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THREE DIMENSIONAL EVALUATION OF CONDYLAR HEAD INCLINATION WITH RESPECT TO RAMUS AMONG POST PUBERTAL CLASS II PATTERNS

Abhilasha Goyal, R. H. Kamble, Sunita Shrivastav, Narendra Sharma

Department of Orthodontics, Sharad Pawar Dental College, Wardha, Maharashtra, India.

ABSTRACT

Objective: To assess the condylar head inclination with respect to ramus in Angle's Class II division 1 and division 2 skeletal patterns using Digital Volume Tomography.

Material and method: The sample consisted of 45 post pubertal patients who were divided on the basis of clinical and cephalometric analysis into three groups - skeletal Class I, Class II division 1 and Class II division 2. The selected cases underwent Digital Volume Tomography and the images obtained were used to assess condylar head inclination, mediolateral and anteroposterior thickness of the condylar head on right and left sides for all the three groups. ANOVA, Least significance difference and Paired student's t test were done.

Results: The Class II division 2 group showed significantly more anteriorly angulated condyles as compared to those of Class II division 1 and Class I groups on both right and left sides. Class II division 1 group showed significantly smaller mediolateral dimension as compared to Class I and Class II division 2 groups. The anteroposterior dimension was not significantly different in all three groups studied.

Conclusion: There exists a variation in the condylar morphology in the various skeletal malocclusions examined. The individuals with Class II division 2 malocclusion had a tendency towards having more anteriorly angulated condyles. Also the mediolateral dimension of condylar head of individuals with Class II division 1 malocclusion is smaller than Class II division 2 and Class I malocclusions.

Key Words: Condyle, Class II malocclusion, DVT

INTRODUCTION

In dentofacial orthopaedics, thorough knowledge of the skeletal and dental components that contribute to a particular malocclusion is essential as these may influence the approach to treatment. Form and function are considered to be closely linked, also it follows that the morphology of the temporomandibular joint (TMJ) might be related to functional forces.

The role of mandibular growth has specially intrigued practitioners due to its variability and relative unpredictability. There are several factors that could affect the TMJ morphology and position, such as age, sex, facial growth pattern, pathological or functional alterations, decreased or increased muscular activity, and dental occlusion changes.[1-4] As a result of these changes, there is a remodelling and reconfiguration of the TMJ surfaces as an adaptation response.[5] However, the amount of this remodelling will depend on the mechanical and functional conditions to which adjacent structures are faced.[4, 5]

Studies evaluating maxillary and mandibular skeletal and dental positions and vertical components of Class II patients have reported conflicting results. Most of the studies selected Class II patients on a dental basis, but patients with a dental Class II malocclusion may have a Class I or a Class II skeletal pattern.[6] Few studies evaluated patients with both skeletal and dental Class II malocclusion.[7-9] The only exceptions are the studies by Gianelly et al[10], who studied the position of condyle in the fossae in Class II patients with deep-bite and no overjet, and the study by Ricketts, [11-12] in which the Class II group were studied. He stated that those with skeletal Class

Corresponding Author:
Dr. Abhilasha Goyal, Senior Resident, Department of Orthodontics, Sharad Pawar Dental College, Wardha, Maharashtra, India.
Email: abhilasha.goyal04@gmail.com

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II division 2 malocclusions, when compared with normal Class I or Class II division 1 subjects have larger masticatory muscles that are oriented in a more anterior direction. It shows that TMJ loading in patients with skeletal Class II division 2 patterns differs from those having other dentofacial morphologies.

It has been claimed that Class II division 2 malocclusions do not exhibit a distinct skeletofacial pattern, and, with the exception of the maxillary central incisor position, there is no other difference in morphology when compared with Class II division 1 subjects. This view, however, has been challenged by others who claim that Class II division 2 malocclusion is a distinct dentoskeletal entity.[13]

As the mandible and the TMJ can be loaded differently in persons with varied dentofacial morphologies, one could hypothesize that the condyle might differ between people with various malocclusions.

There is no doubt that scarce information exists on the morphologic assessment of the dentofacial complex and the factors that may or may not contribute to its growth. Three-dimensional high resolution imaging allows the quantification of facial bone tissues in approximately real dimensions (1:1 ratio) without significant magnification, distortion or superimposition providing clear visualization of the areas of interest and opening new perspectives for analyzing these joints with any difficulty.

The purpose of this study was to determine the relationship between condylar characteristics measured using preorthodontic three dimensional reconstructions of post pubertal Class II patients and their skeletal malocclusions.

MATERIALS AND METHOD

Sample selection

Forty five patients, ranging in age from 18 to 40 years, were selected from the outdoor patients Department of Orthodontics, Sharad Pawar Dental College and students of Datta Meghe Institute of Medical Sciences (DU), Sawangi (M), and Wardha.

The selected patients were divided into three groups based on clinical and cephalometric examination as Group 1- Skeletal Class I, Group 2- Skeletal Class II division 1 & Group 3- Skeletal Class II division 2 comprising of 15 patients each. The cephalometric criteria used for dividing the sample into Skeletal Class I and Skeletal Class II are described in Table 1.

Radiographic analysis

The lateral cephalograms were taken by a Planmeca proline cc (Finland) machine. Tracings were digitized and analyzed using Vistadent software. The selected cases, after cephalometric evaluation, were subjected to Digital Volumetric Tomography.

The samples were scanned using Phillips Allura Xper FD20 3D RA, Digital Subtraction Angiography unit (Netherlands) with exposure parameters of 80 kVp, 10 Ma and 4-5 sec with Field of View- 12" 270^0 rotation. The images were obtained with the patients in maximum dental intercuspation and the head positioned so that the Frankfort horizontal plane was perpendicular to the floor.

Three dimensional (3D) images, as well as, multiplanar reconstruction (MPR) images were obtained using 3D RA software at computer work station, which were then evaluated using Intruis Suite R2 software.

For each sample a total of 3 measurements (for right and left side each) were calculated:

1. Condylar head inclination with respect to ramus
   This measurement was completed according to the format described by Sug-Joon Ahn et al 14 (F ig.1)
2. Mediolateral thickness of condylar head
   Measured as the largest mediolateral dimension. (Fig.2a)
3. Anteroposterior thickness of condylar head
   Measured as the largest anteroposterior dimension. (Fig.2b)

Statistical analysis

Descriptive statistics for all variables were studied. Group differences were tested with one-way ANOVA and Multiple Comparison Least Significant Difference test. Paired Student t-test was used for each measurement to evaluate the average of differences between the sides for each element of the sample of all the groups.

RESULTS

Statistical description of the condylar head inclination and dimensions of condyle according to skeletal pattern are given in Table 2&3.

With respect to the condylar head inclination (for both right and left sides) One Way Anova test revealed statistically significant values (p value=0.001*) between the groups and within the groups. Significant findings were obtained when Group 1 was compared to Group 2 and Group 3 (p value=0.001). Also, when Group 2 was compared to Group 3 the values were statistically significant with (p value=0.001).

For the thickness of condyle mediolaterally, for both right and left sides, it was observed that there is statistically significant difference when comparing Group 1 to Group 2(p value=0.01) and Group 2 to Group 3(p value=0.01). No statistically significant difference was found when comparing Group 1 to Group 3(p value=0.09).

A statistically non significant difference was identified regarding the anteroposterior thickness of the condyle when the three groups were compared.

A paired Student's t test showed no statistical difference between right and left sides for all the variables. (Table 4)

DISCUSSION

Understanding the TMJ morphology in the Class I and Class II groups remains a challenge for orthodontists. In literature it has been stated that the condyle and the fossa might differ in shape and their interrelations among people with various malocclusions while the mandible and the temporomandibular joint can be loaded differently in persons with diverse dentofacial morphologies.

The difficult visualization of the TMJ (due to its complex anatomy and the superimposition of adjacent structures) might be a factor responsible for the discrepancies in the results of different studies concerning this joint. Nowadays other methods are used for evaluating 3-dimensional morphology of the skeletal structures of TMJ such as cone beam computed tomography (CBCT), multi slice computed tomography (MSCT) and Digital Volume Tomography (DVT). All of these provides an optimal imaging of the osseous components of the TMJ and gives a full size truly volumetric 3D description in real anatomical (1:1) size. The evidence of its accuracy was evaluated by Anuraag B. Choudhary et al[15] who assessed the diagnostic quality of images generated using the then newly developed digital volume tomography (DVT) system and comparing them with conventional images obtained from patients with maxillofacial trauma. The results and statistical analysis clearly indicated that the diagnosis of maxillofacial traumatic injuries involving the midface and mandibular condylar region (condylar head) is significantly enhanced using Digital Volume Tomography compared with conventional radiographs.

Condylar head inclination with respect to ramus in all three groups on right and left sides, were evaluated. The Class II division 2 group showed significantly more anteriorly angulated condyles as compared to those of Class II division 1 and Class I groups on both right and left sides (Fig 3). This shows altered glenoid fossa relationship in the experimental group. The Class II division 1 group had increased anterior condylar angulation as compared to Class I group but less as compared to Class II division 2 groups.

Findings of this study can be explained by the research done by Gail Burke et al[1] who evaluated the correlation between the skeletal growth pattern and condyle glenoid fossa relation using preorthodontic lateral cephalograms and tomograms of 136 preadolescent Class II patients. He stated that patients with vertical facial morphologic characteristics displayed posteriorly angled condyles whereas anteriorly angled condyles were significantly correlated to the patients with a horizontal facial morphology.

Similar findings were obtained by Elias G. Katsavrias[16] who studied the shapes of the condyle and the glenoid fossa in patients with Class II division 1, Class II division 2, and Class III malocclusions. Axially corrected tomograms of 189 patients were used (109 Class II division 1, 47 Class II division 2, and 33 Class III). The Class III group had a more elongated and anteriorly inclined condylar head with a wider and shallow fossa.

In the present study the Class II division 2 group consisted of predominantly horizontal growers while the Class II division 1 group consisted of a mixed sample of vertical and horizontal growers. This explains the increased angulation in the Class II division 1 group than the Class I group. Also the methodology used in the previous studies was different from the one used in this study.

Although no significant difference was found between the right and left sides for condylar head inclination, the mean value obtained for the right side in all three groups were greater than that of the left side. This asymmetry may be attributed to side preferences during mastication.

To the best of our knowledge to date, no study has been conducted to study the condylar head inclination with respect to ramus in skeletal Class II division 1 and Class II division 2 cases. The previous studies only concentrated on the association of growth pattern in Class II cases with the condylar head inclination.

The correlation obtained between condylar head inclination and facial morphology is consistent with results previously reported in early literature. Posterior inclination of the condyles has been shown to dominate the individuals with the Classic long face syndrome, and anterior inclination of the condylar head can be associated with counter-clockwise mandibular rotators.[17] It has also been reported in the literature that reduced condylar growth represents clockwise rotation of the mandible in relation to the cranial base.[18] Proliferation of condylar cartilage and endochondral ossification of the condyle occurs via a complex of biomechanical interactions. The magnitude, direction and duration of the resultant condylar growth may be influenced by genetic determinants as well as intrinsic and extrinsic control factors.

Animal studies have shown that mandibular protrusive appliances can result in increased chondrocytic proliferation and subsequent osseous development of the condyle in a posterior and posterosuperior direction.[19-22] the magnitude of the temporomandibular joint's adaptability and subsequent alteration will also be dependent upon maturational age, adaptive potential and neuromuscular function.[1]

The dimension of the condyle showed statistically significant results for mediolateral dimension of the condyle. On comparison of Class II division 1 showed significant values when compared with Class I and Class II division 2 whereas the values were not significant when Class I and Class II division 2 were compared.

Overall, the mean for Class II division 2 was greater than that on Class I and Class II division 1 respectively for both mediolateral and anteroposterior dimensions of the condyle (Fig 4).

Krisjane et al[23] studied the TMJ parameters in Class II and Class III patients using volumetric three dimensional imaging and they concluded that there were no statistically significant differences in the anteroposterior width of the condyle in both the groups. These findings are in favour of the present study.

We found a statistically significant difference in the mediolateral dimension of the condyle; the values being least for Class II division 1and greatest for Class II division 2 samples. This variation may be attributed to the mixed sample present in the Class II division 1 group (horizontal and vertical growers). However no significant difference was found when Class I and Class II division 2 group were compared.

The axial view is most appropriate to assess the symmetry between the condyles in the anteroposterior and mediolateral aspects because it shows both condyles in the same image. This also permits measuring the real dimensions of the condyles.

The dimensions of the condyle showed no statistically significant differences between the right and left sides.

These findings of symmetry are supported by various studies present in the literature. Cohlmia et al[24] assessed the temporomandibular joint in Class I, Class II division 1, Class II division 2 and Class III patients and found that the anteroposterior thickness of the condylar head was not significantly different between the right and left sides in the sample studied.

Vitral et al[25] and Rodrigues et al[26] using the same methodology, found similar results in a Class II division 1 subdivision and Class I sample , respectively. Also the results of study by Rodrigues et al[26] on a sample of Class II division 1 and Class II malocclusion support the findings of the present study. These results seem to confirm the statement of Ben-Bassat et al[27] that the occlusal features might be associated with TMJ structure remodelling to create symmetrical relationships.

Contrasting results were shown in the study done by Vitral et al[28] on subjects with normal occlusion. He found statistically significant difference in the linear measurement of the mediolateral diameter of the condylar process between the right and left sides.

CONCLUSIONS

The individuals with Class II division 2 malocclusion had a tendency towards having more anteriorly angulated condyles as compared to individuals with Class II division 1 and Class I malocclusions.

Individuals with Class II division 1 malocclusion showed significantly smaller mediolateral dimension as compared to Class I and Class II division 2 individuals.

The anteroposterior dimension was not significantly different in the three groups examined.

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Table 1: Cephalometric measurements for determination of Skeletal Class I and Skeletal Class II

Cephalometric measurement	Skeletal Class I	Skeletal Class II
Angle SNA	82°± 2°	82°± 2°
Angle SNB	80°±2°	less than 76 °
Angle ANB	0° to 4°	More than 5°

Table 2: Descriptive statistics, ANOVA and Least Significance Difference test for all three groups for right side.

	Variables	Mean (SD)	p value (ANOVA)	p(1,2)	p(1,3)	p(2,3)
Skeletal Class I	Condylar head inclination	5.68(2.35)	0.001	0.001[b]	0.001[b]	0.001[b]
	Mediolateral width of condyle	18.41(2)	0.001	0.01[b]	0.09[b]	0.001[b]
	Anteroposterior width of condyle	7.77(0.86)	0.67	0.37[b]	0.67[b]	0.64[b]
Skeletal Class II division 1	Condylar head inclination	9.77(1.58)				
	Mediolateral width of condyle	17.13(0.86)				
	Anteroposterior width of condyle	7.53(0.59)				
Skeletal Class II division 2	Condylar head inclination	16.20(2.91)				
	Mediolateral width of condyle	19.25(0.75)				
	Anteroposterior width of condyle	7.66(0.70)				

SD-standard deviation, [b]Least Significant Difference test, p<0.05.

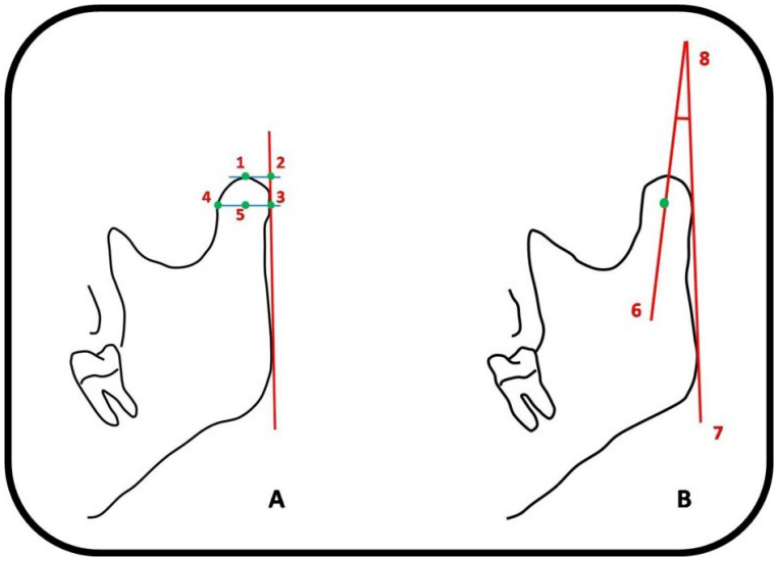
Table 3: Descriptive statistics, ANOVA and Least Significance Difference test for all three groups for left side.

	Variables	Mean (SD)	p value (ANOVA)	p(1,2)	p(1,3)	p(2,3)
Skeletal Class I	Condylar head inclination	5.43(2.08)	0.001	0.001[b]	0.001[b]	0.001[b]
	Mediolateral width of condyle	18.55(1.72)	0.001	0.001[b]	0.29[b]	0.001[b]
	Anteroposterior width of condyle	7.77(1.20)	0.89	0.66[b]	0.7[b]	0.96[b]
Skeletal Class II division 1	Condylar head inclination	9.17(1.19)				
	Mediolateral width of condyle	17.24(0.89)				
	Anteroposterior width of condyle	7.63(0.59)				
Skeletal Class II division 2	Condylar head inclination	16.00(3.16)				
	Mediolateral width of condyle	19.02(0.72)				
	Anteroposterior width of condyle	7.65(0.70)				

SD-standard deviation, [b]Least Significant Difference test.

Table 4: t test for right and left sides among all groups.

Variables	Skeletal Class I	Skeletal Class II division 1	Skeletal Class II division 2
Condylar head inclination	0.43	0.126	0.794
Mediolateral width of condyle	0.839	0.228	0.228
Anteroposterior width of condyle	0.99	0.387	0.387



A, Landmarks and reference planes, and B, measurements used in this study : **1**; most superior point of condylar head; **2**; point intersecting perpendicular projection of point 1 and ramus tangent; **3**; outermost point of condylar head; **4**; point intersecting perpendicular projection of point 3 and inner condylar outline; **5**; midpoint between points 3 and 4 ; **6**; line connecting points 1 and 5 (condylar axis) ; **7**; ramus tangent ; **8**; angle between condylar axis and ramus tangent (condylar head angle)

Figure 1: Condylar head inclination with respect to ramus:

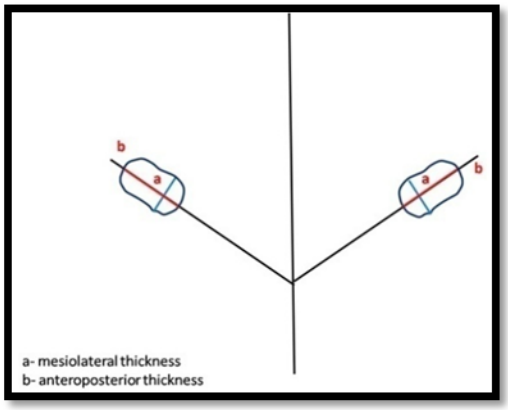
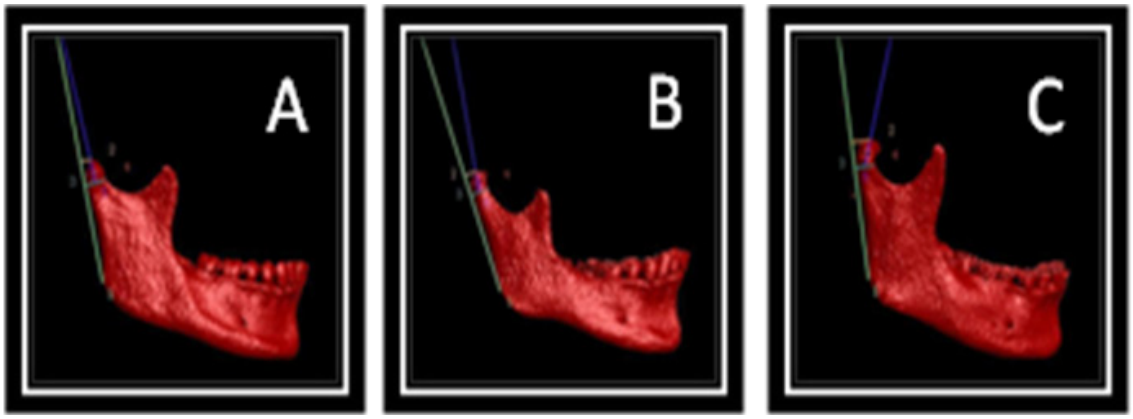


Figure 2: Anteroposterior and mediolateral thickness of condylar head:



A: Condylar inclination in Skeletal Class I, B: Condylar inclination in Skeletal Class II division 1; C: Condylar inclination in Skeletal Class II division 2.

Figure 3: Images of condylar inclination in various skeletal patterns

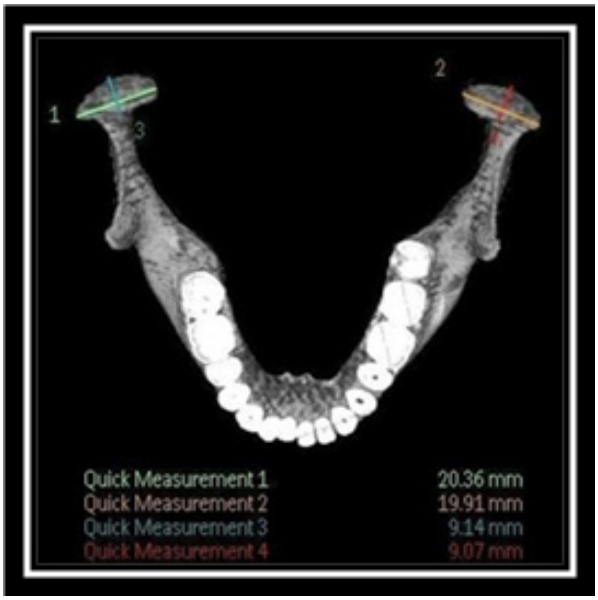


Figure 4: Mediolateral and anteroposterior dimensions of condyle in Skeletal Class II division 2

Quick measurement 1 and 2: mediolateral dimensions of condyle
Quick measurement 3 and 4 : anteroposterior dimensions of condyle