Cephalometric Assessment of Condylar Position among Individuals with Different Skeletal Malocclusion Patterns

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ABSTRACT

Introduction: There are variations in growth and orientation of cranial base region where the maxilla and mandible articulate. This leads to differential movement of the maxilla and mandible causing changes in glenoid fossa and condylar position. Therefore, this study was conducted to determine the condylar position in patients with different skeletal sagittal malocclusion patterns.

Methods: An analytical cross-sectional study was conducted among 165 individuals, having skeletal Class I, Class II and Class III relationship (55 in each group) selected by convenience sampling method after receiving ethical approval and informed consent. Lateral cephalograms were taken and measurements for determining condylar position were done and compared among three groups. Data were analyzed in SPSS version 16. Kruskal-Wallis H test was used to determine the mean difference in between condylar positions of three skeletal malocclusion patterns and Mann-Whitney U test was done for their pairwise comparison.

Results: There was no significant difference in posterior cranial base length (P=0.200) and saddle angle (P=0.517) in three skeletal malocclusion class groups. However, the three malocclusion patterns showed significant differences in gonian angle (P=0.001) and articular angle (P=0.013). Significant moderate negative correlation in saddle angle and articular angle (P<0.001) was observed.

Conclusion: The findings of this study concluded that condylar position based on posterior cranial base length was not associated with different skeletal malocclusion patterns. However, articular angle was significantly lower in skeletal class III than in class II.

Key words: Condyle; Malocclusion; Position.

INTRODUCTION

There is controversy regarding the role of the condylar position in the correct functioning of the stomatognathic system and it has been the center of study throughout the history of dentistry.[1] The variations in the morphology of cranial base have been assumed to affect the anterior-posterior positioning of jaws.[2]

Bjork for the first time demonstrated the existence of a significant relationship between cranial base morphology and jaw relationship using cephalometric radiographs.[3] Since the upper and lower jaws articulate with different parts of cranial base, the variations in growth and orientation of cranial base region produce alteration in movement of maxilla and mandible leading to change in glenoid fossa and condylar position.[2]

Conflict of Interest: None

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Among individuals with different malocclusion patterns, variations of condylar position in the glenoid fossa have been correlated.[4] However, there is a paucity of data regarding the significance of condylar position in different sagittal malocclusion patterns in Nepal. Therefore, this study was done to determine the condylar position based on posterior cranial base length in individuals with different skeletal malocclusion patterns.

METHODS

An analytical cross-sectional study was conducted from February to July 2022 in the Department of Orthodontics and Dentofacial Orthopaedics, Kathmandu Medical College Teaching Hospital, Duwakot, Bhaktapur, Nepal. Ethical approval was obtained from Institutional Review Committee of the same institution [Ref. no. 2401202201].

Convenience sampling method was used to select the study participants with different skeletal malocclusion patterns (Class I, Class II and Class III). Individuals of age 15 to 35 years having skeletal Class I, Class II and Class III relationship, no history of prior orthodontic treatment and those with all natural dentition were included in the study. However, patients with craniofacial anomalies, syndromes, cleft or symptoms or signs of dysfunction of the masticatory system were excluded. Informed consent was received from the study participants before data collection.

Sample size was calculated using data of similar study done by Hegde et al.[2] by considering the articular angle values for three malocclusion planes.

Using formula,

Sample size (n) = $2sd^2 (z\alpha+z\beta)^2/(m_1-m_2)^2$
Where,
m_1-m_2 = Difference in mean
$(z\alpha+z\beta)^2 = 7.84$

$sd= (sd_1+sd_2)/2 = \left(\frac{4.02+3.54}{2}\right)^2$

Actual sample size (n) = 2*14.2884*7.8/ (34.03-32)^2
= 54.38 (55) in each group ie, 165 in total (total 3 groups)

All participants had their pre-treatment lateral cephalograms taken. The lateral cephalograms were hand traced by the principal investigator on 0.003-inch acetate paper using a 0.3 mm lead pencil. The same researcher noted the following landmarks and cephalometric analysis was based these landmarks:

1. Point A (A): It is the deepest point on the midline between the anterior nasal spine and alveolar crest between the two central incisors.
2. Point B (B): It is the deepest point between the alveolar crest of the mandible and the mental process.
3. Articulare (Ar): Intersection of the posterior border of the condyle and the posterior cranial base.
4. Sella (S): Center of sella turcica.
5. Nasion (N): Most anterior point on frontonasal suture.
6. Gonion (Go): Lowermost point at the intersection of mandibular and ramal planes.
7. Gnathion (Gn): The most anterior and inferior point of the bony outline of the chin.

The following measurements were made:

a. Angular measurements for the assessment of sagittal growth pattern**:** SNA, SNB, ANB.
b. Angular measurements for the assessment of cranial base flexure: N-S-Ar (Saddle angle), S-Ar-Go (Articular angle), Ar-Go-Gn (Gonian Angle)
c. Linear measurements for the assessment of position of condyle: S-Ar (Posterior cranial base length).

Individuals were divided into three groups on the basis of ANB values. Class I =2°<ANB<4° ;ClassII=ANB>4°;ClassIII= ANB <2°.[5]

Data were entered in Microsoft Excel Sheet and analysed in Statistical Package of Social Sciences (SPSS) version 16. Descriptive statistics were presented in the form of frequency, percentage, mean, standard deviation and median depending upon the nature of data. Kruskal-Wallis H test was done to determine the difference in between condylar position of three skeletal malocclusion classes. Mann-Whitney U test was done for pairwise comparison of condylar position in between groups. Spearman's rho was done to determine the correlation in between saddle angle and articular angle in between groups. The significance level was set at p<0.05.

RESULTS

Condylar position of 165 individuals of age 18.83±4.01 years were measured. Among them, 56 (33.9%) were males and 109 (66.1%) were females. Sex distribution of the study participants is shown is Figure 1. Distribution of mean S-Ar, gonian angle, saddle angle and articular angle values in among different skeletal classes is presented in Table 1.

Gonian and articular angle were found significantly different when compared in between three groups (P=0.001 and P=0.013, respectively, Table 2). On pairwise comparison, class I had significantly lower mean gonian angle than class II (P=0.007) and class III (P=0.001). Also, articular angle was significantly higher in class II than in class III (P=0.004).

In the study population, significant moderate negative correlation (P<0.001) was observed in between saddle angle and articular angle (r=-0.433, Figure 2). However, on determining correlation in between these two angles among individuals of each group, significant moderate negative correlation was found in class II (r=-0.449, P=0.001, Figure 4) and class III (r=-0.528, P<0.001, Figure 5) but insignificant in class I (P=0.111, Figure 3).

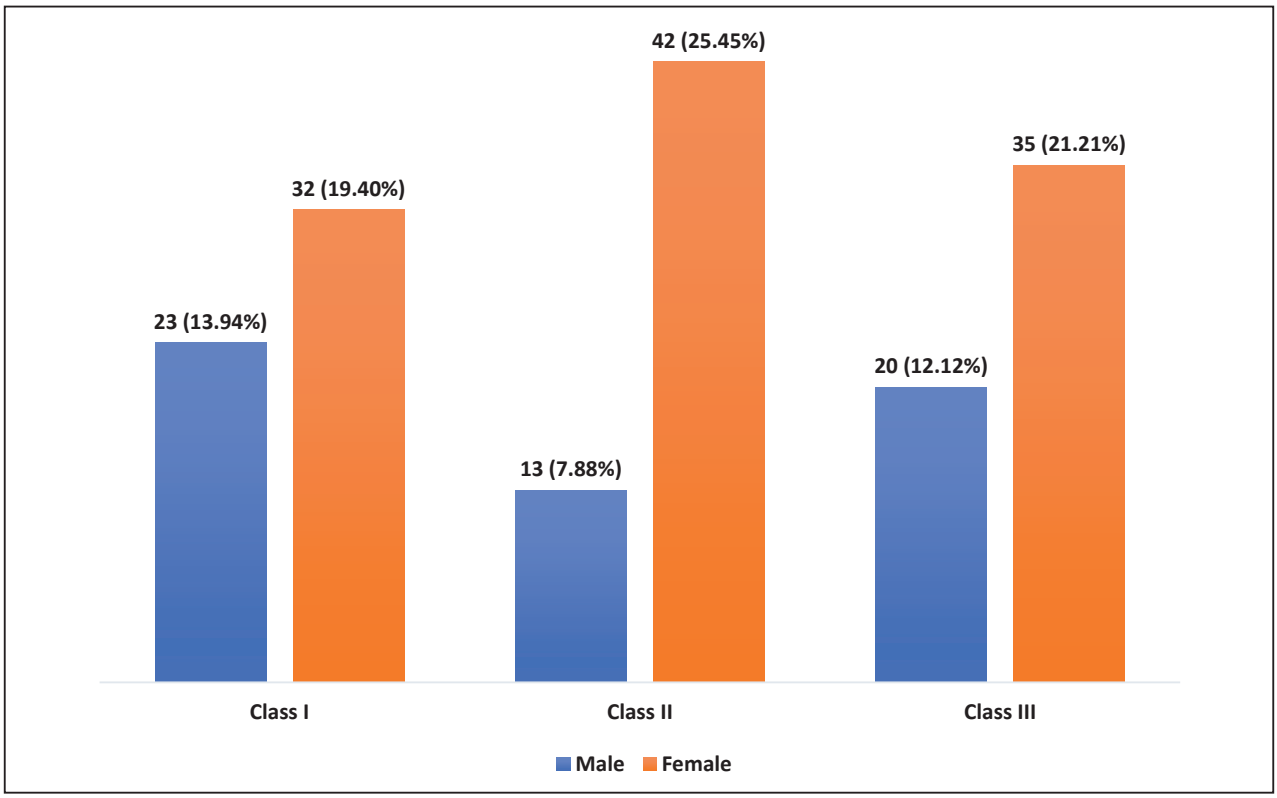


Figure 1: Sex distribution of the study participants (n=165, 30 in each group)

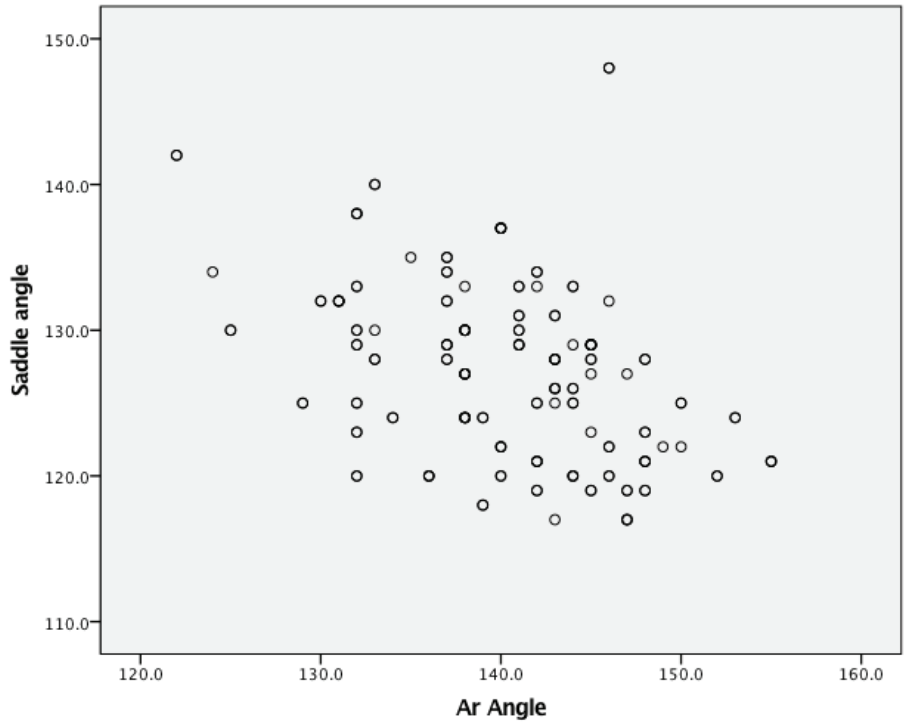


Figure 2: *Graph showing correlation between saddle angle and articular angle in all three classes.*

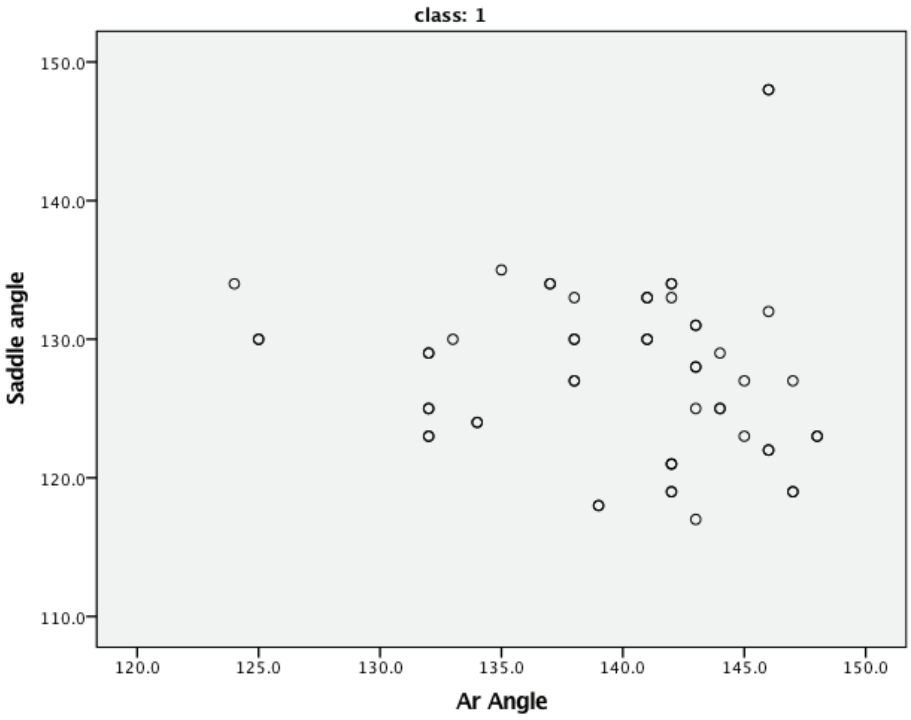
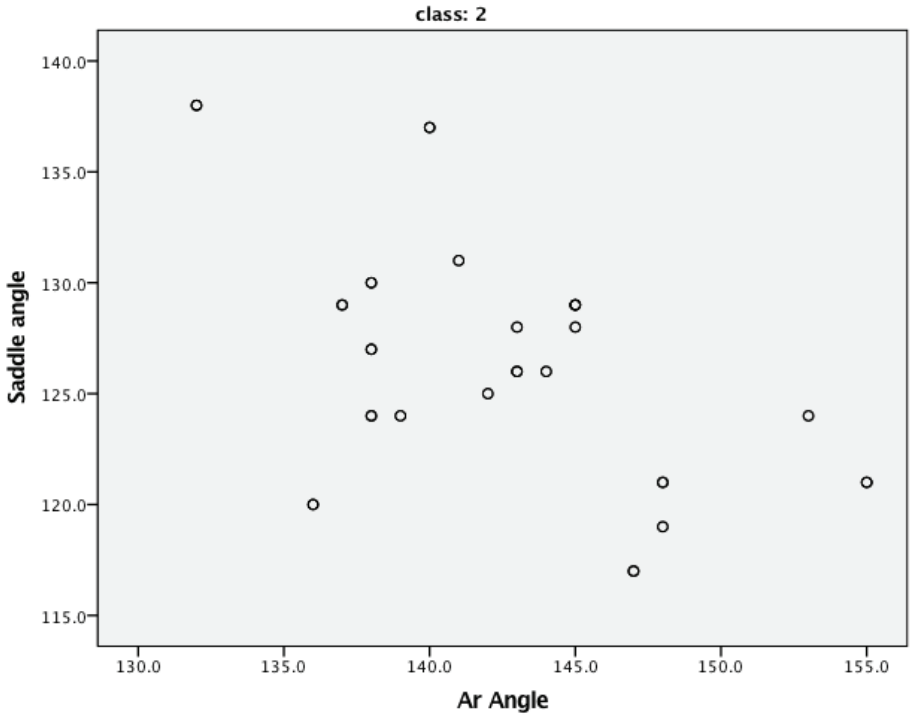
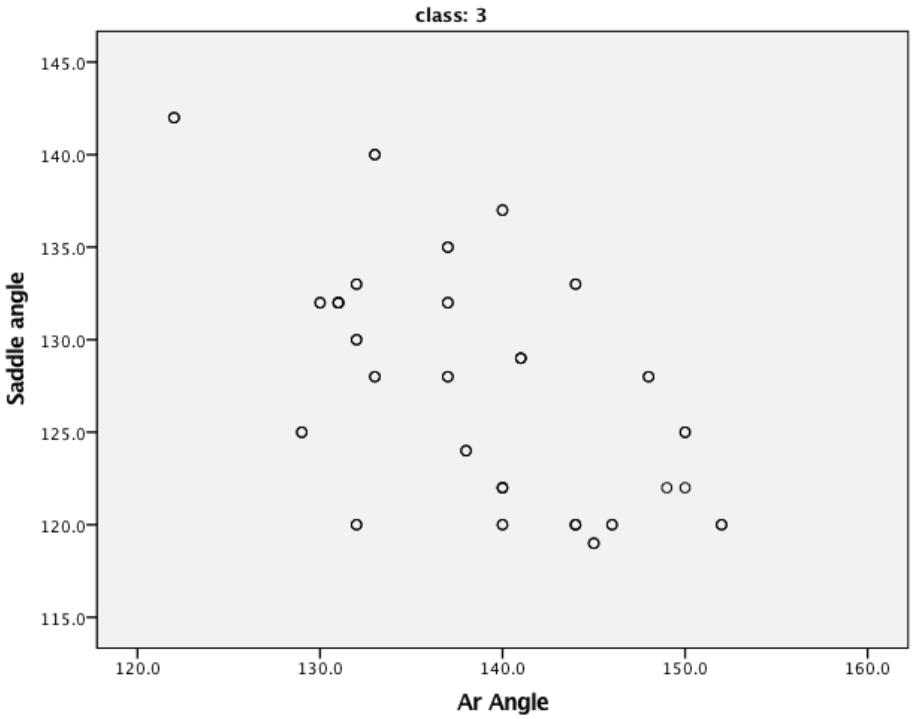


Figure 3: *Graph showing correlation between saddle angle and articular angle in skeletal class I group.*



r = -0.449
P = 0.001

Figure 4: *Graph showing correlation between saddle angle and articular angle in skeletal class II group.*



r = -0.528
P <0.001

Figure 5: *Graph showing correlation between saddle angle and articular angle in skeletal class III group.*

Table 1: Distribution of condylar position values among different skeletal classes.

Measurement	No. of study participants	Ar-S in mm	Gonian angle in degree	Saddle angle in degree	Articular angle in degree
Class I					
Mean±SD	55	18.46±3.51	121.98±5.60	127.49±6.45	139.84±5.96
Median		19	124	127	142
Class II					
Mean±SD	55	17.38±3.25	125.20±6.27	126.44±5.46	142.47±5.67
Median		18	125	126	143
Class III					
Mean±SD	55	17.69±5.27	128.89±14.26	127.76±6.51	138.40±7.35
Median		17	128	128	138
Total					
Mean±SD	165	17.84±4.10	125.36±9.91	127.23±6.15	140.24±6.55
Median		18	125	127	141

Table 2: Kruskal-Wallis H test to test the difference in different parameters between different classes.

Cephalometric parameter	Group	Median	Mean rank	P value*
Ar-S in mm	Class I	19	92.12	0.200
	Class II	18	76.50	
	Class III	17	80.38	
Gonian angle in degree	Class I	124	64.24	**0.001**
	Class II	125	86.95	
	Class III	128	97.82	
Saddle angle in degree	Class I	127	85.13	0.517
	Class II	126	77.05	
	Class III	128	86.80	
Articular angle in degree	Class I	142	82.30	**0.013**
	Class II	143	96.75	
	Class III	138	69.95	

*Kruskal-Wallis H test

Table 3: Pairwise comparison in different skeletal malocclusion classes

Variables	Comparative groups	No. of participants	Mean rank	P value*
Gonian angle	Class I	55	47.29	0.007
	Class II	55	63.71	
	Class I	55	44.95	0.001
	Class III	55	66.05	
	Class II	55	51.24	0.159
	Class III	55	59.76	
Articular angle	Class I	55	50.42	0.094
	Class II	55	60.58	
	Class I	55	59.88	0.149
	Class III	55	51.12	
	Class II	55	64.17	0.004
	Class III	55	46.83	

*Mann-Whitney U test

DISCUSSION

Understanding the morphology and relative location of the temporomandibular joint in various skeletal malocclusion classes is quite difficult.[4] The location of the condyle within the glenoid fossa is still a matter of debate despite advancements in diagnostic techniques.[1] Clinicians should be aware of the spatial variations in the condyle-glenoid fossa relationship in order to recognize any degenerative joint disease or to indicate problems that have already developed. This knowledge will help with better treatment planning when it is necessary to achieve values that are closer to normal.[4]

The position of the condyle in the glenoid fossa may have influence on the sagittal, transverse, and vertical relationship of the jaws, which may result in the development of various malocclusions.[6] Therefore, this study was conducted to determine the condylar position in patients with different skeletal sagittal malocclusion patterns.

In this study, posterior cranial base length was measured as a linear distance from S-Ar as suggested by Bjork.[3] There was no significant difference observed in S-Ar distance between subjects of the three skeletal malocclusion groups. This result was comparable to a research by Hegde et al., in which insignificant difference was found between the mean posterior cranial base lengths among the three malocclusion classes.[2]

Gonian angle in the current study was significantly larger in class III when compared to class I and II skeletal malocclusion group. This finding is in accordance to results by Al Maaitah et al.[7] and Gasgoos et al.[8] where gonian angle was found larger in individuals with skeletal class III malocclusion. Increase in effective mandibular length (Ar-Gn) is hypothesized to contribute to an increase in gonian angle.

The present study results showed that there was no significant mean difference in saddle angle between three malocclusion classes which was in accordance to a study by Alia et al.[9] The reason being anatomically temporomandibular joint placed away from mid sagittal plane so that changes in cranial base may not be translated to the mandible. Similarly, no correlation between sagittal skeletal relationship and cranial base angle could be identified in other studies.[10,11,12] In contrast to the finding of the current research, Proff et al.[13] observed that class III had a reduced cranial base angle compared to class I and II suggesting that the mandibular condyles may be positioned more anteriorly in patients with Class III malocclusion. However, according to Chin et al.[14] the SNB angle decreased as the cranial base angle increased.

Articular angle was significantly smaller in skeletal class III than in class II malocclusion group in this study. However, Hegde et al.[2] and Al Maaitah et al.[7] found no significant difference in articular angle among three groups.

There are studies showing changes in cranial base morphology as a possible indicator of skeletal malocclusion.[7,15-18] However, some studies have shown no relation between condylar position and sagittal skeletal relationship.[2,19] There can be a number of possible reasons for the lack of difference in condylar position between patients with different malocclusion patterns. One possibility is that the condyle is a relatively stable structure that is not significantly affected by changes in the skeletal position of the jaws. Another possibility is that the condylar position is influenced by a number of factors, including the type of dental malocclusion, the age of the patient, and the length of the patient's teeth. The present study did not control for these factors, so it is possible that they influenced the results. Further research is needed to investigate the role of these factors in determining the condylar position in patients with malocclusion. It is also

important to note that this study was limited by the use of lateral cephalometric radiographs. Lateral cephalometric radiographs provide a two-dimensional view of the condyle, which can make it difficult to accurately assess the condylar position. Studies using three-dimensional imaging techniques may be able to provide more accurate information about the condylar position in patients with different malocclusion patterns. This study is limited by its small sample size and the fact that it was conducted in a single institutional population. Additional research is needed to confirm the study findings in larger and more diverse populations.

CONCLUSION

The study findings concluded that condylar position based on posterior cranial base length was not associated with different skeletal malocclusion patterns. However, articular angle was significantly lower in skeletal class III than in class II indicating the position of mandible in upward and forward direction thus, decreasing the height of the upper face and increasing the degree of prognathism. The results of this study suggest that skeletal malocclusion patterns were not primarily influenced by condylar position. Other factors, such as the morphology of the cranial base and the growth pattern of the mandible, may play a more important role.

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