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Evaluation of Glenoid Fossa roof thickness, Joint space and Inclination of Articular eminence with Mandibular Condyle Using Cone Beam Computed Tomography (CBCT) in Patients with Temporomandibular Joint Disorders (TMD) and Normal Individuals - A Retrospective study

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Abstract

Introduction: Temporomandibular joint is a bilateral diarthrodial synovial joint between the mandible and the squamous part of the temporal bone. The joint along with its associated structures play a crucial role in the multiplanar movement of the mandible. Thus it aids in activities such as mastication and phonation.

Aim and objectives: Aim of the study is to determine the Roof thickness of Glenoid Fossa, Joint space, and assess the inclination of articular eminence with mandibular condyle Using Cone Beam Computed Tomo graphy in TMD Patients and Normal individuals.

Methodology: A Retrospective study of 60 CBCT images, 30 TMD and 30 Non-TMD patients aged between 18-45 years were acquired from the archives of department database. The images were recorded using PLANMECA PROMAX 3D MID PROFACE CBCT machine in DICOM format and was imported and analysed using Radiant DICOM viewer 2021.1 software. The images were sliced at 1.0 mm size thickness in the parasagittal section for the glenoid fossa roof, joint space and articular eminence angulation assessment. The thickness of the glenoid fossa, anterior & superior joint space along with articular eminence inclination were measured.

Results: In our study, The mean value of Right & Left Glenoid Fossa Roof Thickness present in TMD & Normal individuals were 1.97 ±1.83, 1.66 ±1.18 and 1.10 ±0.71, 1.27 ±0.85 respectively; The mean value of Right & Left Anterior Joint space present in TMD & Normal indivduals were 1.76 ±0.58, 1.64 ±0.79 and 1.96 ±0.77, 1.88 ±0.70 respectively. The mean value of Right & Left Superior Joint space present in TMD & Normal individuals were 3.19 ±1.36, 3.13 ±1.45 and 3.17 ±1.41, 3.05 ±1.30 respectively. The mean value of Right & Left articular eminence inclination present in TMD & Normal individuals were 31.62 ±10.32, 30.49 ±9.98 and 42.34 ±9.18, 41.02 ±10.48 respectively. Pearson's correlation coefficient was significant ($p<0.05$), between TMD and Normal individuals with respect to Glenoid fossa roof thickness and articular eminence inclination.

Conclusion: In our study, glenoid fossa roof thickness and articular eminence inclination were found to be displaying significant variations bet ween the experi mental and control group.

Keywords: TMJ, CBCT, glenoid fossa roof thickness, joint spaces, articular eminence

Introduction

Tempo roman dibular joint is a bilateral diarthrodial synovial joint between the mandible and the squamous part of the temporal bone. It is also called as the ginglymo-arthrodial joint due to its ability to show both sliding and hinge movements. The joint along with its associated structures play a crucial role in the multi planar movement of the mandible. Thus it aids in activities such as mastication and phonation [1]. Tempo roman dibular disorders (TMD) is a term for describing pain and dysfunction of the masticatory muscles and tempo roman dibular joints (TMJs). It is associated with features such as regional pain in the face and preauricular area, limited jaw movements, and noises from the TMJs during jaw movements [2]. The most frequently encountered TMD includes pain-related disorders like myalgia, headache attributed to TMD, and arthralgia and also disorders associated with the TMJ, primarily disc displacements and degenerative diseases [3]. A thin plate of temporal bone located between the tempo roman dibular joint (TMJ) components and middle cranial fossa forms the roof of glenoid fossa (RGF) [4]. Some suggests that reduction in the thickness of RGF might be related to some complications such as dislocation of mandibular condyle into cranial fossa, therefore, these observations emphasize the need for more detailed research on the thickness of RGF and its probable relationship with TMD [5,6]. The dimension of the joint space helps in determining the optimal condylar position in the glenoid fossa. Radiographically, joint space is described as the radiolucent zone between condylar and temporal parts [7]. In the opening and closing movements of the mouth, the condyle and the articular disc complex slide under the articular eminence (AE)[8]. The AE inclination is defined as the angle between the posterior wall of the AE and a horizontal reference plane, which constitutes an important element in the biomechanics of TMJ and the entire masticatory system [9,10].

The above-mentioned parameters have been used in our study aiming to determine the morphological changes associated with them in TMD and Normal individuals.

Materials & methods

A study of 60 CBCT images, 30 TMD patients and 30 Normal individuals were acquired from the archives of the Department of Oral Medicine and Radiology of Meenakshi Ammal Dental college. The images were recorded using PLANMECA PROMAX 3D MID PROFACE CBCT machine in DICOM format and was imported and analysed using Radi Ant DICOM viewer

2021.1 software. The inclusion and exclusion criteria are as follow.

Inclusion Criteria

- CBCT images having good resolution and image clarity.
- Adequate coverage displaying bilateral TMJs & large field of view (FOV) CBCT scans.
- CBCT scans of individuals between 18 years – 45years.

Exclusion Criteria

- CBCT of patients younger than 18 and elder than 45 are excluded.
- CBCT scans of subjects with gross facial asymmetry, deformities, history of previous orthognathic surgery, fracture of the condyle;
- CBCT images with artifacts.
- CBCT scans of subjects with congenital anomalies, acute trauma, musculoskeletal or neurological disorders and any systemic diseases that could affect the joint.

Sample size

The study was conducted with samples of 60 CBCT images (120 TMJs) in male and female patients between the ages 18-45 years. The sample of 60 were equally divided between males and females in each group of TMD and Normal individuals respectively.

Image standardization

The images were standardized as follows, in parasagittal section the vertical toggle is placed parallel to the long axis of coronoid and condyle and it passes through the highest point of the condylar head. The horizontal toggle is placed in a position such that a tangential line drawn parallelly to the articular eminence and glenoid fossa at the level of auditory canal as seen in fig.1(a). These were checked in the Para coronal and axial sections as shown in fig. 1(b) and 1(c) that the horizontal and vertical toggles divides the condylar head into two equal halves.

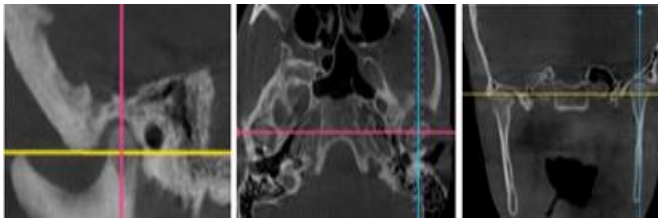

Fig 1: shows image standardisation in (a)parasagittal, (b)axial & (c)Para coronal section

Image interpretation

The images were sliced at 1.0mm thickness in the parasagittal section for the glenoid fossa roof, joint space and articular eminence angulation assessment.

The images were placed in a standard position in the multiplanar reconstruction (MPR), so that all the slices were made according to the correct positioning of the patient's head.

Measurement of glenoid fossa roof thickness

• In parasagittal plane, the thickness of the glenoid fossa is defined as the distance between the outer cortical outline and the inner cortical outline as shown in fig 2.

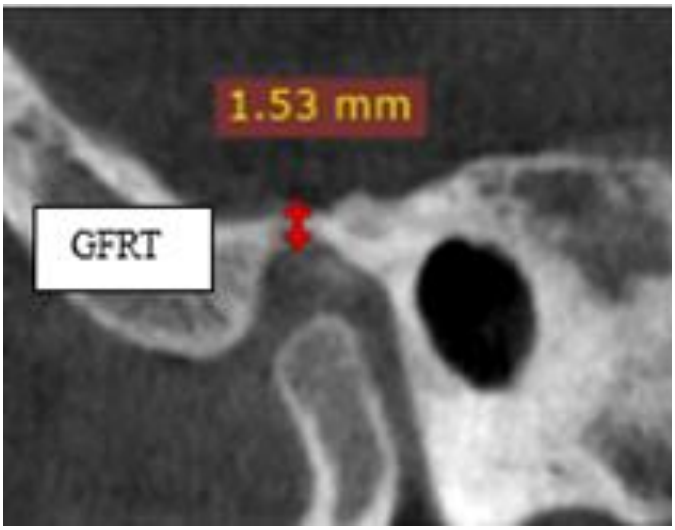

Fig 2: shows Glenoid fossa roof thickness measurement in parasagittal section

Measurement of joint spaces

• Anterior and superior joint spaces were measured in the parasagittal plane.

• A horizontal tangent on uppermost area of glenoid fossa was drawn and the intersection of this line with

glenoid fossa was selected as superior reference point. The right distance between Superior Reference point and superior prominent point of condylar head was considered as superior joint space (SJS) as shown in fig 3(a).

Two tangents were drawn parallel in relation to posterior slope of articular eminence and anterior surface of condylar head and the perpendicular distance between them were measured as anterior joint space (AJS) as shown in fig 3(b).

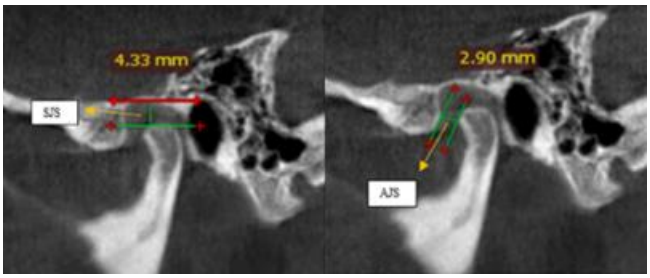

Fig 3a and Fig 3b: shows superior & Anterior joint space measurement in parasagittal section

Measurement of articular eminence angulation

• In parasagittal section, it is formed by the internal angle between line connecting the articular eminence vertex and the mandibular fossa vertex and the line from the articular eminence vertex is made parallel to the horizontal toggle as shown in fig 4.

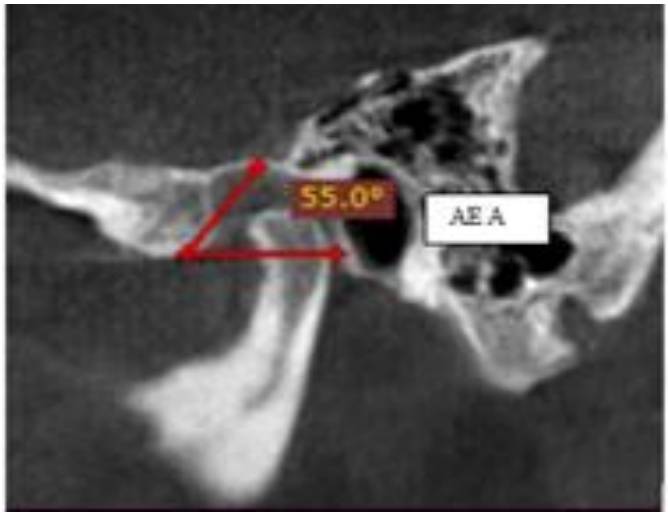

Fig 4: shows Articular Eminence Angulation measurement in parasagittal section

Statistical Analyses

The data obtained was entered in Microsoft Excel Spreadsheet and was subjected to statistical analysis. All analyses were carried out using Statistical Package for Social Sciences (version 19, IBM, Chicago, USA). Alveolar width and Alveolar height of both the groups were expressed as Mean ± Standard Deviations (Mean ±S. D). The data was subjected to normality test using Shapiro Wilk test. As data followed a normal distribution and samples were selected in a random manner, parametric tests of significance were used for comparison. Independent sample t-test was used for:

Intergroup comparison of

a) Glenoid Fossa Roof Thickness (GFRT) between TMD patients and normal individuals,

b) Anterior Joint space between TMD patients and normal individuals,

c) Superior Joint space between TMD patients and normal individuals,

d) Inclination of articular eminence between TMD patients and normal individuals.

Results

Table 1: Demographic details of TMD patients and Normal individuals.

Table 1 shows Demographic details of TMD patients and Normal individuals. The mean age of TMD patients was 27.29 ±9.30 years and the mean age of Normal individual was 30.62 ±9.07 years.

Group	Mean Age (Mean ±S. D)	Gender	
		Male n (%)	Female n (%)
TMD patients (n=30)	27.29 ±9.30	15 (50)	15 (50)
Normal individuals (n=30)	30.62 ±9.07	15 (50)	15 (50)

Table 2: Intergroup comparison of Glenoid Fossa Roof Thickness (GFRT) & Articular eminence inclination between TMD patients and Normal individuals

Group	Glenoid fossa roof thickness GFRT (mm)			Articular eminence inclination (Degree)		
	Right (Mean ±S. D)	Left (Mean ±S. D)	Overall (Mean ±S. D)	Right (Mean ±S. D)	Left (Mean ±S. D)	Overall (Mean ±S. D)
TMD patients (n=30)	1.97 ±1.83	1.66 ±1.18	1.81 ±1.50	31.62 ±10.32	30.49 ±9.98	31.05 ±10.15
Normal individuals (n=30)	1.10 ±0.71	1.27 ±0.85	1.18 ±0.78	42.34 ±9.18	41.02 ±10.48	41.68 ±9.83
p-value	0.007*	0.04*	0.03*	0.03*	0.02*	0.002*

(*p value>0.05 –non-significant)

Table 2 shows Intergroup comparison of Glenoid Fossa Roof Thickness (GFRT) & Articular eminence inclination between TMD patients and Normal in dividuals.

The TMD patients had an increased Glenoid Fossa Roof Thickness on comparison with Normal in dividuals and this difference was found to be statistically significant in all the regions measured right, left and overall (p-values = 0.007,0.04 and 0.03) respectively.

The inclination of articular eminence of TMD patients were lower than Normal in dividuals and this difference was found to be statistically significant (p-values = 0.03,0.02 and 0.002) respectively.

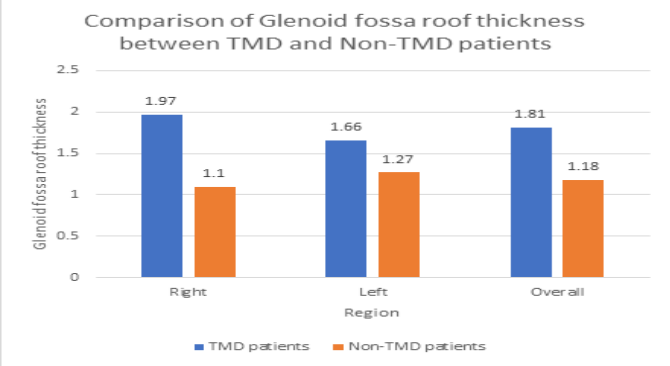

Fig 5: Comparison of Glenoid fossa roof thickness bet ween TMD patients and Normal individuals

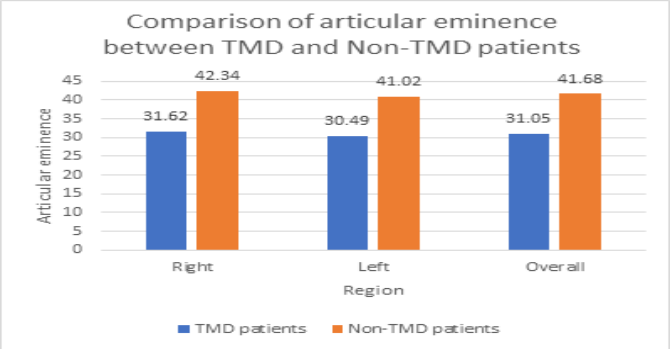

Fig 6: Comparison of Articular eminence inclination between TMD Patients and Normal individuals

Table 3: Intergroup comparison of Superior &Anterior Joint space between TMD patients and Normal individuals.

Group	Superior Joint space (mm)			Anterior Joint space (mm)		
	Right (Mean ±S. D)	Left (Mean ±S. D)	Overall (Mean ±S. D)	Right (Mean ±S. D)	Left (Mean ±S. D)	Overall (Mean ± S. D)
TMD patients (n=30)	3.19 ±1.36	3.13 ±1.45	3.16 ±1.4	1.76 ±0.58	1.64 ±0.79	1.70 ±0.68
Normal individuals (n=30)	3.17 ±1.41	3.05 ±1.30	3.11 ±1.35	1.96 ±0.77	1.88 ±0.70	1.92 ±0.73
p-value	0.55	0.58	0.59	0.27	0.28	0.24

(*p value>0.05 – statistically non-significant)

Table 3 shows Intergroup comparison of Superior & Anterior Joint space between TMD patients and Normal individuals. The TMD patients had increased Superior Joint space and slightly lower Anterior Joint space on comparison with Normal Individuals and this difference was found to be statistically non-significant (p value >0.05).

Table 4: Glenoid Fossa Roof Thickness (GFRT) & Articular eminence inclination of TMD and Non-TMD patients based on gender.

Group		Glenoid fossa Roof thickness (mm)				Articular eminence Inclination			
		Right (Mean ±S. D)	Left (Mean ±S. D)	Overall (Mean ±S. D)	p-value	Right (Mean ±S. D)	Left (Mean ±S. D)	Overall (Mean ±S. D)	p-value
TMD patients (n=30)	Male n=15	2.39±2.29	2.17±1.28	2.28±1.78	0.33	35.22±9.17	30.22±10.47	32.72±9.82	0.17
	Female n=15	1.54±1.02	1.15±0.89	1.34±0.95		30.42±9.19	30.62±10.49	30.52±9.84	
Normal individuals (n=30)	Male n=15	1.31±0.74	1.49±0.9	1.4±0.82	0.23	39.94±10.22	39.95±10.0	39.94±10.11	0.13
	Female n=15	0.90±0.63	1.05±0.77	0.97±0.70		42.45±10.42	39.87±9.96	41.16±10.19	

Table 4 shows Glenoid Fossa Roof Thickness (GFRT) & Articular eminence inclination of TMD and Normal individuals based on gender. GFRT of females were lower than that of males, on comparison of Inclination of articular eminence and Glenoid fossa roof thickness between males and females, the differences were found to be non-significant (p value >0.05).

Table 5: Superior & Anterior Joint space of TMD patients and Normal individuals based on gender.

Group		Superior Joint space (mm)				Anterior Joint space (mm)			
		Right (Mean ±S. D)	Left (Mean ±S. D)	Overall (Mean ±S. D)	p-value	Right (Mean ±S. D)	Left (Mean ±S. D)	Overall (Mean ±S. D)	p-value
TMD patients (n=30)	Male n=15	3.54±1.25	2.99±1.40	3.26±1.32	0.14	1.61±0.59	1.62±0.85	1.76±0.72	0.44
	Female n=15	2.87±1.16	3.28±1.54	3.07±1.35		1.90±0.58	1.66±0.74	1.63±0.66	
Normal individuals (n=30)	Male n=15	3.82±1.37	3.71±1.31	3.76±1.34	0.12	2.39±0.77	2.07±0.84	2.23±0.80	0.12
	Female n=15	2.52±1.16	3.08±1.39	2.8±1.27		1.52±0.49	1.69±0.49	1.60±0.49	

*p value (given for overall value)

Table 5 shows superior & Anterior Joint space of TMD patients and Normal individuals based on gender. Superior joint space of males were higher than that of females in both the groups and males had a slight increase in Anterior joint space compared to females in control group, but non-significant (p value >0.05).

Discussion

The present study was done to evaluate the glenoid fossa roof thickness, anterior, superior joint space and articular eminence inclination in Tempo roman dibular joint dis

order patients and compare these parameters with the asymptomatic Normal individuals and also to note if the changes existed among gender and found that TMD patients had increased Glenoid Fossa Roof Thickness on comparison with Normal individuals which is highly significant (p value =0.03*). It has been suggested that increased roof thickness might be directly proportional to the mechanical stress applied to the TMJ which tend to compose the compensated bone formation in the roof of glenoid fossa that help to maintain the consistency [11]. This study was in accordance with the study done by, Khojastepour L et al [12] in 2019.

Present study correlates with the study done by Ejima K et al [11] in 2013, in 77 asymptomatic European patients in which significant differences were observed in roof of glenoid fossa thickness in joints with osteoarthritic changes and also found that RGF thickness is unaffected by condyle morphology and the number of remaining teeth.

The intergroup comparison of TMD and Non-TMD samples in glenoid fossa roof thickness based on gender was done in our study in which no statistically significant differences were found between males and females of TMD and Non-TMD groups which positively correlates with the study done by Hyun-Jeong Park et al [13] in 2019 in 111 korean asymptomatic patients and found that the thickness did not differ by gender.

In our present study, No statistically significant differences were found between the groups (p value = > 0.05) which negatively correlates with the study done by Yasa Y et al[14] in 2018, in 200 asymptomatic individuals and 200 TMD patients and observed significant differences in Anterior joint space between both groups.

In our study in both TMD and Non- TMD patients, males had increased anterior and superior joint space when compared with females which is in accordance with the study done by

Ahmed J [15] et al in 2021, where a retrospective CBCT analysis was performed on 119 patients. They concluded that except for the left anterior joint space, all other spaces (posterior and superior joint spaces) were significantly larger in males.

On intergroup comparison of inclination of articular eminence between TMD and Non-TMD groups revealed a statistically significant difference (p value = 0.002*). It was observed that inclination of articular eminence in TMD patients were lower than Normal individuals.

Our study corresponds with the study done by Caglayan F [16] et al in 2014, which includes 52 patients with TMJ dysfunction and 41 patients without TMJ dysfunction and also stated that this is due to flattening of articular eminence which was observed in patients with internal derangement.

This was not in accordance with the study done by Paknahad M [17] et al in 2015, in which bilateral TMJs of 40 patients with TMD and 23 symptom-free cases were evaluated for articular eminence inclination and depth & width of glenoid fossa. They concluded that articular eminence inclination and glenoid fossa depth & width were higher in patients with Temporomandibular joint dysfunction than in control group.

Further studies are required to be done in larger samples to evaluate the variations in these parameters.

Conclusion

In our study, glenoid fossa roof thickness and articular eminence inclination were found to be displaying significant variations between the experimental and control group. These parameters were considered to be reliable since it is a CBCT study in assessing the TMD. Our data could help towards a better understanding of anatomical variations between normal individuals and

patients with TMD. Hence CBCT plays a crucial role in the assessment of treatment outcomes in disorders affecting the TMJ.

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Abbreviations

CBCT – Cone Beam Computed Tomography; TMJ – Temporomandibular joint; TMD – Temporomandibular joint disorders; RGF – Roof of Glenoid Fossa; GFRT – Glenoid Fossa Roof Thickness; AJS – Anterior Joint Space; SJS – Superior Joint Space; AE – Articular Eminence; CT – Computed Tomography; MDCT - Multidetector Computed Tomography; MRI – Magnetic Resonance Imaging; 3D – Three Dimensional; MPD – Myofascial Pain Dysfunction.