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A CBCT Comparison of Condylar Modifications in Patients Treated with Twin Block Appliance

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Abstract:
Aims and Objectives- The aim of present research was to investigate condylar alterationsafter twin block functional appliance therapy by CBCT.
Methodology- 24 patients treated by Twin Block appliance was used in this research. On 3D images, the pre-treatment (T0) and post-treatment (T1) condylar volume was measured. Linear and angular measurements were also measured and compared using 3D images. The paired ‘t' test and Wilcoxon signed rank test were used to evaluate and compare variances between T0 and T1.
Results- Increases in Condylar volume, Gonial angle, Lower Facial Height angle, linear measurement respectively, and reductions in angular measurement.
Conclusion-Because of the changes in condylar length, growth of condyleoccurs in upward and backward direction, and mandibular rotation in downward direction, Twin Block appliance therapy rises the condylar volume, length of the mandible, size in between the condyles, and CC-Gn, angle of lower facial height, gonial angle, and height of anterior face by transformationof the glenoid fossa and pushing the mandible forward, the Saddle angle, ANB angle, and Facial Convexity are decreased.
Keywords- Twin Block Appliance; Condyle, Functional Appliance Therapy.

Introduction:

The value of both attractiveness and appearance now a day’s recognized.[1] Patients diagnosed by Class II malocclusions are commonly talk about esthetic improvement because their unattractive profile will result in a negative self-image.Among the most common orthodontic conditions, Class II malocclusion, that consists unique skeletal, dental, and facial traits, affects about one-third of the population. Mandibular retrognathism is much more common among people with Class II malocclusion.[2]

Different removable or fixed appliances have been used to modify the growth for the correction of skeletal discrepancies in the treatment of Class II malocclusion with retrognathicmandibule.Twin Block is the best appliance in regulation of the mandibular plane angle and has the ultimate long-term result on the labial variant of the lower incisors, as well as the highest degree of ease and patient compliance of any other removable appliance.[3-13]

Various methods such as lateral cephalograms[14-16], orthopantomograms[17], computed tomography scans[18,19], and magnetic resonance imaging[20,21] have been used in orthodontic literature to predict TMJ adaptation following functional therapy.The visualization of the TMJ using traditional methods, on the other hand, has a range of limitations.[22-27]CBCT provides near to accurate image with less bias, higher resolution, and the ability to create 3D images in all three planes (sagittal, coronal, and axial).

It is also commonly used for accurate calculation of dental and maxillofacial pathologies, orthodontic diagnosis and treatment planning, craniofacial morphology, and airway evaluation.Various studies in the literature demonstrated the use of CBCT to estimate volume of mandibular condyle.[28,29] They relatedsize from 2D cephalograms and 3-dimensional conebeam computed tomography in recent studies (CBCT).According to Lee et al.,[30] image fusion is a reliable tool for determining surgical results that is unaffected by spatial or surgical changes. CBCT was used to evaluate growth of condyle following functional appliance, according to the literature.However, only a few studies have used CBCT to determine condylar response to functional appliances. The present study aimed to compare pretreatment and posttreatment CBCT images to see how the Twin block appliance influenced condyle.

Methodology:

The present study was done in the Department of Orthodontics and Dentofacial Orthopedics of the Dental College. The Dental institution approved the ethical clearance for the study. All the patients were informed regarding the study, and their consent was obtained. Research included 48 CBCT imaging (24 pre-treatment and 24 post-treatment), 24 patients (13 females, mean age - 12.61 years and11 males, mean age - 12.82 years) who met the inclusion criteria were selected.

Inclusion criteria-

- Patients who doesn’t finished the growth spurts.
- Class II division 1 malocclusion with regular maxilla and mandibular retrognathism.
- Relationship betweenmolars and a canines class II.
- Development pattern either horizontal or average.
- Age range 11-14 years (As per Hagg and Taranger- Stage MP3-FG and MP3-G)

The Twin-Block functional appliance was used for the treatment of all patients. At the completion of functional therapy, a class I molar and canine relationship achieved, and increased overjet was reduced.Functional therapy took an average of 7-9 months. On CBCT images taken prior (T0) and after treatment, the reaction of condylefor functional therapy was assessed (T1).Using the KODAK 9000 3D Extraoral Imaging Device, a complete head CBCT was taken prior to the placement of the Twin Block to test the location and volumeof the condyle, mandibular body, intercondylar length, height of anterior face, gonial angle, saddle angle, height of lower face angle, and convexity of face. (Fig-1)

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Fig-1: Kodak 9000 3D Extraoral Imaging

The participants were photographed in an upright position with the Frankfort horizontal plane parallel to the ground before and after treatment.During the scanning process, it was advised to breathe normally through their nose and stop swallowing. Software was used to acquire CBCT datasets with a 0.300 mm reconstruction slice thickness and a 728 x728 matrix. A single 270-degree rotation 20-second high resolution scan was performed by using isotropic voxel size at 0.300mm and 14 x 19 cm field view. The Digital Imaging and Communications in Medicine(DICOM) method was used to export the raw images.The software CS 3D Imaging Software was used to define and quantify all landmarks. (Fig-2)

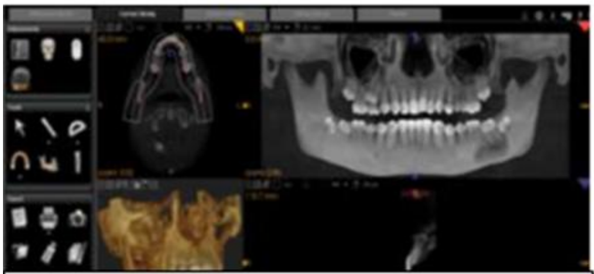

Fig-2: CS 3D Imaging Software

The CBCT analysis was done by using conventional oblique and curved slicing. The oblique slicing wasused at 167.1 mm to perform the facial convexity calculation by measuring saddle angle, gonial angle, height of lower face angle, Co-Gn, CC-Gn, and Na-Me. Curved slicing at 20.1 mm obtained linear measurements such as the distance between the right and left condylion. (Fig-3)

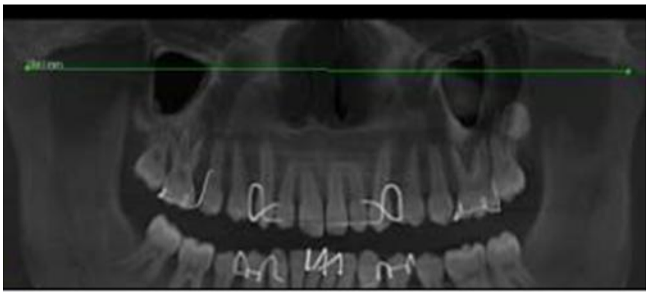

Fig-3: Linear measurements

To get a better picture of the sphenoid bone, height of lower face angle, saddle angle, ANB angle, gonial angle, and facial convexity the oblique slicing was changed to 83.7 mm. (Fig-4)

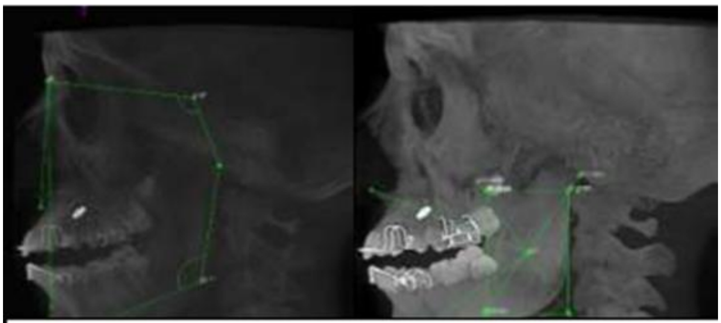

Fig-4: Angular measurements

Custom slicing at 899µm was used to extract the volume, height, length and width of the condyle. Between the posterior mandibular condyle point (PCo) and the anterior mandibular condyle point (AMo), the condylar length was calculated (ACo).On either side of the superior mandible condyle (SCo), each of these points are 4 mm below the condyle. The coronal plane was used to measure the width of condyle, that is the linear distance from the medial to lateral poles of mandible.Height of the condyle was determined as a perpendicular linear distance between the superior mandible condyle (SCo) and a perpendicular line tangent to the posterior surface of the ramus in the sagittal plane from the most inferior point of the sigmoid notch (InfSig). (Fig-5)

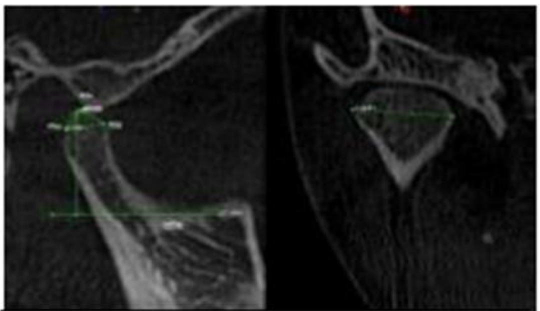

Fig-5: Condylar volume

The data collected was statistically analyzed. The paired "t" test was used with the aid of SPSS 23.0 software. Means, standard deviations and errors were calculated at p ≤0.05significance level.

Results:

The mean, standard deviation and correlations of volumetric, angular, and linear measurements were taken before and after treatment. The volume of condyle increased on both left and right sides (p<0.001), according to volumetric calculation. The ANB angle, saddle angle, and angle of facial convexity all decreased (p<0.001), while the gonial angle and height of lower face angle increased (p<0.001).When linear factors testing discovered that CoR-CoL, CC-Gn, Co-Gn, and height of anterior facedimensions increased significantly on both sides (p<0.001). For all measurements, comparing differences by sex was negligible (p<0.001). (Table-1)

Measurements	T0		T1		Mean Difference	P Value
	Mean	SD	Mean	SD		
Left condyle volume, mm^3	2719.02	119.24	3066.48	134.64	-347.456	<0.001
Right condyle volume, mm^3	2563.74	121.54	2837.08	122.27	-273.338	<0.001

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Saddle angle	123.16	4.92	122.03	4.98	1.137	<0.001
Gonial angle	120.83	7.14	123.04	6.08	-2.208	<0.001
ANB angle	6.33	1.61	2.96	1.37	3.375	<0.001
Facial convexity	5.08	1.93	1.67	0.81	3.417	<0.001
Lower facial height angle	32.29	4.67	48.17	4.20	-15.875	<0.001
Anterior facial height	107.28	8.78	114.95	8.29	-7.667	<0.001
CoR-CoL mm	189.28	15.70	192.68	15.82	-3.396	<0.001
CoR-Gn	98.57	5.69	102.75	5.45	-4.179	<0.001
CoL-Gn	96.53	5.76	101.65	5.44	-5.125	<0.001
CCR-Gn	88.96	7.89	93.25	7.96	-3.296	<0.001
CCL-Gn	89.53	7.69	92.93	7.97	-3.400	<0.001

Table 1: Descriptive Statistics of the Measurements with Results of Paired "t" tests

Discussion:

The well-balanced face gives the charm.The combination of hard tissue, soft tissue, and the dentoalveolar system determines the beauty of the face.Malocclusion may result from any variance from the stomatognathic system's normal growth. The maxillary surplus, mandibular deficit or a combination of both may cause Class II malocclusion.

According to McNamara[2], 60 % of Class II mandibular deficiency patients want forward positioning or stimulation forsatisfactory mandibular development. With the growing mandibular deficiencies in the Class II patients, it's important to find a way to boost the mandible growth and developmentforwardly.While the treatment of Class II malocclusion with mandibular deficiency, functional jaw orthopaedics may be used to adjust the posture, scale, and mandibular shape.

In this research, the twin block appliance was used because it has numerous benefits over other practical jaw orthopedics appliances. This appliance is intended for round-the-clock use; the functional inclines act similarly to natural dentition; control the eruption of posterior teeth easily and doesn't obstruct the voice, movements of jaw in lateral side and other oral jobs also not affected. In addition, the construction of the appliance is easy compared to other appliance.

Growing children between ages 12 to 14, (mean age- 12.70 years) and in peak pubertal growth period, chosen for this research. Baccetti et al[31], concluded that functional appliance therapy should be begun at or shortly after the pubertal peak (12 years, 11 months), as this results in a more skeletal influence to molar relation improvement, a substantial increase in total length and height of the mandible and a backward development of condyle. The Twin Block appliance allows the condyle to be displaced in the glenoid fossa that promotes the condylar cartilage development, resulting in TMJ shifts.

Due to economical, easy to use, availability and low exposure to radiation, cephalometric and panoramic radiographs are commonly used in orthodontics. However, the cephalometric radiograph has some disadvantages that restrict its used for the TMJ assessment and anatomic overlapping. The reliability of 2D imaging is debatable since it's dependents on the location of the patient's head and the angle at which the beam is projected. The drawbacks of traditional cephalometry include anatomic overlapping and magnification discrepancies on the left and right sides, which result in a dual mandibular border on the radiograph.

One of the most recent developments is 3D Cone Beam Computed Tomography. Due to the lower exposure of radiation, it is more effective than traditional computed tomography in testing craniofacial structures. With CBCT, the entire head can be scanned within seconds with a nominal dose of 50 mSv, whereas traditional computed tomography uses 2000 mSv. Lower costs, improved mobility for orthodontic professionals, versatility in the field of view, and sub millimeter spatial resolution are some

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of the other benefits of CBCT. According to Bruno FrazaoGribel et al[32], CBCT craniometric dimensions are exact to subvoxel scale and theoretically can be used for orthodontic diagnosis. Hang Seo Park et al[33], concluded that 3D measurements are superior to 2D lateral cephalograms, which result in different angular and linear measurements due to superimposition. CBCT measurements were found to be substantially more accurate than lateral, posteroanterior, and submentovertex cephalometric measurements by Hilgers et al[34].

Due to the benefits of CBCT on 2D lateral cephalogram, it was selected in this study to determine skeletal improvements in the condyle, angular (saddle angle, gonial angle, ANB angle, facial convexity, and lower facial height angle) and linear measurements (CoR-CoL, Co-Gn, CC-Gn, and Na-Me) after Twin Block therapy.

There are various discussions about the impact that functional appliances have. Many studies have shown that functional appliances induce skeletal and dentoalveolar changes. With recent technical developments, CBCT can now be used to quantitatively test skeletal and dental improvements. Skeletal adjustments were measured in this analysis, including condylar length, angular and linear measurements.

The condyle is the mandible's growth spot and actas an important part in the mandible's growth and development. The condyle and glenoid fossa were evidently visible in this two-dimensional sagittal slice. The condylar length was calculated from this slice. From the posterior mandibular condyle point (PCo) to the anterior mandibular condyle point (AMo), the condylar length was calculated (ACo).On either side of the superior mandible condyle (SCo), each of these points are 4 mm below the condyle. The coronal plane was used to measure the width of condyle, that is the linear distance from the medial and lateral poles of mandible. Height of thecondyle was determined as a perpendicular linear distance between superior mandible condyle (SCo) and a line drawn perpendicular to the tangent of the posterior surface of the ramus in the sagittal plane from the most inferior point of the sigmoid notch (InfSig).The left side of the condylar volume increased significantly more than the right side, but the difference was not important statistically. The mean value of right and left condylar volume showed a 310.4 mm^3 rise in condylar volume.

The glenoid fossa is indicated by the saddle angle, which is created by the angles Nasion(N)-Sella(S)-Articulare(Ar). After twin block therapy, CBCT tests indicated a decrease in saddle angle, suggesting anterior and downward remodeling of the glenoid fossa.The tangents to the posterior border of the ramus (Ar – Go) and the inferior border of the body of mandible (Go – Me) form the gonial angle. The rotation of mandible is shown by the gonial angle. The increased Gonial angle on CBCT suggests that the mandible is rising downward. The ANB angle tests the relationship between the maxilla and the mandible. If the ANB angle is greater, the skeletal pattern is Class II. After Twin Block therapy, CBCT tests indicated a decreased ANB angle, suggesting that the Class II skeletal relation was resolved by forward growth of the mandible. The degree of mandibular protrusion or retrusion, the relationship of the jaws to each other, the convexity of the maxilla, and the inclination of the lower jaw are all determined by facial convexity. The prognathic profile is aligned with a negative angle.A decrease in facial convexity was found in this study, suggesting that the lower jaw was being moved forward. The crossing of the line from the ANS to the Xi point (present at the middle of the ramus) and the corpus axis (Xi-Pm) forms the height of lower face angle, which remains stable with age and varies due to mechanics of the treatment. CBCT tests indicated a rise in the lower facial height angle, suggesting that the mandible is slipping downward.

Anterior Facial Height (N-Me) is the product of 0.7mm per year vertical growth of the maxillary complex, 0.9mm/year height of upper dentoalveolusand 0.7mm/year height of lower dentoalveolusincreased.As a result, at the end of a year, projected vertical growth anteriorly will be about 2.3 mm. In the present study's CBCT measurements indicated a rise in height of anterior face due to the mandibular rotation in downward direction. The distance between two condyles is determined from the right condylion to the left condyles. Because of forward and downward condylar location, CBCT

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measurements indicated a rise in the right to left condylion, resulting in upward and backward growth of the head of condyle. The direction of chin growth is shown by the Middle of the Cranium (CC-intersection of Ba-N plane and facial axis)-Gn. The increased CC-Gn in this study suggests that the mandible is rising downward. The direction of chin growth is indicated by the center of the condyle (Co)-Gn. Co-Gn increased in this sample, suggesting that the mandible was diminishing.

Conclusion:

- By stimulating the upward and backward condylar growth, Twin Block Appliance therapy increases condylar volume.
- Twin Block Appliance therapy induces upward and backward growth of the condyle, increasing the intercondylar gap and mandibular volume.
- Owing to the remodeling of the Glenoid fossa and forward location of the condyle, Twin Block Appliance therapy raises the Gonial angle and reduces the saddle angle.
- Because of downward rotation of the mandible, Twin Block Appliance therapy raises the height of lower face angle and height of anterior face.
- Twin Block Appliance therapy reduces the ANB angle and facial convexity, modifying the class II malocclusion via mandibular forward development.
- Because of the increased duration of the mandible and forward placement of the chin, Twin Block Appliance therapy raises the CC-Gn and Co-Gn.

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