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Relationship of Skeletal Class of Malocclusion with Radiomorphometric Indices of Mandible in Short-Face Patients

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Objectives This study aimed to assess the relationship of skeletal class of malocclusion with some radiomorphometric indices of the mandible in short-face patients.

Methods This cross-sectional study was conducted on 179 short-face patients between 17 to 30 years who sought orthodontic treatment during 2013 to 2020. The gonial and antegonial angles, and type and depth of antegonial notch were assessed bilaterally on traced panoramic radiographs. The correlation between radiomorphometric indices and class of malocclusion was analyzed using One-way ANOVA and Independent T-test by SPSS version 25 (alpha=0.05).

Results The mean size of gonial angle was significantly different among the three classes of malocclusion (P<0.001), and the largest gonial angle was recorded in class III, and the smallest in class I patients. The mean size of antegonial angle and antegonial depth were not significantly different among the three classes of malocclusion (P=0.487). The difference in the mean size of gonial and antegonial angles was not significant between males and females (P=0.119, and P=0.176, respectively). However, the mean antegonial depth in males was significantly greater than that in females (P<0.001). Type I antegonial notch was more common in females than males at both sides. Age had no significant correlation with gonial angle, antegonial angle, or antegonial notch depth (P=0.422, P=0.737, P=0.392, respectively).

Conclusion Facial growth pattern in short-face patients can be predicted with antegonial angle. Also there is significant correlation between skeletal class of malocclusion and the size of gonial angle.

Keywords Dental Occlusion; Face; Radiology; Malocclusion

Introduction

Orthodontic diagnosis and treatment planning require some basic information that is obtained by radiography. Lateral cephalometry and panoramic radiography are the most commonly used imaging modalities for this purpose. Lateral cephalograms are traced to obtain information regarding skeletal and dental relationships and type of malocclusion. However, due to superimposition of structures in the right and left sides of the jaws, some measurements cannot be accurately made on lateral cephalograms. Panoramic radiography is also extensively used for orthodontic diagnosis and treatment planning, and provides valuable information regarding the dentition, dental arches, skeletal structures, and temporomandibular joints without the problems related to superimposition of anatomical structures. [1]

It is imperative for orthodontists to find a reliable method for prediction of growth pattern. Short facial height usually indicates a low MPA (Mandibular plan angle), and dentoalveolar retrusion in the maxilla and mandible. Short facial height often affects the occlusal plane and the mandibular plane angle.

The gonial angle is routinely measured during orthodontic treatment processes. It is correlated with the mandibular plane angle, and therefore, can be used for prediction of the mandibular growth pattern. [2] On lateral cephalograms, the gonial angle is located at the intersection of the line tangent to the inferior border of the mandible and the line tangent to the mandibular ramus and condyle, and indicates the form of the mandible based on the relationship of mandibular body and ramus. Due to superimposition of images of the two sides of the mandible, and the difference in divergent angles of the rami bilaterally, the gonial angle is often measured as the mean value of the right and left angles. [1] A large gonial angle indicates a tendency for backward rotation of the mandible along with posterior growth of the condyles [3], which is characterized by canting of the mandibular plane and backward direction of growth. Conversely, reduction of the size of gonial angle leads to forward growth of the mandible. Thus, small size of the gonial angle indicates vertical growth of the condyles. [4] The mean size of the gonial angle is 128±7 degrees [3], and it is often 3-5 degrees larger in females than males. [4]

The antegonial notch is located in the inferior part of the mandible at the intersection of mandibular ramus and body of mandible, right after the mandibular angle. It was described as pregonial notch by McIntosh [5], and antegonial notch. [6]

Considering the gap of information regarding the gonial and antegonial angles and depth and type of antegonial notch, this study aimed to assess the relationship of skeletal class of malocclusion and some radiomorphometric indices of the mandible including the gonial and antegonial angles and depth and type of antegonial notch in short-face patients. The null hypothesis was that no significant correlation would be found between skeletal class of malocclusion and gonial and antegonial angles and depth and type of antegonial notch in short-face patients.

Methods and Materials

This cross-sectional study was conducted on panoramic radiographs of short-face patients presenting to the School of Dentistry, at Qazvin University of Medical Sciences between 2013 and 2020 seeking orthodontic treatment. The study was approved by the ethics committee of this university (IR.QUMS.REC.1399.533), and the patients consented to the use of their records for research purposes. Patient records were evaluated anonymously.

The minimum sample size was calculated to be 195 assuming type 1 error of 0.05, maximum standard deviation of antegonial index to be 0.57, and maximum estimated error of 0.08. Considering the limited number of total patient records during the study period (n=1500), the sample size was adjusted to be 179 using the sample size formula for a limited population.

The facial height of patients was calculated according to the Jarabak index [7], and compared with the information available in patient records. A total of 409 records belonged to patients between 17 to 30 years with decreased lower facial height.

Patients with congenital and systemic diseases, severe maxillary protrusion or retrusion, high number of edentulous areas, and cleft lip and/or palate, incomplete patient records, and poor-quality radiographs were excluded. Type of skeletal malocclusion of patients was determined using the Wits and Steiner's analyses [8] on their lateral cephalograms by an experienced orthodontist, and checked with the information available in patient records. Digital panoramic radiographs of patients available in their records were then traced by a trained senior dental student using a tracing paper (Ortho Organizer), and the radiomorphometric indices including the gonial and antegonial angles, and type and depth of antegonial notch were assessed on traced digital panoramic radiographs by an experienced oral and maxillofacial radiologist (Figures 1 and 2). The antegonial notch depth was measured by a digital caliper. Type of antegonial notch was also determined (Figures 3 and 4). Size of gonial and antegonial angles and type and depth of antegonial notch were all recorded.

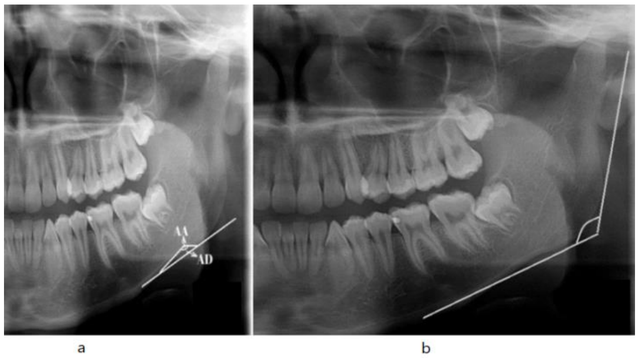

Figure 1: Antegonial and gonial angle. a, AA: Antegonial angle; AD: Antegonial depth. b, Gonial angle

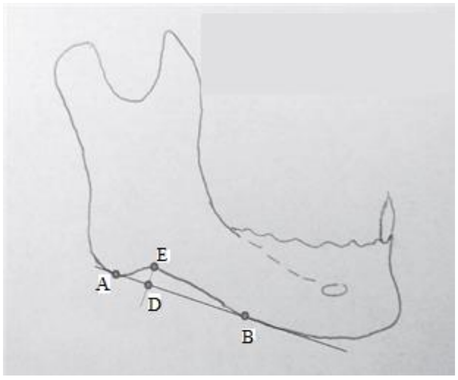

Figure 2: ED (mm): Antegonial depth; AEB angle: Antegonial angle

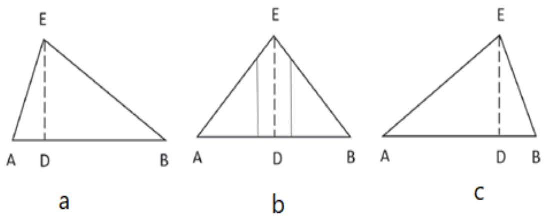

Figure 3: Types of antegonial notch.
a: type 1. b: type 2. c: type 3

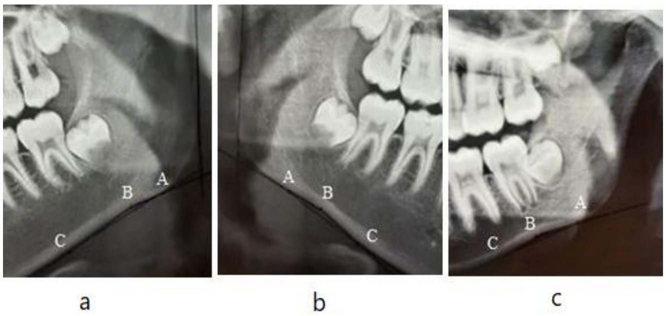

Figure 4: Types of antegonial notch. a, type 1. b, type 2. c, type 3. Type of antegonial notch was determined by connecting the points A, B, and C.

Statistical analysis:

Data were analyzed by SPSS version 25 (IBM Corp., Armonk, NY, USA). Measures of central dispersion were reported for quantitative variables, and frequency and percentage values were recorded for qualitative variables. The mean size of gonial and antegonial angles and depth of antegonial notch were compared among the three classes of malocclusion by one-way ANOVA, and between males and females by independent t-test. Pairwise comparisons of classes of malocclusion for each variable were carried out by the LSD post-hoc test. The Chi-square test and Fisher's exact test were applied to compare the type of antegonial notch in the right and left sides based on class of malocclusion and gender of patients. The Pearson's correlation coefficient was used to analyze the correlation of age with the size of gonial and antegonial angles, and depth of antegonial notch. The normality of the data was checked and confirmed using histogram and Q-Q plot. In addition, the assumption of homogeneity of variances was checked and confirmed with Levene test. P<0.05 was considered statistically significant in all comparisons.

Results

A total of 179 patient records were evaluated in this study. The mean age of patients was 21.11±3.65 years. Among all, 128 (71.5%) were females and 51 (28.5%) were males.

- Frequency distribution of class of malocclusion and type of antegonial notch:

Table 1 presents the frequency distribution of class of malocclusion and type of antegonial notch in the right and left sides. As shown, class II malocclusion had the highest frequency (58.1%). Also, type I was the most common type of antegonial notch in both the right (58.1%) and left (62.6%) sides.

Table 1- Frequency distribution of class of malocclusion and type of antegonial notch in the right and left sides

Variable		Number	Percentage
Class of malocclusion	Class I	53	29.6
	Class II	104	58.1
	Class III	22	12.3
Type of antegonial notch in the right side	I	104	58.1
	II	71	39.7
	III	4	2.2
Type of antegonial notch in the left side	I	112	62.6
	II	67	37.4
	III	-	-

-Radiomorphometric indices of mandible based on the class of malocclusion:

Table 2 presents measures of central dispersion for radiomorphometric indices of the mandible in short-face patients. One-way ANOVA revealed a significant difference in the mean size of gonial angle among the three classes of malocclusion (P<0.001), and the largest gonial angle was recorded in class III and the smallest in class I malocclusion patients. LSD test for pairwise comparisons showed significant differences between all three classes of malocclusion (P=0.001 for class I versus class II, P<0.001 for class I versus class III, and P=0.002 for class II versus class III).

The mean size of antegonial angle (P=0.164) and the mean antegonial notch depth (P=0.818) were not significantly different among the three classes of malocclusion.

Table 2- Measures of central dispersion for radiomorphometric indices of the mandible in short-face patients

Variable	Mean	Std. deviation
Right gonial angle (degrees)	118.7	6.68
Left gonial angle (degrees)	119.64	7.67
Mean gonial angle (right and left)	118.85	6.63
Right antegonial angle (degrees)	163.74	9.12
Left antegonial angle (degrees)	164.43	6.30
Mean antegonial angle (right and left)	164.09	6.96
Right antegonial depth (mm)	1.73	0.86
Left antegonial depth (mm)	1.56	0.69
Mean antegonial depth (right and left)	1.65	0.70

-Radiomorphometric indices of the mandible based on gender:

Table 3 presents the radiomorphometric indices of the mandible in short-face males and females. According to independent t-test, the mean size of gonial and antegonial angles was slightly larger in females, but not statistically significant (P=0.119, P=0.176). However, the mean antegonial notch depth in males was significantly greater than that in females (P<0.001).

The Chi-square test and Fisher's exact test were used to compare the type of antegonial notch in the right and left sides based on class of malocclusion and gender of short-face patients (Table 4).

Type of antegonial notch in the right side was not significantly different based on the class of malocclusion (P=0.487). However, the difference in this regard was significant in the left side, such that the frequency of type I antegonial notch in the left side was significantly higher in class I malocclusion patients (P=0.008).

Also, the type of antegonial notch in the right and left sides was significantly different between males and females, such that type I was significantly more common in females in both the right and left sides.

The Pearson's correlation coefficient showed no significant correlation between age and gonial angle (r=0.06, P=0.422), antegonial angle (r=0.03, P=0.737), and antegonial notch depth (r=-0.06, P=0.392).

One-way ANOVA showed that the mean age of patients with type II right antegonial notch was significantly higher than the mean age of patients with other types (P=0.005); however, no significant correlation was found between agend type of left antegonial notch (P=0.119).

Table 3- Radiomorphometric indices of the mandible in short-face males and females

Variable	Gender	Mean	Std. deviation	P-value*
Gonial angle	Male	117.63	5.15	0.119
	Female	119.34	7.09	
Antegonial angle	Male	162.97	5.78	0.176
	Female	164.53	7.35	
Antegonial notch depth	Male	1.98	0.80	<0.001
	Female	1.52	0.61	

*Independent t-test

Table 4- Comparison of the type of antegonial notch in the right and left sides based on class of malocclusion and gender of short-face patients

Variable		Type of right antegonial notch			Type of left antegonial notch	
		Number (%)			Number (%)	
		Class I	Class II	Class III	Class I	Class II
Class of occlusion	I	34 (64.2)	19 (35.8)	0 (0.0)	42 (79.2)	11 (20.8)
	II	59 (56.7)	41 (39.4)	4 (3.8)	56 (53.8)	48 (46.2)
	III	11 (50.0)	11 (50.0)	0 (0.0)	14 (63.6)	8 (36.4)
P-value*			0.487		0.008	
Gender	Males	25 (49.0)	22 (43.1)	4 (7.8)	18 (35.3)	33 (64.7)
	Females	79 (61.7)	49 (38.3)	0 (0.0)	94 (73.4)	34 (26.6)
P-value*			0.006		<0.001	

Discussion

Considering the gap of information regarding the gonial and antegonial angles and depth and type of antegonial notch, this study aimed to assess the relationship of skeletal class of malocclusion and some radiomorphometric indices of the mandible including the gonial and antegonial angles and depth and type of antegonial notch in short-face patients. The null hypothesis was that no significant correlation would be found between skeletal class of malocclusion and the above mentioned radiomorphometric indices of the mandible in short-face patients.

The results showed that the mean size of gonial angle was significantly different among the three classes of malocclusion (P<0.001), and the largest gonial angle was recorded in class III and the smallest in class I malocclusion patients. The mean size of antegonial angle and antegonial depth were not significantly different among the three classes of malocclusion (P=0.164, P=0.818). The difference in the mean size of gonial and antegonial angles was not significant between males and females (P=0.119, P=0.176). However, the mean antegonial depth in males was significantly higher than that in females (P<0.001). Distribution of types of antegonial notch was significantly different between males and females, such that type I was more common in females than males at both the ride and left sides. According to the obtained results, the null hypothesis of the study was partly accepted and partly rejected.

Salem et al. [9] discussed that the antegonial notch has a strategic position, and its shape can well predict the mandibular growth pattern. [9] The present results showed a significant correlation between the type of antegonial notch and the class of malocclusion. Also, the type of antegonial notch in the right and left sides was significantly different in males and females, and type I was more common in females at both the right and left sides. Tayebi et al. [10] evaluated the correlation of skeletal age estimated according to the cervical vertebral maturation stage, and chronological age, and also the correlation of skeletal and chronological age with mandibular inferior cortical bone thickness by using radiomorphometric indices. They found that by an increase in skeletal and chronological age, the mandibular inferior cortical bone thickness, and consequently the related radiomorphometric indices, except for the gonial index, increased. They found no significant correlation between antegonial index and mental index with class of malocclusion. However, the gonial index had a significant correlation with the class of malocclusion. In the present study, the gonial angle was significantly correlated with the class of malocclusion, which was similar to the results of Tayebi et al [10]; however, age had no significant correlation with radiomorphometric indices of the mandible and condyle in the present study, which was different from their findings.

The masseter muscle attaches to the gonial region of the mandible. Also, evidence shows that the activity of the muscles of mastication, particularly the masseter, varies in different classes of malocclusion. [11] The role of mastication muscles in normal/abnormal growth of facial structures has been previously documented. [12] Porwolik et al. [6] evaluated the anatomical details of the antegonial notch and showed that in both males and females, type III was the most frequent and type I was the least frequent type of antegonial notch irrespective of its direction. Type II antegonial notch was more common in males while type III was more common in females. [6] In contrast to their findings, type I was the most frequent and type III was the least frequent type in the present study, and type I was more common in females. The difference between their results and the present findings may be attributed to racial differences and higher number of females than males in the present study.

Atef et al. [13] evaluated the role of computed tomography for age estimation in a Libyan population and found a significant correlation between the size of gonial angle and Gonion-Gnathion length with age, such that these measurements increased with age. In contrast to their study, the present study found no significant correlation between age and gonial or antegonial angle or antegonial notch depth. This finding may be due to the limited age range of patients in the present study. Further studies on patients with a wider age range are required to cast a final judgment in this regard.

Behl et al. [14] evaluated the mandibular ramus and gonial angle as possible landmarks for age estimation and gender determination according to digital panoramic radiographs in a north Indian population. They found a significant difference in gonial angle between males and females, and reported that this angle was larger in females. Unlike their study, the present study found no significant difference in the mean size of gonial and antegonial angles between males and females. However, the mean antegonial depth in males was significantly greater than that in females. Moreover, they found significant correlations between age and linear measurements, while age had no significant correlation with the assessed variables in the present study. The difference between their results and the present findings may be explained by racial differences, differences in site of attachment of the masseter muscle at the Gonion region, different nutritional regimens of patients, and limited age range of patients, and the lower number of males than females in the present study.

Tafakhori et al. [15] evaluated the correlation of the mandibular anatomy with age and gender on panoramic radiographs. The mean radiomorphometric indices were not significantly different among different age groups, and all the mean values of the measured angles were larger in females while other measured indices were larger in males. Similarly, age had no significant correlation with the measured indices in the present study, and the difference in the mean size of gonial and antegonial angles was not significant between males and females. However, the mean antegonial depth was significantly greater in males than females.

Mostafa et al. [16] assessed the effects of dental status, age and gender on mental and panoramic mandibular indices of the mandible. They reported the significant effect of age on both indices, and found no significant correlation between panoramic indices of the mandible and gender. Their results regarding the effect of age were different from the present findings. Gupta et al. [17] analyzed the correlation of antegonial notch depth, morphology of the symphysis, and ramus morphology in class II malocclusion patients with different growth patterns. They detected a significant correlation between antegonial depth and gender, and this variable was significantly greater in males, which was similar to the present findings, and also the results of Singer et al. [18] However, Mangla et al. [19] found no significant correlation between antegonial notch depth and gender. Difference in antegonial notch depth between males and females was attributed to the difference in level of sex hormones, which affects bone formation. [20]

This study had some limitations. Due to unavailability of computerized patient data, computerized analysis with the respective software programs was not possible. The number of female patients was higher than male patients, and the age range of participants was limited, which could have affected the results. Further studies with a larger sample size on equal number of male and female patients with a wider age range are required using digital software programs to more accurately assess the indices. Also, the correlation of class of malocclusion with other radiomorphometric indices such as condylar height should be investigated in future studies.

Conclusion

The present results emphasized on the role of antegonial angle in prediction of facial growth pattern in short-face patients, and indicated significant correlation of skeletal class of malocclusion with size of gonial angle.

Conflict of Interest

No Conflict of Interest Declared ■

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