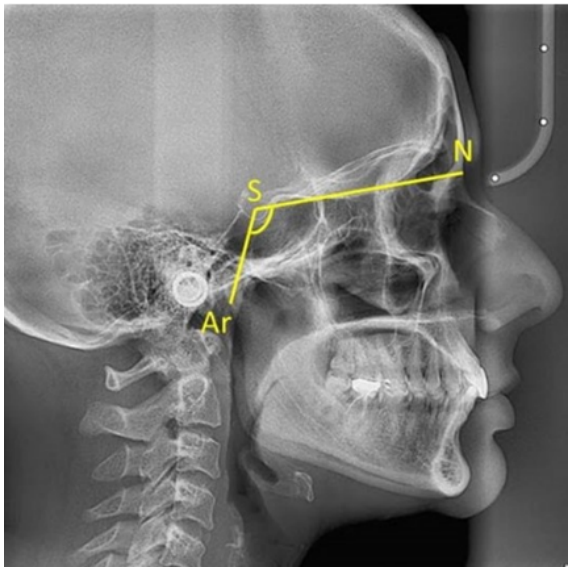
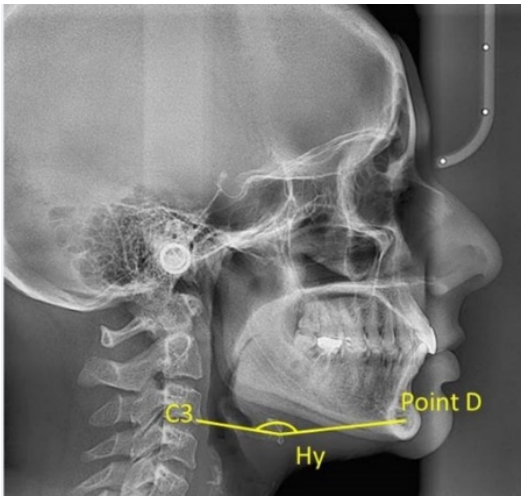


Fig. 2:



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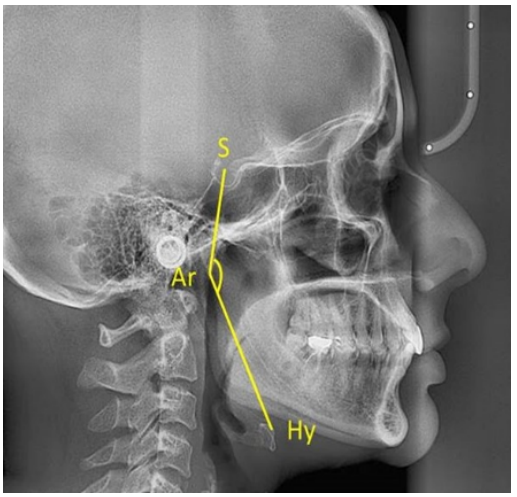

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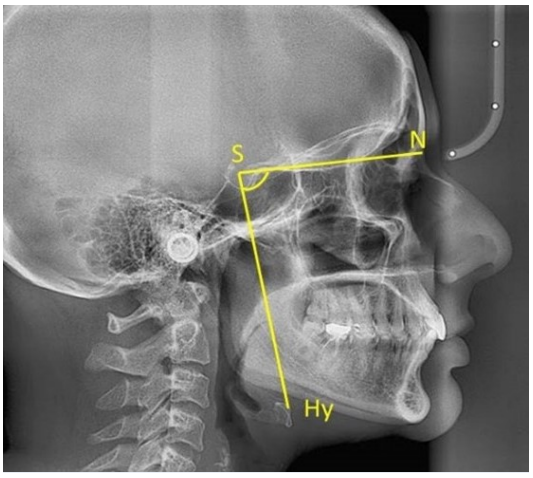

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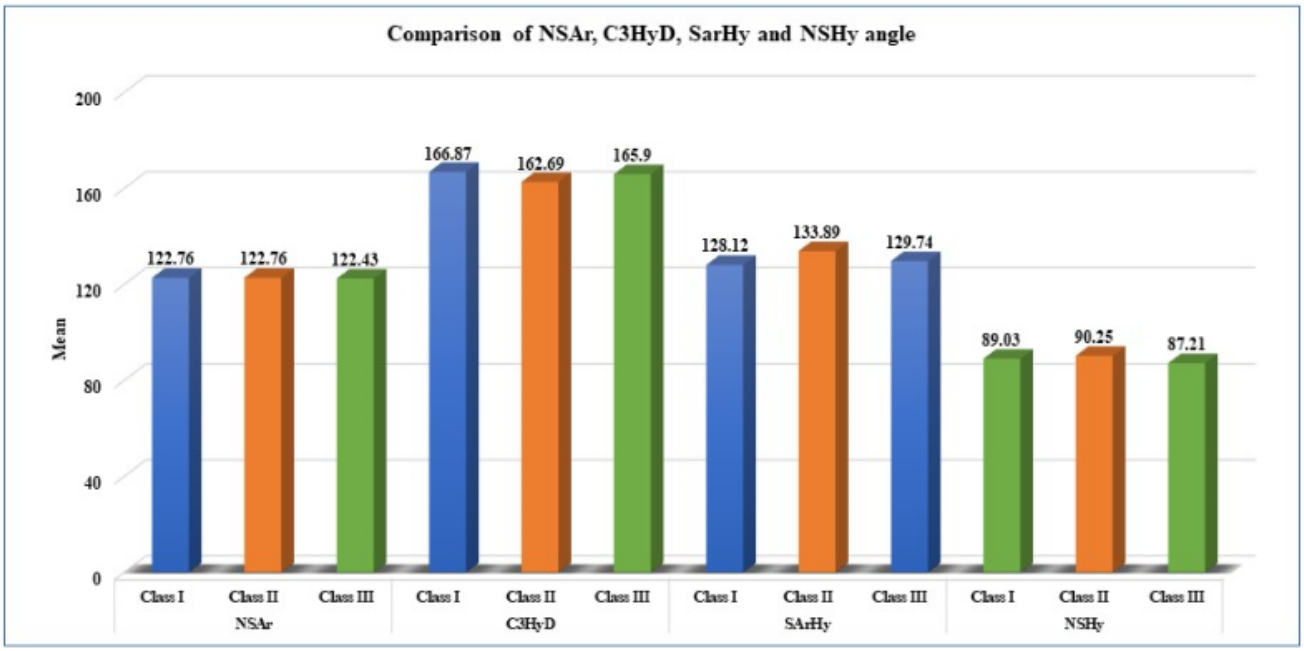

Graph 1:

Table 1: Comparison of NSAr, C3HyD, SArHy, and NSHy angles between maxillary prognathism and mandibular retrognathism in skeletal class II

Skeletal Class II	Group	N	Mean	Std. Deviation	P value
NSAr	Maxillary prognathism	20	120.78	5.33	**0.018***
	Mandibular retrognathism	20	124.75	4.80	
C3Hy-PtD	Maxillary prognathism	20	159.14	11.87	0.137
	Mandibular retrognathism	20	166.25	17.24	
SArHy	Maxillary prognathism	20	133.33	5.52	0.546
	Mandibular retrognathism	20	134.45	6.13	
NSHy	Maxillary prognathism	20	87.55	3.68	**0.001***
	Mandibular retrognathism	20	92.95	3.36	

*Statistically significant (p<0.05)

3.2. Hyoidale angle (C3HyD)

The mean hyoidale angle measured in the maxillary prognathism group was found to be 159.14° ±11.87, whereas it was found to be 166.25° ±17.24 in the mandibular retrognathic group. The study revealed a statistically non-significant difference between the two groups in the skeletal class II pattern (p >0.05). (Table 1) (Graph 1)

3.3. SArHy angle

The mean SArHy angle measured in the maxillary prognathism group was found to be 133.33° ±5.52, whereas it was found to be 134.45° ±6.13 in the mandibular retrognathic group. The study revealed a statistically non-significant difference between the two groups in the skeletal class II pattern (p >0.05). (Table 1) (Graph 1)

3.4. NSHy angle

The mean NSHy angle measured in the maxillary prognathism group was found to be 87.55°±3.68, whereas it was found to be 92.95°±3.36 in the mandibular retrognathic group. The study revealed a statistically significant difference between the two groups in the skeletal class II pattern (p < 0.05). (Table 1) (Graph 1)

4. Discussion

The field of Orthodontics places an emphasis on growth and the factors that influence it. The Spheno-occipital synchondrosis lengthens the basicranium and has a noteworthy influence on post-natal growth. According to Enlow,[10] the growth of the maxilla is under the effect of the basal component of the cranium which is directly influenced by the development of the brain. Whereas the mandible grows in an independent manner, however, it is also affected

by the location of the glenoid fossa. Thus, the relationship between the maxilla and mandible is determined by the cranial base.

According to Hopkin et al,[11] the basicranium played an important role in sagittal orthodontic discrepancies. In addition, Scott[12] stated that the flexion of the cranial base, the relative anterior movement of the maxillary and mandibular components in relation to the cranium, surface deposition between the Nasion and Menton affects facial prognathism.

There is significant debate about whether the posterior base should be measured from the Basion or the Articulare, despite the fact that the N-S length is typically employed to calculate the anterior cranial base. As Articulare is simpler to recognize than Basion, Bjork[1] recommended using it instead. Later, further research employed Articulare to specify the posterior boundary of the cranial base.[12]

Over the past 20 years, several studies had been done to determine the hyoid bone position in relation to facial morphology, as it is connected to the cranium as well as to the mandible. Research has shown the adaptation of the hyoid bone in diverse malocclusions and after orthognathic surgeries.

The present study investigated the influence of the cranial base and the position of the hyoid bone on skeletal relationships and vice-versa in skeletal Class II individuals with the prognathic maxilla and retrognathic mandible.

The saddle angle (NSAr) was evaluated among the mandibular retrognathic and the maxillary prognathic cases in the class II group and was noticed to be statistically significant. ($p < 0.05$) with mean values in the mandibular retrognathic group being substantially higher when compared to the maxillary prognathic group (Table 1). This is in agreement with a study by Mestriner, Junior, and Valente where large NSAr values were associated with mandibular retrognathism.[13]

The hyoidale angle was further assessed and compared between maxillary prognathism and mandibular retrognathism subgroups in Class II skeletal pattern. The mandibular retrognathic group revealed higher mean averages compared to the maxillary prognathic group however, the differences were noticed to be not statistically significant. ($p> 0.05$) (Table 1).

When the SArHy angle was assessed in the Class II group among the maxillary prognathic and mandibular retrognathic subjects, no statistically significant results were noticed. ($p > 0.05$) (Table 1).

When the NSHy angle was evaluated among the mandibular retrognathic and maxillary prognathic patterns among Class II cases, a statistically significant difference of $p<0.05$ was observed, with higher mean values in mandibular retrognathic cases (Table 1). This denotes that the highest mean average was observed in Class II cases with mandibular retrognathism, suggestive of a correlation between mandibular retrognathism and the NSHy angle. This observation may be explained by the muscle attachment to the hyoid bone and the mandible, which causes it to move backwards and forwards in tandem with the jaw in the sagittal plane.[14]

The Articulare was used as a cephalometric landmark in the present study, however, certain authors such as Varjanne and Koski[15] preferred the Basion due to its proximity to the cranial base. However, Bhatia and Leighton[16] 1993, demonstrated a high correlation between these two points and the selection between these points is unlikely to contradict the study findings. Hence, the Ar was selected as a landmark point in this study. Further research may be carried out using the Basion as a landmark for a comprehensive investigation.

According to Jarvinen, the SN plane may be rotated and hence is not reliable, he suggested the usage of the Frankfurt plane for the purpose of investigation. In order to examine this in more detail, a study considering the Frankfurt plane as a reference plane may be carried out. Furthermore, linear measurements of the cranial base and growth patterns have not been considered in this study which has been shown to be a greater influence on skeletal discrepancies in studies by Andria et al and Dhopatkar, Bhatia, and Rock.

Hence, further research needs to be conducted to demonstrate the influence of cranial base angulations and hyoid bone position.

5. Conclusion

The condylar position was anterior in maxillary prognathism compared to mandibular retrognathism of Skeletal Class II. The hyoid bone was positioned forward and upward in maxillary prognathism individuals and downward and backward in mandibular retrognathism individuals belonging to skeletal class II.

6. Conflict of Interest

None

7. Source of Funding

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