ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 5, Issue – 2, March - 2022, Page No. : 304 - 312

Temporomandibular joint changes in class in malocllusion treated with functional therapy using twin block – A CBCT study

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Citation of this Article: Dr. Pooja, Dr. Suma T, Dr. Rajkumar S. Alle, "Temporomandibular joint changes in class ii malocllusion treated with functional therapy using twin block – A CBCT study", IJDSIR- March - 2022, Vol. – 5, Issue - 2, P. No. 304 – 312.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

The Twin block appliance is one of the most commonly used functional appliances today in skeletal class II correction. This appliance achieves rapid functional correction of malocclusion by the transfer of favorable occlusal forces to occlusal inclined planes that cover the posterior teeth, designed for full time wear. To evaluate skeletal changes in subjects with skeletal class II cases - height of condyle, length of condyle, height of condylar process, length of mandible, height of mandibular ramus, mandibular body length, changes in glenoid fossa, temporomandibular joint changes after 6-month treatment with Twin Block appliance, using cone beam computed tomography three dimensional images. Samples were collected from the patients of age group between 10-15 years of both sexes, who were in their pre-pubertal and pubertal stage, who reported to the department of orthodontics and dentofacial orthopedics, Raja Rajeswari dental college and hospital, Bengaluru. Patients were diagnosed with angles class II malocclusion with overjet greater than 6mm and ANB more than 4°. Before starting functional therapy diagnostic records such as study models, photographs, lateral cephalograms, Orthopantamogram and cone beam computed tomography investigation were performed. Hand wrist radiographs were taken to assess growth status. All the measurements were done on constructed 3dimensional image.

Cone Beam Computed Tomography investigation was performed (90KvP, 10Ma, acquisition time- 10.8 sec). All the measurements were automatized and standardized according to parameters of the equipment. The data were analysed using student pair 't' test. Therapies with twin block appliance resulted in correction of class II relationship, reduction of overjet and improvement in skeletal discrepancy in patients

having class II skeletal pattern in their growing phase.

Keywords: CBCT, Class II, height of condyle, length of condyle, height of condylar process, length of mandible, height of mandibular ramus, mandibular body length, glenoid fossa depth.

Introduction

Functional appliance therapy improves the functional relationship of the dentofacial structures by eliminating unfavorable developmental factors and improving the muscle environment .In the treatment of patients with Class II malocclusion with mandibular retrognathia different removable (activator, monoblock, bionator, twin block etc.) or fixed (herbst, jasper jumper, forsus, twin force etc.) functional appliances have been used to encourage or redirect the growth of mandible to correct skeletal discrepancy.[1.]

Twin block appliance brings out more sagittal changes than vertical changes, such as there is increase in mandibular length (Co-Gn) which corrects the facial profile from convex to straight, anteroposterior diameter and height of condyle is increased, forward positioning of condyle and backward movement of disk are observed. Glenoid fossa modification occurs due to stretch forces of the retro diskal tissues, capsule and altered flow of viscous synovium. Significant glenoid fossa bone formation is seen in six months of twin block therapy. Impact of the viscoelastic tissues may be highly significant and should be considered along with the standard skeletal, dental, neuromuscular and age factors that influence condyle-glenoid fossa growth with orthopaedic advancement.

Recently CBCT has been used to obtain accurate images with high resolution and minimal distortion and allows the creation of three dimensional (3D) images in sagittal, coronal, and axial planes. It is possible to make more precise measurements of craniofacial structures since there are no projections or overlapping of bilateral structures. Cone beam computed tomography has an advantage of identifying condylar changes, mandibular length, inter-condylar distance before and after twin – block therapy. It is proposed that CBCT could be an effective method for assessment of condylar and mandibular morphology in the predicting of mandibular growth and quantifying outcomes of facial orthopaedic treatment.[2]

So in the present study CBCT scan is used to compare skeletal changes in height of condyle, length of condyle, height of condylar process, glenoid fossa depth, height of ramus, mandibular body length, mandible length between pretreatment and six months post twin block insertion in patients with angle’s class 2div 1

Materials and methods

Patients of age group between 10 & 15 years of both sexes were selected who reported to the department of orthodontics and dentofacial orthopedics, Raja Rajeswari dental college & Hospital, Mysore Road, Bengaluru.

The inclusion criteria were as follows: (1) Patients in pre-pubertal and pubertal stage of growth (age group 10-15 years, as confirmed by hand wrist radiograph) (2) Angles class II malocclusion with ANB more than 4° (3) Bilateral class II molar and canine relation (4) Increased overjet. The exclusion criteria were: (1) Severe vertical growth pattern (2) Class II due to maxillary prognathism (3) Patients in post pubertal stage (4) Facial asymmetry (5) History of trauma.

All 10 patients with skeletal class II malocclusion satisfying the inclusion criteria were advised to take lateral cephalogram (which were exposed with jaws in centric occlusion, lips relaxed and head in natural head position), OPG, hand wrist (to assess growth). In addition to this CBCT scan (SCANORA 3 D, SOREDEX, FINLAND CBCT SOFTWARE: ON D E

M A N D 3 D A N D S C A N O R A SOFTWARE. TUBE CURRENT: 4.0- 12.5 M TUBE VOLTAGE: 60-90 KvP) was also done (because of its accuracy, high resolution and less image distortion) to assess skeletal changes in pre and post twin block insertion cases.

After collecting all diagnostic records construction bite was taken for fabrication of twin block. CBCT for pre and post twin block delivery with 3 months of follow up was taken to assess following parameters on the 3-D constructed images of Cone beam computed tomography.

Table 1:

Parameters	Landmarks
Height of condyle	Distance between top of condyle and cross-sectional line that goes from the most prominent point of condyle and is perpendicular to the tangent of ramus mandible (Figure 1)
Glenoid fossa depth	Linear distance between highest point of condyle and deepest point in glenoid fossa (Figure 2)
Length of condyle	Linear distance between the anterior and posterior point of the condyle in the sagittal plane (Figure 3)
Height of condylar process	Linear distance between the highest point of condyle and line that goes through incisura mandubulae and is perpendicular to the tangent of rams mandible (Figure 4)
Length of mandible	Distance between the most distal point of condyle and gnathion (Figure 5)
Height of mandibular ramus	Distance between the highest point of condyle and gonion (Figure 6)
Mandibular body length	Distance between points gonion and agnation (Figure 7)

Legend Figure

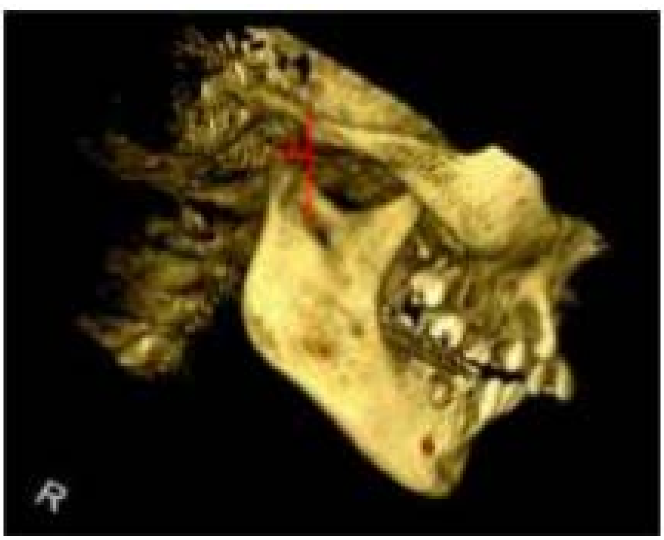

Figure 1: height of condyle.

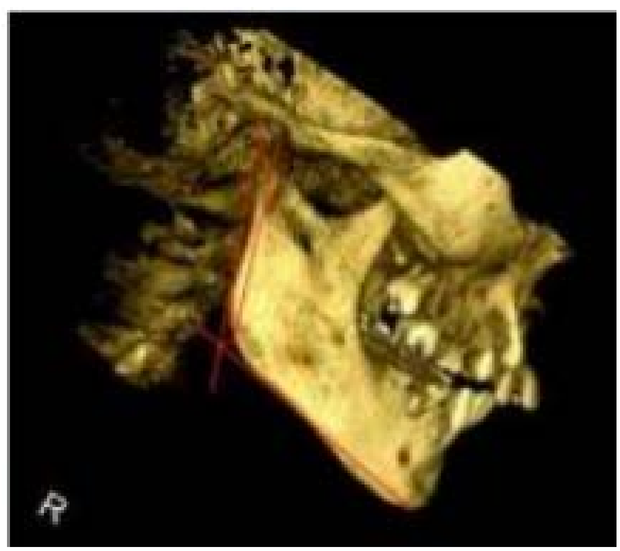

Figure 2: length of condyle.

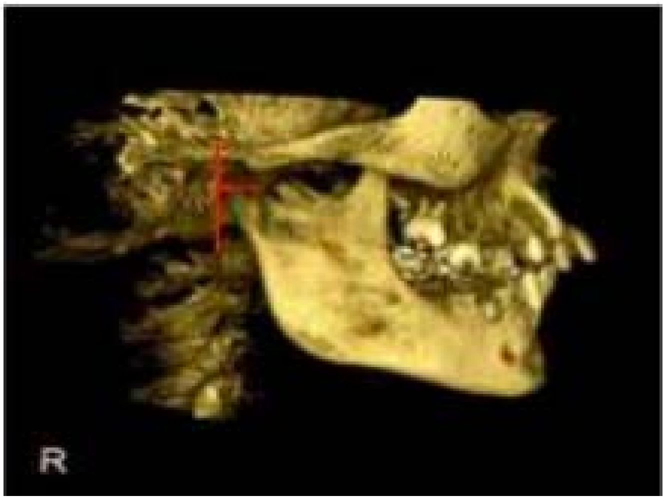

Figure-3: height of condylar process.

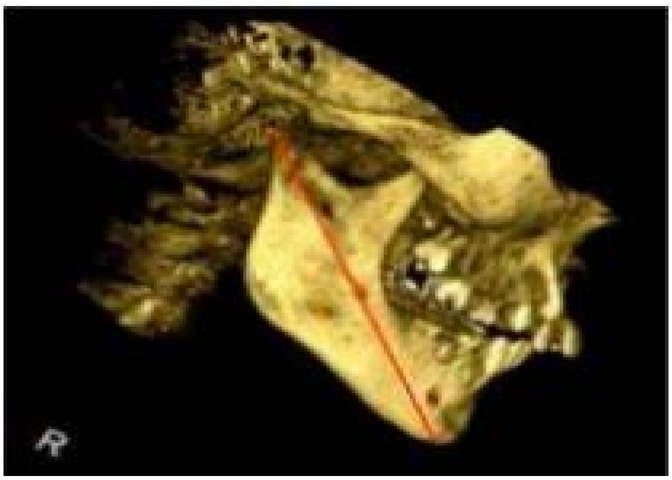

Figure 4: length of mandible.

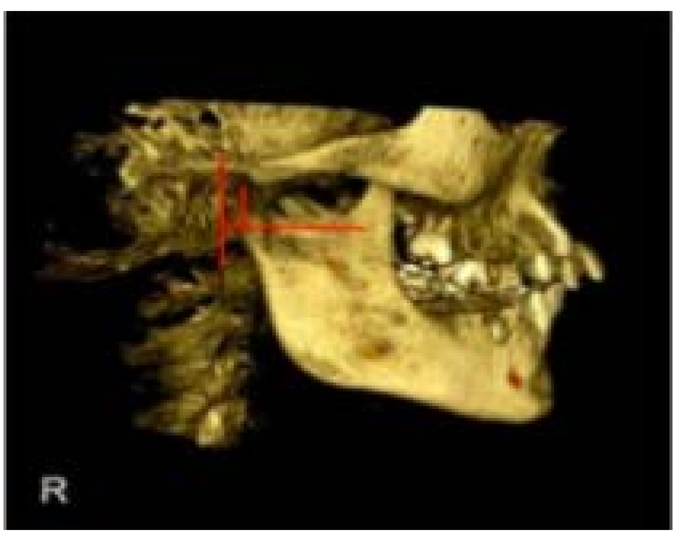

Figure 5: height of mandibular ramus.

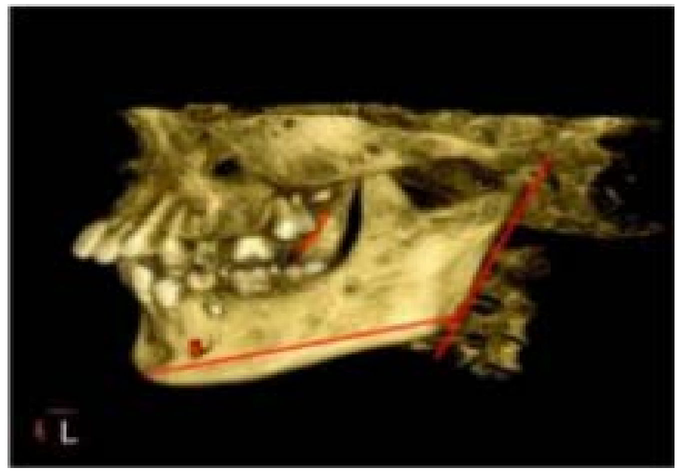

Figure 6: mandibular body length.

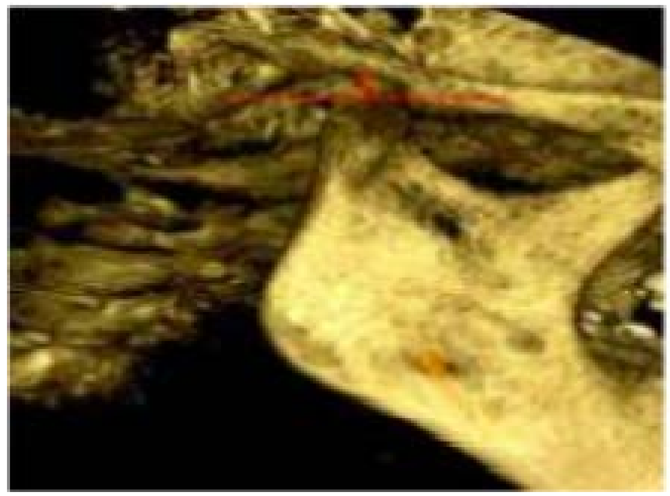

Figure 7: glenoid fossa depth.

Statistical analysis

This study data was analysed using the software SPSS software (statistical package for social sciences) V.22, IBM Corp. The frequency distribution for the parameters on the right and left side were expressed in terms of mean and SD. Student paired t test was used to compare the skeletal changes in height of condyle, length of condyle, height of condylar process, height of ramus, length of mandibular body, mandible length, glenoid fossa depth. The level of significance [P- value] was set at P< 0.005.

Results

Table 2 shows comparison of pretreatment and post treatment mean values for height of condyle, length of condyle, height of condylar process, height of ramus, length of mandibular body, mandible length, glenoid fossa depth for the right side showing statistically significant change in the above-mentioned skeletal parameters except for glenoid fossa depth. There was greater change seen in mandible length followed by height of ramus, height of condylar process. The level of significance [Pvalue] was set at P< 0.005.

Table 2:

Comparison of mean values of various study parameters on Right Side between pre treatment and post treatment time intervals using Student Paired t test

Parameters	Time	N	Mean	SD	Mean Diff	t	P-Value
Height of condyle	Pre Rx	10	4.38	0.63	-0.81	-4.248	0.002*
	Post Rx	10	5.19	0.59			
Length of condyle	Pre Rx	10	9.43	0.72	-1.25	-7.185	<0.001*
	Post Rx	10	10.68	1.01			
Height of Condylar process	Pre Rx	10	12.85	2.89	-1.75	-3.835	0.004*
	Post Rx	10	14.60	2.43			
Height of Ramus	Pre Rx	10	46.32	3.30	-2.30	-3.748	0.005*
	Post Rx	10	48.62	3.68			
Length of Mand.Body	Pre Rx	10	58.09	3.75	-1.56	-4.861	0.001*
	Post Rx	10	59.65	4.26			
Mandible length	Pre Rx	10	92.27	5.45	-2.84	-4.477	0.002*
	Post Rx	10	95.12	5.92			
Gleniod fossa depth	Pre Rx	10	1.64	0.89	-0.11	-0.442	0.67
	Post Rx	10	1.75	0.82			

Table 3 shows comparison of pretreatment and post treatment mean values for height of condyle, length of condyle, height of condylar process, height of ramus, length of mandibular body, mandible length, glenoid fossa depth for the left side showing statistically significant change in the above-mentioned skeletal parameters except for glenoid fossa depth. There was greater change seen in posttreatment values of mandible length followed by, height of condylar process, length of mandibular body. Least change with P- value of 0.76 was seen in glenoid fossa depth The level of significance [P-value] was set at P< 0.005.

Table 3:

Comparison of mean values of various study parameters on Left Side between pre treatment and post treatment time intervals using Student Paired t test

Parameters	Time	N	Mean	SD	Mean Diff	t	P-Value
Height of condyle	Pre Rx	10	4.86	0.87	-0.80	-3.867	0.004*
	Post Rx	10	5.66	0.66			
Length of condyle	Pre Rx	10	9.39	0.87	-0.93	-4.644	0.001*
	Post Rx	10	10.31	0.99			
Height of Condylar process	Pre Rx	10	12.72	2.48	-1.92	-5.113	0.001*
	Post Rx	10	14.64	2.25			
Height of Ramus	Pre Rx	10	45.84	3.24	-1.06	-2.902	0.02*
	Post Rx	10	46.90	3.31			
Length of Mand.Body	Pre Rx	10	56.54	4.06	-1.72	-4.748	0.001*
	Post Rx	10	58.25	3.91			
Mandible length	Pre Rx	10	93.89	5.01	-1.99	-3.284	0.009*
	Post Rx	10	95.88	5.54			
Gleniod fossa depth	Pre Rx	10	1.93	0.91	-0.11	-0.320	0.76
	Post Rx	10	2.04	0.97			

Discussion

Despite controversies on the effectiveness of FJO, it has been shown that in the short term, FJO produces different dentoskeletal results based on timing of treatment.[3]

Twin-block induces supplementary lengthening of the mandible by stimulating increased growth at the condylar cartilage, and have maximum therapeutic effects if the mandibular growth spurt is included. The trimming technique permits guidance of eruption and individual tooth movements. Occlusal changes can be seen in all three planes. In the sagittal plane the mandible can be repositioned, incisors can be protruded or retruded and buccal segment teeth can be moved mesiodistally. In the vertical plane, routine objectives include guiding the inclination and growth direction of the maxillary base and extruding teeth. In the transverse plane the clinician can correct a functional crossbite, expand the dental arches.

Wadhawan N, et al did study on temporomandibular joint adaptations following two phase therapy: an MRI study and concluded that forward condylar position within the glenoid fossa and articular disc retrusion with respect to the condylar head were statistically significant after functional appliance therapy.4 Linear measurements from the Centre of the external auditory meatus to the post-glenoid spine revealed forward relocation of the post-glenoid spine along the Frankfurt Horizontal plane. Forward relocation of the C-GF complex was one of the mechanisms of action of functional appliances.

Herbst appliance can be used in Skeletal Class II patients with maxillary dentoalveolar protrusion and mandibular dentoalveolar retrusion, Twin Block appliance is used in mandibular retrognathy patients. Therefore, the present study was aimed at studying the skeletal effects of twin block .[5]

Treatment timing is very crucial in order to achieve maximum result from functional appliances. In one of the studies in which parameters and results were similar to the present study ten patients treated with functional appliances were investigated, four patients received treatment before the pubertal peak in skeletal growth, whereas in six patient's treatment included the pubertal peak. The amount of actual supplementary mandibular growth induced by treatment (measured by Co-Gn or Co-Pg) in all the peak samples. None of the samples treated in the pre peak period had a clinically significant amount of supplementary mandibular growth.[6]

The subjects in this study were in the fourth and fifth epiphyseal stages according to the method described by Björk (1972). These stages show the initition and peak of growth spurt, respectively. Thus, in this study treatments were performed including the peak of pubertal growth in order to achieve maximum therapeutic effects of the appliance. The results of this study reveal significant increase in mandibular length measured at the distance Ar-Pog and forward movement of point Pog after treatment with the Twin block appliance. Also it was one of the largest standard deviations in the change of point Pog position and mandibular length, indicating that not all patients responded to functional appliance treatment as.

favorably as the average values indicate. So it can be inferred from these different studies that functional appliance effectivity is seen in pubertal peak period.[7] Functional appliances brings about change in profile of class II patient's with mandibular retrognathia either by restricting maxillary growth or by advancing mandible. This present study focuses on the changes seen in different parts of mandible and TMJ. In different studies these changes seen were quantified.

Lund and Sandler reported changes on Ar-Pog (2.4 mm) after 12 months of Twin- block therapy. Toth and McNamara found that additional increase in Condylion–Gn length after 16 months with Twin block was 3 mm which is comparable to our study. The SNA angle is not increased under these circumstances, so it could be assumed that some restriction of maxillary growth occurs, but was not detected because of dentoalveolar remodeling masked skeletal changes following Twin-block treatment. Mandibular base did not move anteriorly, composite mandibular length was increased, and skeletal discrepancy was improved.[8]

Similar study was conducted by Schaefer et al who reported statistically significant greater elongation of mandible ramus in twin block group than in herbst group.[9] Mills and MC Colloch in the year 1998 reported 2.9mm additional increase in ramus height. They determined that overall mandibular length increase resulted from ramus height. Only 1/3rd of the increase was due to increase in mandibular body length (Go-Gn).[10]

In the current study Twin block therapy resulted in increase in dimensions of different skeletal parameters like height of condyle, height of condylar process, length of condyle, depth of glenoid fossa, height of ramus, length of mandibular body and total body length.

Out of 6 skeletal parameters values change in five parameter was greater on right side than the left side for example greater change in length of condyle was seen on right side than the left. So we can say that growth in the mandible on right side contributed more in change of patients profile with retrognathic mandible than left side without any gross facial asymmetry.

In the orthodontic practice, validity of 2D imaging is doubtful depending on the changes created by patient's head position and beam projection angle. Anatomic superimposition and magnification difference of the left and right sides cause double border of the mandible on the radiograph are the other disadvantages of conventional cephalometry. Recent improvements in technology have led to 3D CBCT. CBCT is at the forefront of digital radiography in the present era. In the assessment of craniofacial structures, CBCT is more adequate than conventional helical computed tomography because of lower radiation exposure. While it is possible to scan the complete head in a few seconds with an effective dose of 50 mSv with CBCT, conventional computed tomography uses 2000 mSv.[11]

Other advantages of CBCT are lower costs, increased accessibility to orthodontic practices, flexibility in the field of view, and submillimeter spatial resolution. The 3D image is reconstructed from raw data by means of a mathematical algorithm that has the ability to calculate and eliminate the magnification factor, so in CBCT there is no magnification and measurements reported to be reliable and anatomically accurate.

Some researchers evaluated the accuracy of CBCT imaging of TMJ. Hilgers et al. compared the linear TMJ measurements of CBCT with digital cephalometric radiographs and reported that CBCT measurements were significantly more reliable than lateral cephalometric, posteroanterior, and sub mento vertex measurements. Studies were carried out by different authors to check accuracy of 3D CBCT with other 2D imaging techniques. Honey et al compared the diagnostic accuracy of CBCT, OPG and linear tomography. The findings revealed that CBCT images provided superior reliability and greater accuracy than linear tomography and TMJ panoramic projections.[11]

So, by comparing the effectiveness of accuracy of CBCT over other 2D imaging technique we decided to use this advanced imaging technique for the present study to determine the alterations in the skeletal parameters i.e height of condyle, length of condyle, depth of glenoid fossa, height of ramus, length of mandibular body, mandible length, height of condylar process after orthopedic treatment.

Thus, it can be inferred from the study that therapies with twin block appliance resulted in correction of class II relationship, reduction of overjet and improvement in skeletal discrepancy in patients having class II skeletal pattern in their growing phase.

Conclusions

The treatment of Class II cases with Twin block appliance exhibited the following changes.

1. There was increase in height of condyle between pre-treatment and post-treatment where value for right side was 0.81mm and left side was 0.80mm with average increase of 0.80mm.

2. Increase in length of condyle was seen between pre-treatment and post-treatment for which value on right side was 1.25mm and for left side was 0.93mm with average increase of 1.09mm.

3. Condylar process height increased between pretreatment and post-treatment where the value for right side was 1.75mm and for left side 1.92mm with average increase of 1.83mm.

4. There was increase in ramus height between pretreatment and post-treatment where value for right side was 2.30mm and for left side was 1.06mm with average increase of 1.68mm.

5. Length of mandibular body increased between pretreatment and post-treatment where value for right side was 1.56mm and for left side was 1.72mm with average increase of 1.64mm.

6. Increase in Mandible length was seen between pretreatment and post-treatment for which value on right

side was 2.84mm and for left side was 1.99mm with average increase of 2.41mm.

7. Glenoid fossa depth changed between pretreatment and post-treatment value for right side was 0.11mm and left side 0.11mm which was not significant.

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