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Relating Facial Asymmetry with Mandibular Morphometric Parameters: A CBCT Study

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Abstract

Introduction: It is imperative to have a sound knowledge of causes and various aspects of facial asymmetry. **Objectives:** To evaluate asymmetry in the lower third of face, correlate the asymmetry with morphological features of the mandible, to correlate the dental and skeletal asymmetry in the mandible and to determine a correlation between these parameters and skeletal asymmetry at point menton using CBCT. **Methods:** Pre-treatment records of 15 patients (07 males and 08 females, aged 16.93 ± 2.19 years) with asymmetry of lower third of face due to unknown aetiology and chin deviated to right (Group A, study group) were compared with 15 patients (07 males and 08 females, aged 16.12 ± 2.06 years) presenting with no gross facial asymmetry (Group B, control group). Multiplanar Reformation view of CBCT data in sagittal plane was used to assess condylar height, ramus length and mandibular body length in both groups. **Results:** The mean condylar heights on both sides were similar in Group B (P-value > 0.05). The condylar height on right side in Group A was smaller compared to the left side condyles in both groups (P-value < 0.001). No significant difference was observed in mean ramus and body length between the 02 groups (P-value > 0.05). The skeletal midline deviation was higher compared to the dental midline deviation towards right in Group A (P-value < 0.001). **Conclusion:** Condylar height is an important factor responsible for asymmetry of the lower third of the face and deviation of chin in adolescent patients with asymmetry of unknown aetiology.

Keywords: CBCT, Condylar Height, Facial Asymmetry

1. Introduction

In the present scenario, the number of patients seeking orthosurgical care secondary to various oro-facial deformities is rising primarily to improve facial and smile aesthetics. Therefore, it is imperative for the orthosurgical team to have a sound knowledge about the etiopathogenesis and various clinical aspects of facial asymmetry[1]. The facial asymmetry can be broadly attributed to congenital, acquired and developmental causes[2].

The facial asymmetry is prevalent in approximately 34% of the orthodontic patients. The lateral deviation of the chin is one of most remarkable feature of asymmetry of lower third of face. Lateral deviation of the chin accounts for 74% of asymmetry patients with a frequency of lateral guidance of the upper and midface equal to 5% and 36%, respectively[3]. To successfully manage the facial asymmetry, it is pertinent to determine the underlying cause along with the correct extent and level of asymmetry. The assessment of facial asymmetry with Two Dimensional (2D) radiographic modalities is associated with numerous limitations such as distortion and elongation of radiographic images and superimposition of various anatomic structures which makes accurate assessment very difficult. Cone-beam Computed Tomography (CBCT) is a recommended diagnostic modality to triumph over the above limitations and to allow thorough accurate Three Dimensional (3D) assessment of craniofacial asymmetries[4].

The quantification of lateral deviation at chin level is important in the evaluation and management of facial asymmetry. This can be affected by asymmetries at the level of cranial-base, temporomandibular fossa, maxilla

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or mandible. In order to study the facial asymmetry, various authors have compared mandibular morphology, especially condyles in adult patients with/without asymmetry of the face. On evaluating the volume and position of TMJ structures among patients with mandibular asymmetry, it has been observed that the volume of the condyle is significantly smaller on the affected side[5]. Min-Hee Oh et al[6] studied the deviation of menton point among patients with facial asymmetry and observed that the asymmetry is associated with the difference in the right and left side of the mandible and is caused by a smaller condyle on the deviated side, particularly in neck length along with reduced neck and head volumes.

The aim of the present study was to evaluate asymmetry in the lower third of face, correlate the asymmetry with the morphological features of the mandible, to correlate the dental and skeletal asymmetry in the mandible and also to determine a correlation between these parameters and skeletal asymmetry at point menton using CBCT.

2. Materials and Methods

This study was conceived and executed at Department of Orthodontics and Dentofacial Orthopedics of a tertiary care government teaching institution. The clearance of the ethical committee of the institute was obtained prior to the start of study. Treatment records of patients with facial asymmetry, either undergoing orthodontic treatment or archived at the institute were the sample population.

The inclusion criteria were: Adolescent patients with asymmetry of the lower third of face; chin deviated to right due to unknown etiology, healthy Temporomandibular Joint (TMJ) with normal mobility, no history of orthodontic treatment or trauma to the jaw bones and all medical and orthodontic patient records available.

The exclusion criteria were: Patients diagnosed with idiopathic or progressive condylar resorption, lesions such as osteochondroma or synovial chondromatosis, patients with congenital deformity such as cleft lip and palate, hemifacial microsomia, hemifacial hyperplasia or generalized syndromes (Treacher Collins syndrome etc.) and patients with TMJ ankylosis.

With these definitive inclusion and exclusion criteria, records of 15 adolescent patients diagnosed with asymmetry of the lower third of face were selected. These selected patients constituted study group (group A) in which all patients had facial asymmetry in the lower third of face with chin deviated to right. To match the study group, 15 patients without any gross facial asymmetry, undergoing routine orthodontic treatment were selected which constituted control group (group B). The control group selected was matched with the study group in both age of the patients and gender to avoid any bias. The records included complete case record sheets, extraoral & intraoral photographs, Lateral Cephalogram, Posteroanterior (PA) Cephalogram, Orthopantomogram (OPG) and CBCT.

The radiographs were recorded with New Tom CBCT machine (M/s Cefla Dental Group, Italy) installed in the department, using a standardized technique and exposure parameters with tube voltage of 60-90 KV, tube current 1-10 ma (pulsed mode), focal spot of 0.5 mm and image resolution of 3.94 IP/mm.

The Multiplanar Reformation View (MPR) of CBCT data in sagittal view was used to assess the condylar height, ramus length and mandibular body length. Measurement of the condylar height was recorded using technique described by Kjellberg H et al[7]. A tangent was constructed on the posterior border of ramus; perpendicular was drawn to this tangent from the most cranial point on condyle and most caudal point of the sigmoid notch. The rectilinear distance between these two perpendiculars was considered as condylar height. Ramus length was measured as the distance between the tangent from sigmoid notch to gonion point and mandibular body length was measured from gonion point to gnathion point. PA cephalogram was used to calculate skeletal and dental midline deviations.

In order to overcome the intra and inter-examiner variability, 10 randomly selected CBCT records were re-examined by the same investigator (DC) and also by a Senior Orthodontist (SD) at interval of one week.

3. Statistical Analysis

The data was analyzed with Statistical Package for Social Sciences (SPSS version 22.0, IBM Corporation, USA) for MS Windows. The p-values <0.05 were considered as statistically significant. The statistical analysis was done using Chi-Square test and independent sample t test.

4. Results

The kappa score of 0.8 and 0.9 respectively indicated excellent intra and inter operator reliability in obtaining

the CBCT data. The mean age ± SD of age of cases studied in group A and group B was 16.93 ± 2.19 years and 16.12 ± 2.06 years respectively. The minimum–maximum age range in group A and group B was 14–21 years and 13–21 years respectively. The mean age of cases studied did not differ significantly between two study groups (P-value > 0.05) (Table 1).

Table 1. Comparison of mean age

Age (years)	Group A (n = 15)		Group B (n = 15)		P-value
	Mean	SD	Mean	SD	
Age (years)	16.93	2.19	16.12	2.06	0.999NS

Values are mean and SD, P-value by independent sample t test. P-value < 0.05 was considered to be statistically significant. NS-Statistically non-significant.

Table 2. Distribution of gender among the study groups

Gender	Group A (n = 15)		Group B (n = 15)		P-value
	n	%	n	%	
Male	7	46.7	7	46.7	0.999NS
Female	8	53.3	8	53.3	
Total	15	100.0	15	100.0	

Values are n (% of cases), P-value by Chi-Square test. P-value<0.05 is considered to be statistically significant. NS-Statistically non-significant.

Of 15 cases studied in group A, 7 (46.7%) were males and 8 (53.3%) were females. Of 15 cases studied in group B, 7 (46.7%) were males and 8 (53.3%) were females (P-value > 0.05) (Table 2).

4.1 Comparison of Mean Condylar Height

The mean condylar height on the Right side was smaller in group A compared to group B (P-value < 0.05). The mean condylar height on the Left side was similar between two study groups (P-value > 0.05) (Table 3, Figure 1).

Table 3. Comparison of mean condylar height

Condylar height	**Group A (n = 15)**		**Group B (n = 15)**		**P-value (Inter-Group)**
	Mean	SD	Mean	SD	
Right	12.07	1.07	15.27	1.25	0.001***
Left	15.25	1.30	15.25	1.30	0.982NS
Ratio (Right/ Left)	0.79	0.026	1.00	0.016	0.001***
P-value (Intra-group) (Right v Left)	0.001***		0.832NS		

Values are mean and SD. P-value (Inter-Group) by independent sample t test. P-value (Intra-Group) by paired t test. P-value<0.05 was considered to be statistically significant. ***P-value<0.001, NS-Statistically non-significant.

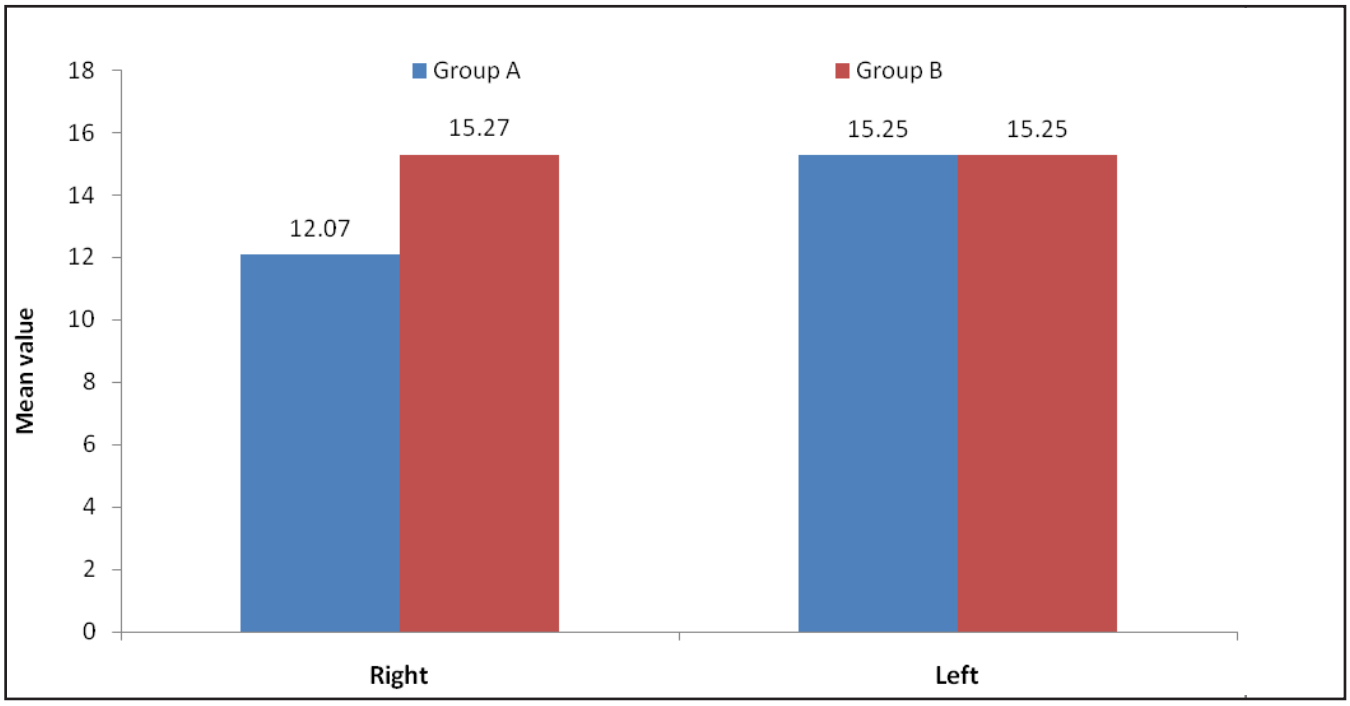


Figure 1. Comparison of mean condylar height.

4.2 Comparison of Mean Right to Left Condylar Height Ratio

The mean condylar height ratio (Right/Left) among the cases studied was significantly lower in group A compared to group B (P-value < 0.001) (Table 3, Figure 2).

4.3 Comparison of Mean Condylar Height (Right Versus Left Condyle)

In group A, mean condylar height on the Right side was significantly lower compared to mean condylar height on the Left side (P-value < 0.001). In group B, mean condylar

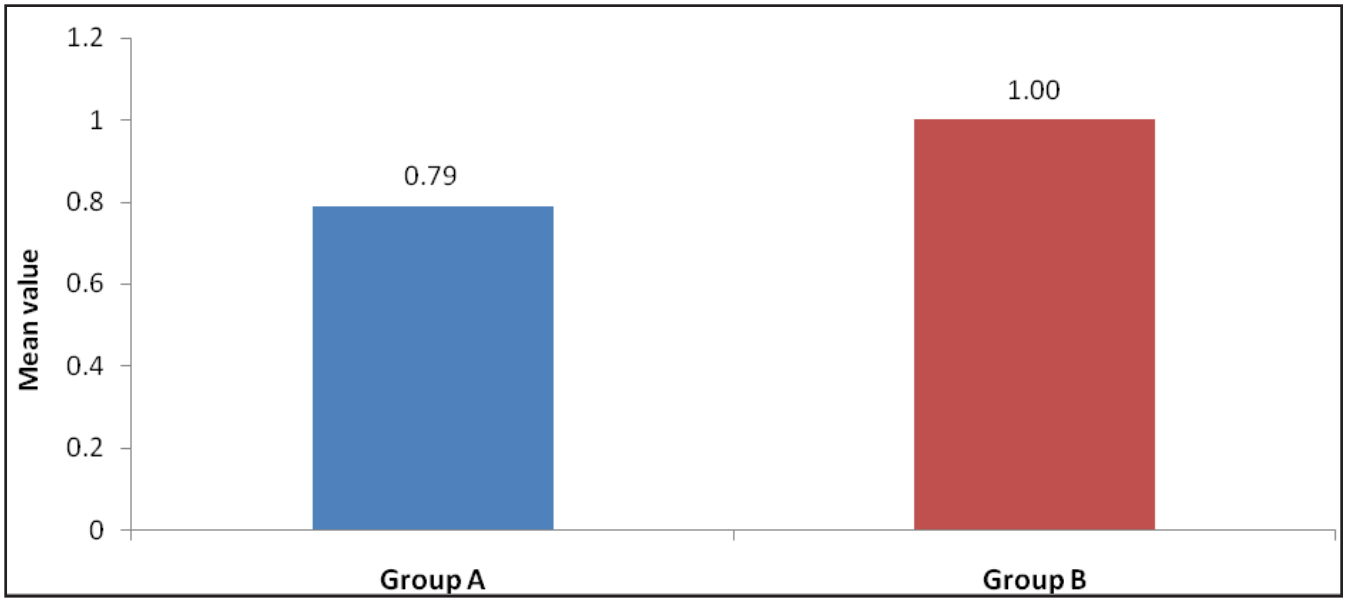


Figure 2. Comparison of mean Right to Left condylar height ratio.

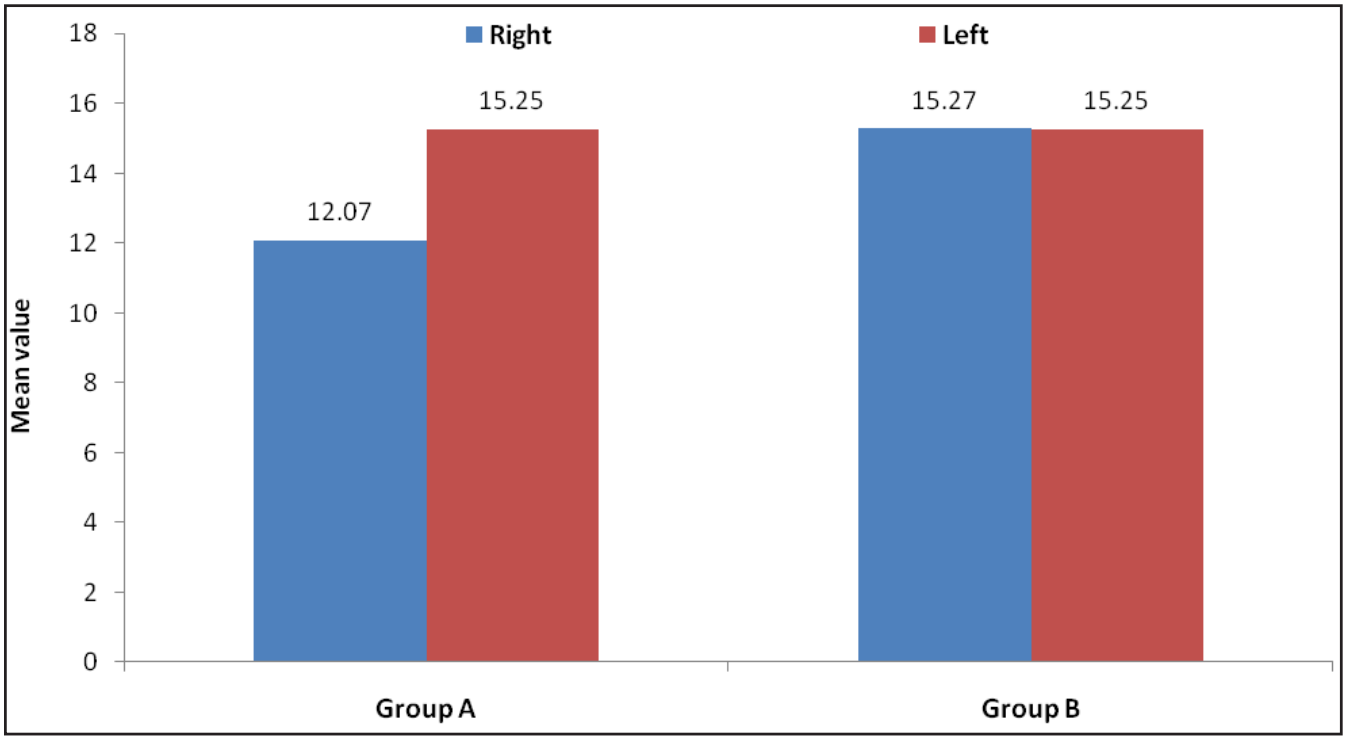


Figure 3. Comparison of mean condylar height (Right versus Left condyle).

height on the Right side did not differ significantly with mean condylar height on the Left side (P-value > 0.05) (Table 3, Figure 3).

4.4 Comparison of Mean Ramus Length and Mean Right to Left Ramus Length Ratio

The mean Ramus length and mean Right to Left ramus length ratio on the both Right side and Left side was similar in both groups (P-value > 0.05) (Table 4).

4.5 Comparison of Mean Body Length and Mean Body Length Ratio

The mean body length and mean body length ratio on the Right side and Left side was similar in both groups (P-value > 0.05) (Table 5).

4.6 Mean Skeletal versus Dental Deviation in group A

The mean skeletal midline deviation was significantly higher compared to the dental midline deviation towards right (P-value < 0.001) (Table 6).

Table 4. Comparison of mean ramus length

Ramus length	Group A (n = 15)		Group B (n = 15)		P-value
	Mean	SD	Mean	SD	
Right	44.02	1.80	43.92	1.62	0.999NS
Left	44.13	1.58	44.83	1.37	0.999NS
Ratio (Right / Left)	1.00	0.001	1.00	0.001	0.999NS

Values are mean and SD, P-value by independent sample t test. P-value<0.05 is considered to be statistically significant. NS-Statistically non-significant.

Table 5. Comparison of mean body length

Body length	Group A (n = 15)		Group B (n = 15)		P-value
	Mean	SD	Mean	SD	
Right	73.19	2.03	72.73	2.44	0.999NS
Left	73.13	2.06	73.86	2.23	0.999NS
Ratio (Right / Left)	1.00	0.001	1.00	0.001	0.999NS

Values are mean and SD, P-value by independent sample t test. P-value<0.05 was considered to be statistically significant. NS-Statistically non-significant.

Table 6. Mean skeletal midline to dental midline deviation in group A

	Skeletal Midline Deviation (n = 15)		Dental Midline Deviation (n = 15)		P-value
	Mean	SD	Mean	SD	
Deviation (mm)	4.38	0.70	3.53	0.64	0.001***

Values are mean and SD, P-value by paired t test. P-value<0.05 is considered to be statistically significant. ***P-value<0.001.

5. Discussion

The presence of some degree of facial asymmetry is a common finding in orthodontic patients and it is sub-clinically prevalent in the majority of individuals[1]. The presence of <3% asymmetry between right and left side is usually not perceptible to the laymen[8]. However, asymmetry beyond this limit may be associated with impairment of esthetic, morphologic and stomatognathic functions. This warrants meticulous clinical and radiographic assessment of the underlying cause, accurate diagnosis and localization of the asymmetry in three planes of space and systematic treatment planning[1,2]. A sound knowledge of etiology and identification of the correct level of asymmetry is crucial for diagnosis, treatment planning and long term stability of the treatment results[2].

The facial asymmetry may range from deformity of a single bone to the involvement of multiple bones/facial structures on the affected side of the face. The contralateral side of the face may present with various compensations and distortions in growth which further aggravate the asymmetry[2]. The abnormalities involving the mandible are the main causative factor behind the asymmetries involving lower third of face. However, the asymmetry at this region may also arise due to involvement of other parts of facial skeleton such as base of the skull, maxilla or at multiple level. Studies have shown higher contribution of mandible in comparison to maxilla in causing asymmetries in the lower one-third of face[2,9]. Literature also reveals that asymmetry in face is most appreciated at the menton point[10,11].

Understanding the aetiology and extent of facial asymmetry start with detailed case history. A thorough clinical evaluation helps the clinician to determine the asymmetry in all three plane of space. To augment the clinical interpretation of the asymmetry several

radiographic views are available: OPG, PA Cephalogram, CBCT etc. CBCT being the latest and one of the most reliable modality to study facial asymmetry was utilised in the present study. Various authors have used CBCT/CT to study the asymmetry in the lower third of face[5,10-13]. However, more emphasis is being given to mandibular condyle morphology and volume and condyle fossa relation. The present study compared morphometric parameters of mandible among two study groups: In addition to condylar height, length of ramus and body was also compared. To determine the relation of parameters studied with asymmetry, ratios were used to negate the effect of magnification among the radiographs.

To ascertain the morphometric parameter involved with the asymmetry at point menton, ratios of different parameters were compared on the Right side and Left side: Condylar height, ramus length and body length. In our study, mean condylar height on the Right side among the asymmetry cases studied was significantly lower compared to mean condylar height on the Left side which was also indicated by decreased ratio of right to left of 0.79. However, in control group mean condylar height on the Right side did not differ significantly compared to mean condylar height on the Left side. Similar findings were observed by Min-Hee Oh et al[6] in their study wherein the length of condylar neck showed significantly higher right and left side discrepancy in the asymmetry group. Inter group and intra group comparison of other parameters did not showed any statistically significant difference. Hence, the results indicate that the asymmetry recordable at point menton can be mainly attributed to the difference in the condylar length in the asymmetry group. Authors attempted to search for similar study where ramus length and body length ratios were also used to study asymmetry; however in the absence of previous similar study the results obtained cannot be compared.

Authors also studied the mean deviation of the skeletal midline and compared it with the dental midline shift and it was found that skeletal midline deviation was significantly more than the dental midline shift. Further attempt was made to develop a relation between the ratios of difference between different parameters studied to the deviation of skeletal midline at point menton among patients with asymmetry. It was condylar height only which showed a statistically significant difference between right side and left side. To determine the effect of this difference on skeletal asymmetry at point menton, the following formula was developed:

$$\frac{\text{Ratio of condylar height b/w right side and left side (in \%)}}{\text{Deviation of skeletal midline at point menton (in mm)}}$$

With the results of the present study, an inference can be drawn that with every 18% difference in size of condylar height, the menton point will show deviation of 1mm.

6. Conclusions

The following conclusion can be drawn from this study:

- Patients with facial asymmetry demand high esthetic results, hence it is very important to determine the underlying etiology and locate the level and extent of the asymmetry.
- Although some amount of asymmetry is acceptable to lay population, but increased asymmetry may result in problems like poor esthetics, under efficient mastication and/or TMJ problems.
- The condylar height is an important factor responsible for asymmetry of the lower third of the face which may cause deviation at point menton in adolescent patients with asymmetry of unknown aetiology.

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