EVALUATION OF MORPHOMETRIC ASSESSMENT AND DEGENERATIVE CHANGES OF TEMPOROMANDIBULAR JOINT IN SYMPTOMATIC AND ASYMPTOMATIC SUBJECTS USING CBCT – A COMPARATIVE ANALYSIS

Dr. DHANAVATHULA VENKATA VINAY NAIK BDS[1], Dr. ANUSHA VENKATA NAYANALA MDS[2], Dr.T.BHARANI KUMAR MDS[3], Dr. M.P. V PRABATH MDS[4], Dr.K.AJAY BENARJI MDS[5], Dr.KATURI SUMANA BDS[6], CHOPPARAPU LAVANYA BDS[7], Dr.PUSHPA SAGAR KAJA BDS[8], Dr.PONNAGANTI SAI SREEJA BDS[9], Dr.SAVERI KATRAGADDA MDS[10]

1Department of Oral Medicine and Radiology . Drs Sudha and Nageswara Rao Siddhartha institute of dental sciences, Gannavaram, Andhra Pradesh.

2Associate professor, Department of Oral Medicine and Radiology. Drs Sudha and Nageswara Rao Siddhartha institute of dental sciences, Gannavaram, Andhra Pradesh.

3Associate professor, Department of Oral Medicine and Radiology. Drs Sudha and Nageswara Rao Siddhartha institute of dental sciences, Gannavaram, Andhra Pradesh.

4Head of The Department, Department of Oral Medicine and Radiology. Drs. Sudha and Nageswara Rao Siddhartha Institute of Dental Sciences, Gannavaram, Andhra Pradesh.

5professor, Department of Oral pathology. Drs Sudha and Nageswara Rao Siddhartha institute of dental sciences, Gannavaram, Andhra Pradesh.

6Former Under graduate student, Department of Oral Medicine and Radiology. Drs Sudha and Nageswara Rao Siddhartha institute of dental sciences, Gannavaram, Andhra Pradesh.

7Former Under graduate student, Department of Oral Medicine and Radiology. Drs Sudha and Nageswara Rao Siddhartha institute of dental sciences, Gannavaram, Andhra Pradesh.

8Former Under graduate student, Department of Oral Medicine and Radiology.Drs Sudha and Nageswara Rao Siddhartha institute of dental sciences, Gannavaram, Andhra Pradesh.

9Former Under graduate student, Department of Oral Medicine and Radiology. Drs Sudha and Nageswara Rao Siddhartha institute of dental sciences, Gannavaram, Andhra Pradesh.

10Assistant Professor, Department of orthodontics and Dentofacial orthopaedics. Drs Sudha and Nageswara Rao Siddhartha institute of dental sciences, Gannavaram, Andhra Pradesh

Abstract:

Background: The temperomandibular joint diseases have been associated with various predisposing factors. The assessment of joint spaces, articular eminence height and inclination and the shapes of condylar and glenoid fossa have been evidently proven to vary in patients with TMD'S. The advanced imaging techniques like CBCT have been employed to estimate these parameters.

Objective: Aims and objectives: The aim of the current study is to investigate the condylar morphology, condylar and glenoid fossa shapes and assessment of joint spaces such as anterior, posterior,superior, lateral and medial spaces through CBCT slices in coronal and saggital planes.

Methods: A crosssectional study will be planned with 80 joints in 40 patients will be assessed for the above parameters, the group I consisted healthy patients and group II those having temperomandibular joint diseases(TMD's).The articular eminence height and inclination will be assessed on the midsagittal section. The condylar changes, shapes of the glenoid fossa and condyles as well the joint spaces will be assessed on the selected coronal and sagittal section.

Results: Significant differences were observed between the TMJ disorder and control groups in condylar morphology, with a predominantly triangular shape in the TMJ group and an oval shape in controls ($p < 0.001$). Glenoid fossa morphology showed significant variation between groups, although an oval shape predominated in both ($p < 0.005$). Erosive changes of the mandibular condyle were more frequently noted in the TMJ group. Quantitative TMJ parameters—including articular eminence height and inclination, and superior, medial, lateral, anterior, and posterior joint spaces—showed highly significant differences between the TMJ and control groups ($p < 0.001$). No significant association was observed between condylar shape and TMJ morphometric parameters ($p > 0.05$). Glenoid fossa morphology showed no significant correlation with TMJ parameters except for articular eminence inclination ($p < 0.05$). Among condylar alterations, only the superior joint space demonstrated a significant association in the TMJ group ($p < 0.01$).

Conclusion: The morphological parameters &degenerative changes of temperomandibular joint will be assessed . The current study will elucidate the relationship of assessment of temperomandibular joint morphology and and diagnosis of temperomandibular diseases pertaining to all the choosen para meters between the controlled and diseased subjects

Keywords: Temporomandibular joint disorders (TMDs), Cone-beam computed tomography (CBCT), Condylar morphology, Glenoid fossa morphology, Articular eminence, Temporomandibular joint spaces.

Introduction :

The TMJ's (Temporomandibular joints) refers to highly dynamic and complicated joints. They are very vigorous body joints, undergoing around 2200 motions per twenty-four hours as a result of chewing, grinding, swallowing, communicating, and snoring [1]. The morphologic assessment of TMJ has considerable usage in the arena of TMJ disease control, according to Dupuy-Bonafe et al [2]. As a result, precise estimation of TMJ morphologic variables would help in understanding the internal structures and their functions. Because of the intricacy of the skull foundation and TMJ parts, several studies have used various imaging techniques to explore the morphologic features of TMJ [3].The morphology of the mandibular condyle and articular eminence were initially assessed using conventional X-rays, where like lateral cephalogram was used to establish the eligibility sign for requesting an effective radial tomogram of TMJ, to examine the vital connection along with the structure of joints as well as craniofacial morphology and condylar position [4]. The use of computed tomography (CT) scans for the morphologic identification of TMJ became common place after then. Cone beam computed tomography (CBCT), Micro-CT, Panoramic radiography (PR), and Magnetic resonance imaging (MRI) have all been employed to study the TMJ morphology in the recent years [3]. The face morphologic features of females having skeletal class II deformity and the association of thickness of the posterior aspect fossa and condyle shape were assessed using CBCT [5]. The morphology of condyle varies in different individuals owing to the condylar remodelling. Similarly, the height and the inclination of articular eminence also varies in people and it paves a way for condylar movements and degree of rotation of articular disc over the condyle
[6].

Considerable studies have been conducted to assess the TMJ morphology and the articular disc position by assessment of various joint spaces such as MJS (Medial joint space), LJS (Lateral joint space), SJS (Superior joint space), AJS (Anterior joint space and PJS (Posterior joint space). The researchers have tried numerous methods to assess the morphological variations in the temporomandibular joint, although there is no conclusive evidence regarding the association of TMJ morphology and the pathogenesis of temporomandibular joints [7,8]. More over the TMD'S associated degenerative bone changes such as erosions, changes in the bony surfaces of joint, projections such as osteophytes also have been taken as predictive factors for assessment of TMJ morphology [9]. Therefore, in the current study we aimed at evaluating the articular eminence height and inclination, the condylar bone changes, the assessment of condylar and glenoid fossa shapes and assessment of joint spaces using CBCT.

Aims and objectives of the study

The aim of the current study was to investigate the condylar morphology, condylar and glenoid fossa shapes and assessment of joint spaces such as anterior, posterior, superior, lateral and medial spaces through CBCT slices in coronal and sagittal planes.

Materials and methodology

STUDY DESIGN:

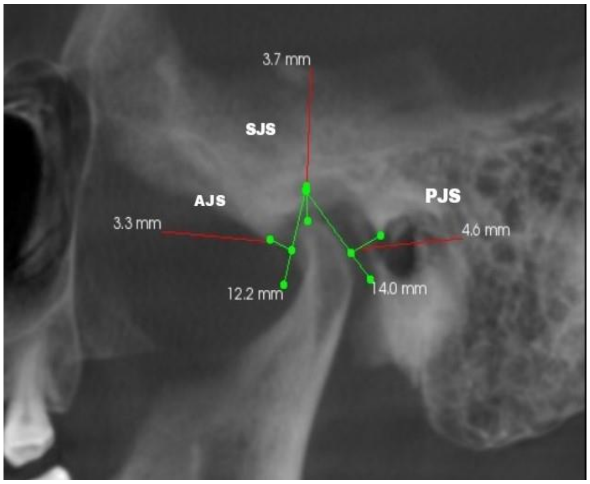
The current study design was a cross sectional case control study. The present study was conducted on the subjects recruited from the outpatient department of DRS Sudha and Nageswararao Siddhartha institute of dental sciences Gannavaram INDIA. Ethical clearance was obtained from the institutional ethical committee. The informed consent was taken from the subjects willing to participate in the study. The study sample was 20 in each group with (n=20) which comprised normal healthy individuals (Control group) which was taken as Group I, and those subjects having clinical signs and symptoms of clicking sounds, pain, tenderness, hyper mobility and hypo mobility of TMJ, trismus, subluxation were included according to taxonomic classification for TMJ disorders and American academy of orofacial pain 10. A detailed case history of all the included subjects was taken and recorded. A total of 80 joints in 40 subjects were assessed. Those having any craniofacial abnormalities, history of trauma to the orofacial area, those undergoing orthodontic therapy, or with systemic corticosteroid therapy and pregnant females as well the systemic diseases affecting the TMJ were all excluded. The assessment of above parameters was made using CBCT machine CARE STREAMITALY with dental imaging CS Software version 8.0.5. Model 9600 having maximum output of 5m as, exposure time 12 sec, KVP 120 with voxel resolution of 0.7 mmcu-0.15mmcu and the field of view (FOV 8cm×8cm) with exposure time of 11 seconds. Standard exposure and patient positioning protocols were followed. Two scout images were taken in the saggital and coronal views. The subjects were made to stand in the gantry so that the head is placed in the horizontal direction and Frankfurt horizontal plane is perpendicular to the table which was considered as accurate positioning. The acquired slices were chosen for assessment of morphology of TMJ with the mentioned parameters using slice thickness, which was approximately 0.4mm. Later the reformatting was done using DICOM software. The interpretations of the CBCT images were done by two radiologists who were experienced so that accuracy of interpretation was maintained.

Assessment of parameters:

[6,10] The articular eminence inclination and height assessed based on the mid parasagittal section, which was taken for measurement in each patient. On the chosen section, two points were marked that is superior most point on the porion (P) and the inferior most point of the articular eminence (E). A straight line joining these two points was drawn using the marking toolbar. Later, the highest point of the articular fossa (R) was marked and another line intersecting

the other line joining the point (R) to the inferior most point of the articular eminence (E) was marked. The angle at this intersection was depicted as articular eminence inclination and measured using the angle toolbar of the software. (Figure3)

- Height of Articular eminence: The articular eminence height was assessed by measuring the perpendicular distance between the lowest point of the articular eminence and the highest point of the fossa. (Figure 3)
- Condylar changes: The condylar bone changes were classified as normal, erosion and osteophyte formation. They were visualized and predicted in the coronal plane (Figure 4)
- Shape of Condyle and glenoid fossa: The condylar shapes of TMJ was assessed as triangular, oval, flattened and round for the condyles in a coronal plane of CBCT slice and triangular, trapezoidal, oval and round shapes for assessing the shape of glenoid fossa in the saggital plane. The central coronal slice was taken to determine the condylar shape and the central saggital plane was assessed for the glenoid fossa shape. (Figure 5 and 6)
- Medial joint space (MJS): The length from the condyles most medial point and the articular fossa was considered as MJS. (Figure 2)
- Superior joint space(SJS): The superior most line of the condyle and the length of articular fossa was considered as SJS. (Figure 1)
- Lateral joint space (LJS): The distance between the most distal point of the condyle and the articular fossa was designated as LJS. (Figure 2)
- Posterior joint space(PJS): The distance parallel to the FH plane between the posterior points of the condyle and the articular eminence outline was assessed as PJS. (Figure 1)
- Anterior joint space(AJS): The distance parallel to the FH plane between the anterior points of the condyle antharticulafossa outline was identified as AJS. (Figure 1)



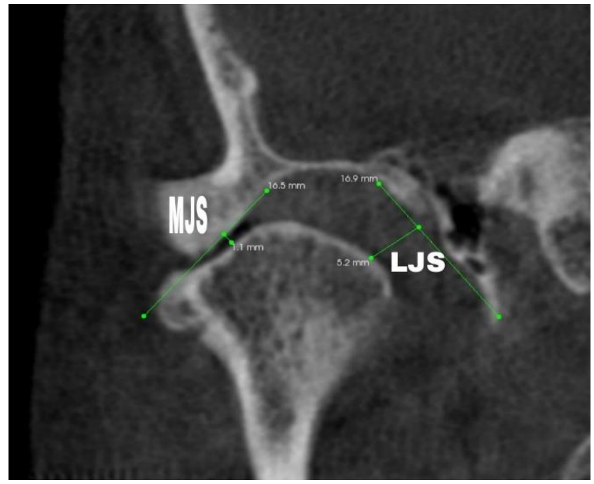
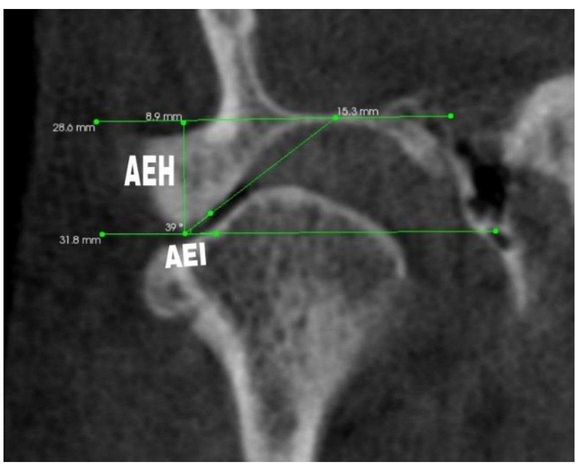


FIGURE: 1

FIGURE:2



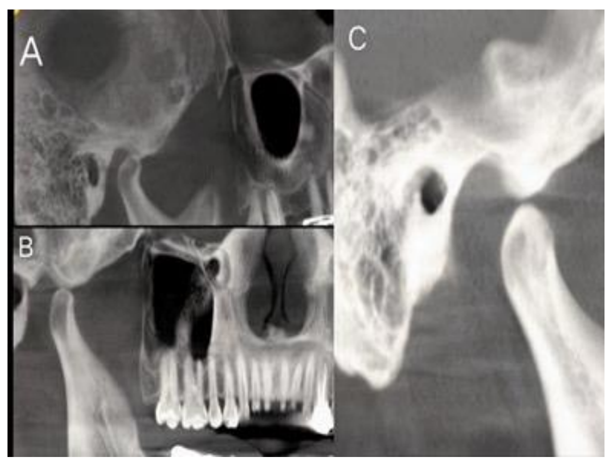
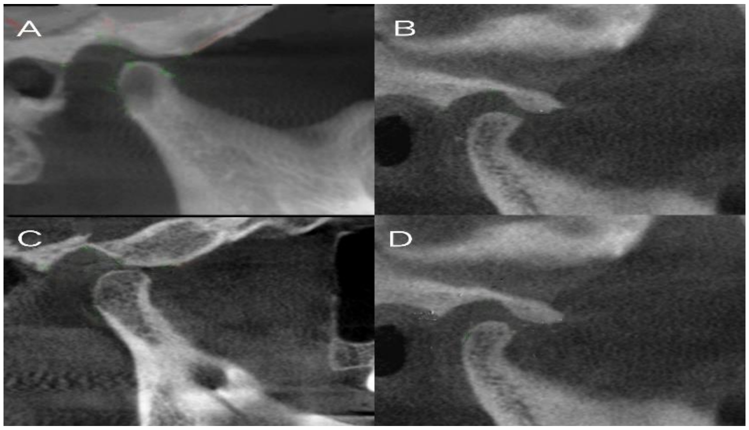


FIGURE:3

FIGURE:4



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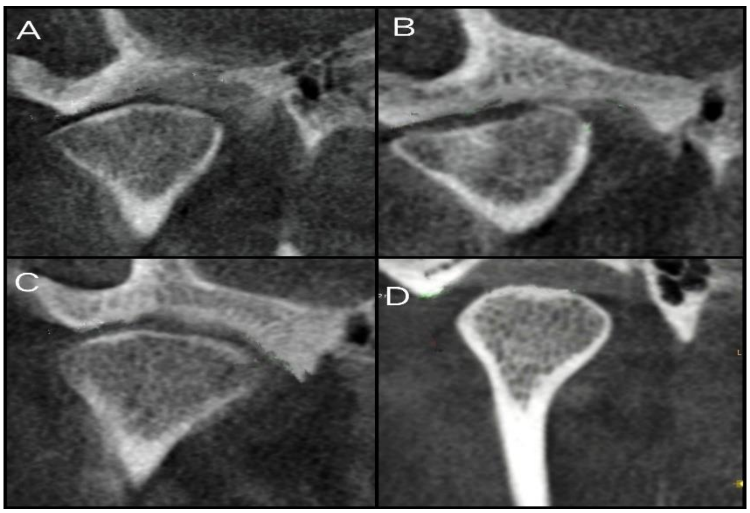

FIGURE:6

Observation and Result

Statistical Analysis: All the statistical analysis was done using MS excel -2007 and SPSS version 21. Qualitative variables were expressed as frequencies and percentages. The quantitative variables were expressed as mean and standard deviations. Chi square test was used for examining the qualitative data. Student independent sample's' test was used for comparison of two means. ANOVA was used for more than two group means comparison. For all the statistical analysis p<0.05 was considered statistically significant.

Table-1: Significant differences were observed in the condylar and glenoid fossa morphologies between the TMJ and control groups. In the TMJ group, the shape was primarily triangular, but in the control group, it was oval. P=0.000 ** indicated a highly significant P value. Comparably, both groups showed an oval-shaped glenoid fossa, with a p value that was very significant (p<0.005). Similarly, erosive alterations in the mandibular condyle were seen.

Table-2: When morphological characteristics such articular eminence height, inclination, SJS, MJS, LJS, AJS, PJS, and SJS were compared between the TMJ and control groups, a highly significant difference was identified for each parameter (P=0.000**).

Table-3a: When morphological parameters including articular eminence height, inclination, SJS, MJS, LJS, AJS, PJS, and inclination were compared with condylar morphologies, no mean significant difference was found between the two groups with (p>0.05).

Table -3b The relationship between glenoid fossa morphologies and TMJ morphological characteristics is shown in the current table. P values were (p<0.05), and there was no significant difference found between the two groups with the exception of articular eminence inclination. All the observations can be seen in the drawn table.

Table-3c: When taking into account the correlation between condylar alterations and the morphological parameters of the TMJ, the superior joint space (SJS) in the TMJ group was the only one where a mean significant difference was observed, with a p value of (p<0.01). The results are displayed in the table.

Discussion :

A precise and dependable image of the maxillofacial structures can be obtained by CBCT imaging. The actual TMJ features in the coronal, saggital, lateral, and axial positions should be evident when projecting the TMJ morphology. Designs in 2D and 3D have been used in the past to ascertain the TMJ morphology of patients who exhibit symptoms and those who do not. A number of parameters, including articular eminence height (AEH) and inclination (AEI), have been used to assess TMJ disorders, particularly disc displacements [3]. The articular eminence is situated in front of the glenoid fossa, and each person has a different posterior surface slope. Depending on the chewing and masticatory forces typically involved with the functional loading, the eminence changes differently [12]. The formation of AEI often ends by the age of 20, and as people age, osteoarthritic alterations become apparent. influencing the shape of the TMJ [13]. The AEI in TMJ was assessed using conventional techniques such as lateral cephalometry, interocclusal and protrusive recordings, and panoramic radiography. But, given more sophisticated methods like wide field of view CBCT compared to traditional imaging, it is now deemed more practical [14]. In TMJ groups, the articular eminence inclination was (32.20± 7.353) in the case group and (22.83 ± 3.441) in the control group. According to Gokalp et al. [15] and Sulun et al. [16], our findings supported the notion that articular eminence inclination was higher in the TMJ category. Conversely, in research conducted by Choudhary et al. [17] and Sumbullu et al. [12], AEI was higher in the normal group as opposed to TMJ. In our study, the articular disc's need to rotate forward on the condylar disc connection during mandibular movements is attributable to the TMJ's steeper AI. Additionally, a steeper AI causes an increase in anterior position relative to the condyle, which results in anterior disc displacement [18]. Furthermore, parafunctional habits, genetic variables, mechanical loading, and unbalanced occlusion are blamed for the changes in the morphologies of the condylar and glenoid fossas as well as the changes in the condylar bone. The pattern of forces would definitely hamper the TMJ morphology [19]. Due to stronger forces the fossa becomes deeper and AEI is steeper. In the current study the triangular shape of condyle was observed in TMJ group (50%), round (27.5%), Oval (10%) and (12.5%) flattened. On the other hand, the control group showed more oval shape observations (65%). Our results concur with the research done by Choudhary et al. [17]. Furthermore, the oval shape of the glenoid fossa was noted in the TMJ and the group under control. Our study's results are consistent with those of Cavallayan et al. [9], who reported a highly significant difference in the morphologies of the condylar fossas in both the TMJ and control groups.

By measuring the joint spaces, such as AJS, LJS, SJS, PJS, and MJS, the etiological causes for disc displacements and degenerative joint illnesses might be identified. Every joint space was identified in the coronal CBCT slide used in the current investigation. notable augmentation in the joint space was observed in relation to the control group's medial joint space. While AJS, PJS, SJS, and LJS all showed increased dimensions in the TMJ group, which is consistent with our findings, a study by A. I. Rawi et al. [6] and Kawamura and Ikeda et al. [20] found that AJS in the TMJ group had decreased, which contradicts our findings. Furthermore, SJS was found to be elevated in individuals with normal TMJs in a study conducted by Dalili et al. [21]; however, their results contradicted our research and Ikeda et al. Imanimoghaddam et al. [19] assessed the patients' various joint spaces. with TMJ issues, where he discovered that AJS was higher in the TMJ group, which is consistent with the results of this study. The mandibular condyle is located in the superioanterior position in the glenoid fossa; this is the reason why PJS is larger than AJS in the analysis done by Martins et al. [22] on the various joint spaces of the TMJ in the saggital plane. The TMJ group in our study had greater MJS and SJS. Notwithstanding the fact that the normal group in our study had higher MJS. Major et al. discovered a correlation between disc displacements and variations in joint space dimensions. In summary, the present study found that the condyle's triangular shape was significantly different in the TMJ group compared to the control group. Similarly, when glenoid fossa shapes were taken into account, the TMJ group also showed a significantly larger oval shape than the control group. Finally, erosive changes in the TMJ were more evident in this study. Additionally, the control group saw an increase in MJS alone among all joint spaces. Moreover, there was no discernible correlation or difference between the joint spaces and the glenoid and condylar fossa. forms of the TMJ. Even though it has been demonstrated that there is no correlation between the presence or absence of TMDs, there was an obvious link between joint spacing and articular eminence height. The current study also discovered a correlation between SJS and condylar alterations, albeit it is yet unclear how this feature may aid in the diagnosis of TMDs. Additional research examining and comparing every TMJ characteristic might aid in the identification of TMDs.

Strengths:

Current study evaluates the joint spaces, articulate eminences heights and inclinations along with the shapes of condylar and glenoid fossa and thus preventing the morbidities associated with age related changes in TMD patients by early evaluation and thus decreasing the risk of future therapeutic and prosthetic rehabilitation among these patients.

Limitations:

The sample size taken was less and larger geographical area should be evaluated to check for the morphological abnormality in TMJ to Aid in better diagnosis and treatment plan.

Conclusion & Summary:

The current study clarified the connection between the diagnosis of temporomandibular disorders and the evaluation of TMJ morphology. Patients with TMDs showed evidence of condyle erosion, and the TMJ group showed evidence of a triangular condyle shape. even though both groups had an oval glenoid fossa shape. In the TMJ group, all other joint spaces were enlarged, and there was also an increase in medial joint space compared to the controls. In addition, the TMJ group had higher articular eminence height and inclination. Additionally, our study found a correlation between the morphology of the condylar fossa and the slope of the articular eminence, as well as between condylar alterations and superior joint space. Our study's findings undoubtedly showed that because of the complicated anatomy of the temporomandibular joint, assessing these parameters and connecting them to TMDs is still questionable and insufficient to establish the existence of temporomandibular joint diseases. In addition, we observed a highly significant difference between the TMJ group and the control group for every metric that was selected.

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Tables1

Table-1: Distributions of the condylar shape, fossa shapes, and condylar changes in the temporomandibular joint disorder and control group.

Morphological Variations	Shapes	Total(n)	TMJ (%)	P value
Condylar shapes	Flattened	5	5(12.5)	**0.000****
	Oval	30	4(10)	
	Round	21	11(27.5)	
	Triangular	24	20(50)	
Glenoid Fossa shapes	Oval	35	12(30)	**0.002****
	Round	22	9(22.5)	
	Trapezoid	11	10(25)	
	Triangular	12	9(22.5)	
Condylar changes	Erosion	12	12(30)	
	Normal	22	22(55)	
	Osteophyte	6	6(15)	

Table-2: Mean and standard deviations of the Morphological parameters between TMJ and control group.

Morphological parameters	Group	N	Mean	Std. Deviation	t value	P-value
AJS	TMJ	40	4.938	2.1479	5.963	**0.000****
	Controls	40	2.830	.6186		
PJS	TMJ	40	7.525	2.1213	7.120	**0.000****
	Controls	40	5.063	.5338		
SJS	TMJ	40	6.088	2.3743	8.041	**0.000****
	Controls	40	3.015	.4504		
MJS	TMJ	40	2.558	1.0444	9.623	**0.000****
	Controls	40	4.245	.3734		
LJS	TMJ	40	4.635	1.6557	6.584	**0.000****
	Controls	40	2.880	.3180		
AEH	TMJ	40	6.495	1.3804	8.487	**0.000****
	Controls	40	8.605	.7528		
AEI	TMJ	40	32.20	7.353	7.304	**0.000****
	Controls	40	22.83	3.441		

Table-3a: Comparison of Morphological parameters according to the condylar shapes in TMJ and controls.

	TMJ					Controls			
Morphological parameters	**Condylar shape**	**N**	**Mean**	**Std. Deviation**	**P-value**	**N**	**Mean**	**Std. Deviation**	**P value**
AJS	Triangular	20	5.075	2.0463	0.323	4	2.500	.7789	0.376
	Round	11	5.136	2.5244		10	3.010	.4606	
	Oval	4	5.725	1.7251		26	2.812	.6458	
	Flattened	5	3.320	1.6843					
PJS	Triangular	20	7.775	2.1880	0.779	4	5.100	.7528	0.987
	Round	11	7.109	2.0032		10	5.070	.5334	
	Oval	4	6.950	2.0404		26	5.054	.5232	
	Flattened	5	7.900	2.5855					
SJS	Triangular	20	6.005	2.3467	0.924	4	2.900	.2944	0.618
	Round	11	5.845	2.6051		10	3.130	.4739	
	Oval	4	6.600	1.8403		26	2.988	.4659	
	Flattened	5	6.540	2.9305					
MJS	Triangular	20	2.620	1.2033	0.806	4	4.500	.5944	0.109
	Round	11	2.691	1.0473		10	4.370	.4191	
	Oval	4	2.325	.2062		26	4.158	.2955	
	Flattened	5	2.200	.8367					
LJS	Triangular	20	4.695	1.3740	0.974	4	2.700	.3559	0.451
	Round	11	4.700	1.1454		10	2.940	.2066	
	Oval	4	4.550	2.9275		26	2.885	.3472	
	Flattened	5	4.320	2.8093					
AEH	Triangular	20	6.600	1.4272	0.841	4	8.925	.7890	0.653
	Round	11	6.473	1.5730		10	8.510	.9085	
	Oval	4	6.675	1.4454		26	8.592	.7014	
	Flattened	5	5.980	.8556					
AEI	Triangular	20	32.25	6.980	0.212		4	22.50	0.769

	Round	11	30.00	8.729			10	22.20	
	Oval	4	30.50	6.807			26	23.12	
	Flattened	5	38.20	3.033					

Table -3b: Comparison of the morphological parameters according to the Glenoid fossa shapes andcondylar changes in TMJ and controls.

	TMJ					Controls			
Morphological parameters	**Glenoid fossa shapes**	**N**	**Mean**	**Std. Deviation**	**P value**	**N**	**Mean**	**Std. Deviation**	**P value**
AJS	Triangular	9	3.822	2.2264	0.295	3	2.9	0.7211	0.547
	Trapezoid	10	5.470	2.1919		1	3.500		
	Round	9	5.544	2.5851		13	2.938	.5810	
	Oval	12	4.875	1.5428		23	2.730	.6392	
PJS	Triangular	9	7.000	2.2995	0.589	3	4.733	.1155	0.281
	Trapezoid	10	7.740	1.8928		1	5.800		
	Round	9	7.044	2.7203		13	5.177	.4206	
	Oval	12	8.100	1.7257		23	5.009	.5977	
SJS	Triangular	9	5.544	2.4403	0.502	3	3.133	.5508	0.263
	Trapezoid	10	6.660	2.4222		1	3.700		
	Round	9	5.344	3.1592		13	2.869	.4309	
	Oval	12	6.575	1.5322		23	3.052	.4399	
MJS	Triangular	9	2.967	1.5248	0.519	3	4.000	.3606	0.197

	Trapezoid	10	2.490	1.0322		1	3.700		
	Round	9	2.222	.7190		13	4.200	.2646	
	Oval	12	2.558	.8339		23	4.326	.4092	
LJS	Triangular	9	4.778	1.2911	0.623	3	2.800	.4000	0.725
	Trapezoid	10	5.050	1.8265		1	3.200		
	Round	9	4.044	2.2667		13	2.908	.2691	
	Oval	12	4.625	1.2578		23	2.861	.3448	
AEH	Triangular	9	6.744	.9112	0.551	3	8.033	.7506	0.151
	Trapezoid	10	6.400	1.3157		1	10.000		
	Round	9	5.967	1.2298		13	8.669	.8350	
	Oval	12	6.783	1.8050		23	8.583	.6610	
AEI	Triangular	9	38.00	4.555	0.045	3	22.33	6.658	0.481
	Trapezoid	10	29.60	8.086		1	28.00		
	Round	9	30.00	8.352		13	22.38	2.063	
	Oval	12	31.67	5.867		23	22.91	3.642	

Table-3c: Comparison of the morphological parameters according to condylar changes in TMJ and controls

	TMJ				
Morphological parameters	**Condylar changes**	**N**	**Mean**	**Std. Deviation**	**P value**
AJS	Osteophyte	6	6.350	3.0468	0.118
	Normal	22	4.391	1.1775	
	Erosion	12	5.233	2.7766	
PJS	Osteophyte	6	7.033	1.8272	0.204
	Normal	22	8.064	2.1901	
	Erosion	12	6.783	1.9917	
SJS	Osteophyte	6	5.067	3.2420	0.002**
	Normal	22	7.195	1.8373	
	Erosion	12	4.567	1.7941	
MJS	Osteophyte	6	2.167	.8959	0.318
	Normal	22	2.473	1.0402	
	Erosion	12	2.908	1.0975	
LJS	Osteophyte	6	5.067	1.2404	0.058
	Normal	22	5.032	1.7638	
	Erosion	12	3.692	1.3014	
AEH	Osteophyte	6	5.850	1.1274	0.357
	Normal	22	6.741	1.4644	
	Erosion	12	6.367	1.3110	
AEI	Osteophyte	6	31.67	7.448	0.384
	Normal	22	31.00	7.771	
	Erosion	12	34.67	6.443	