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Investigation of glenoid fossa roof thickness in patients with and without TMJ disorders in a Turkish Subpopulation

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Abstract

The aim of this study was to evaluate the minimum thickness of the glenoid fossa (GFMT), the discontinuity of the roof of the glenoid fossa, and degenerative bone changes (DBC) using cone-beam computed tomography (CBCT), and to compare these findings between the patients with temporomandibular joint dysfunction (TMD) and patients witout TMD. CBCT images of 72 patients with TMD and 72 patients with non-TMD were evaluated for DBC and GMFC in the TMJ. The obtained data were compared between TMD group and non-TMD group, between DBC group and non-DBC group and between genders. Chi-square, fisher exact, and Mann-Whitney U tests were used to compare the data. The frequency of DBC was statistically different between the TMD group (79.2%) and non-TMD group (55.6%) (p=0.000). There was no statistical difference in the GFMT between in the TMD group (0.873 mm) and non-TMD group (0.853 mm). GFMT was statistically higher in DBC group (0.92 mm) compared to non-DBC group (0.738 mm) (p<0.05). There were no statistical differences between all groups for fossa discontuniuty and nutrition canal (p>0.05). The mean GFMT was found to be statistically higher in males than in females (p<0.05). Moreover, in the TMD group, the mean GFMT was found to be statistically higher in males than in females (p<0.05). The frequency of DBC was higher in TMD group than in non-TMD group. While TMD status had no effect on GFMT, it was found that GFMT increased in the presence of DBC. It was found that TMD and DBC had no effect on glenoid fossa discontinuity.

Keywords: Glenoid fossa roof, temporomandibular joint, cone beam computed tomography

Introduction

There are glenoid fossa and articular eminence under the squamous layer of the temporal bone. The glenoid fossa is sometimes defined as a component of the temporomandibular joint [1]. The glenoid fossa roof is a thin layer of bone located between the middle skull base and the temporomandibular joint (TMJ) components. Although the normal thickness of this layer is considered to be 1 mm or less, it varies according to populations; it has been measured as 0.2-4 mm in autopsy specimens and 0.37-2.58 mm in cone-beam computed tomography (CBCT) studies [2-8].

In the past years, conventional two-dimensional techniques such as transcranial, transfarengial and panoramic radiographs were used in TMJ imaging. Although these techniques were sometimes adequate, they were sometimes insufficient [9,10]. Therefore, more advanced methods such as computed tomography (CT), magnetic resonance imaging, arthrography and CBCT have been needed [11]. CBCT is a more accurate method for the evaluation of TMJ bone tissue than multidetector CT, which has a high radiation dose [12].

In previous morphologic studies of the TMJ, it has been shown that growth in the TMJ may continue with advancing age, occlusion status, jaw movements due to chewing and swallowing [13,14]. It has been reported that glenoid fossa (GFMT) increases after disc perforation [6].

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There have been studies in the literature on GFMT in CBCT images between temporomandibular joint dysfunction (TMD) and non-TMD, in asymptomatic patients, in asymptomatic patients with and without TMJ degeneration findings [1,12,15]. There are very few studies providing information about the loss of bone continuity in the glenoid fossa roof [12,16]. Therefore, the aim of this study was to evaluate GFMT, DBC, glenoid fossa discontinuity, and nutritional canal using CBCT images in a Turkish subpopulation sample living in Malatya and its surroundings areas.

Material and Methods

The approval for this retrospective study was obtained from the The İnönü University Health Sciences Non-Interventional Clinical Research Ethics Committee (2024/5820).

Study Population

In this study, 288 TMJ and glenoid fossa CBCT images of 144 patients were evaluated. CBCT images of 144 TMJ regions obtained from 72 patients, which were taken due to patient complaints such as pain in the TMJ region on clinical examination, sounds and restriction of mouth opening during masticatory movements and other functions, were included in the evaluation as TMD group. CBCT images 144 TMJ regions of 72 patients, which were taken for any other purpose other than TMJ-related complaints, were included in the non-TMD group.

Images of patients with conditions such as trauma, fracture, presence of mini screws and plates due to previous fractures, cysts, tumors, syndromes affecting the maxillofacial area, metabolic bone disease, motion artifact, radiotherapy in the head and neck region, and use of antiresorptive drugs such as bisphosphonate were excluded from the study. Images of patients over 18 years of age were included in the study.

CBCT Technique

In this study, CBCT images were obtained with a NewTom 5G CBCT machine (QR s.r.l., Verona, Italy) in the supine position. The images were evaluated with the NNT (QR s.r.l., Verona, Italy) program. The exposure parameters were 110 kv, 1-20 mA, scanning time 18 s, exposure time 3.6 s, and field of view 15 x 12 cm.

Evaluation of CBCT Images

On multiplanar reformat (MPR) images with voxel values of 0.3, 0.25 and 0.2 mm, axial, coronal and sagittal sections were evaluated for bone discontuniuty in the glenoid fossa roof and degenerative bone change in the condyle head. Bone tissue loss in the glenoid fossa roof was considered as discontinuity and nutritional canal (Figure 1). Flattening, erosion, and osteophytes in the condyle head were considered as degenerative bone change. To determine the images for glenoid fossa measurements, 1 mm thickness sagittal sections were taken from the glenoid fossa in the axial section. The sagittal section with the minimum height of the glenoid fossa roof was determined. And GFMT was measured in 1 mm thick sagittal sections taken from the glenoid fossa (Figure 2) The data obtained from the evaluation were recorded according to gender, TMD, and non-TMD groups.

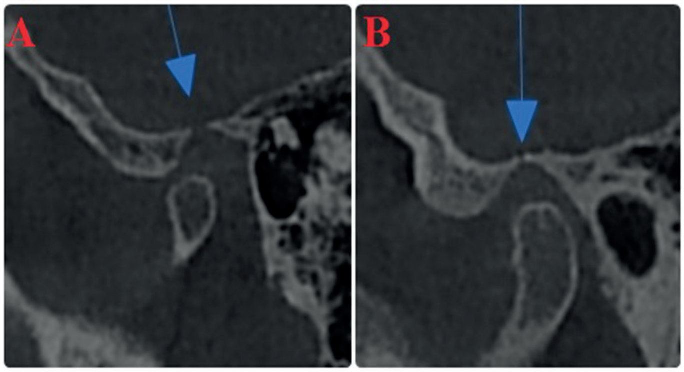

Figure 1. Discontinuity **(A)** and nutrition canal **(B)** in the glenoid fossa roof on the sagittal section image

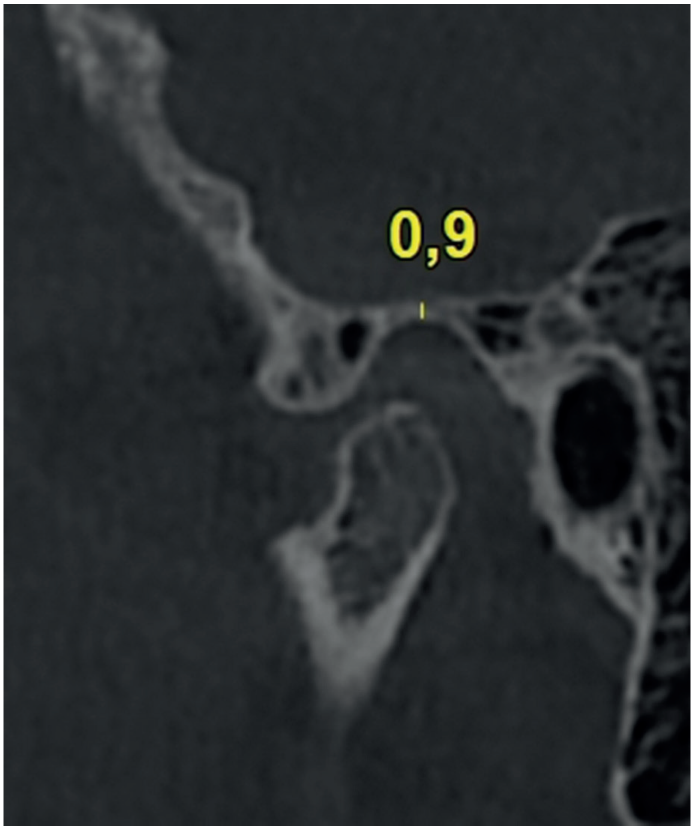

Figure 2. Measurement of the minimum thickness of the roof of the glenoid fossa in 1mm sagittal section

Statistical Analysis

Data were analyzed with SPSS V.23 software (IBM, Chicago, IL, USA). Pearson Chi-square test and Fisher's Exact test were used to compare categorical variables. Mann-Whitney U test was used to compare the minimum thickness dimensions of the glenoid fossa roof according to the groups. Significance level was accepted as $p<0.05$.

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Results

In this study, 288 TMJ and glenoid fossa of 144 patients were evaluated. Of these patients, 72 belonged to the TMD and 72 to the non-TMD group. The number of female patients was 71 (36 TMD, 35 non-TMD) and the number of male patients was 73 (36 TMD, 37 non-TMD). The mean age of the patients included in the study was 40.26 (min:20, max:69, sd:13.36) and the mean age of the TMD group was 40.02 (min: 20, max: 69, sd: 14.72) and the mean age of the nonTMD group was 40.5 (min: 20, max: 64, sd: 11.93).

The prevalence of DBC was 79.2% in TMD patients and 55.6% in the non-TMD group. The incidence of DBC between these two groups was statistically significant (p=0.000) (Table 1). Discontinuity in the glenoid fossa roof was 12.5% and nutrition canal was 1.4% in TMD patients and discontinuity in the glenoid fossa roof was 14.6% and nutrition canal was 5.6% in non TMD patients. There was no statistically significant difference between the incidence of discontinuity and nutrition canal between TMD and non TMD groups (p>0.05) (Table 1).

Table 1. Comparison of the frequency of degenerative changes, glenoid fossa discontinuity and nutrition canal accroding to TMD and NON TMD patients

	TMD		NON TMD		p value
	N	%	N	%	
Degenerative changes	114	79.2	80	55.6	**0.000[a]**
No degenerative changes	30	20.8	64	44.4	
Glenoid fossa discontinuity	18	12.5	21	14.6	0.731[a]
No glenoid fossa discontinuity	126	87.5	123	85.4	
Nutrition canal	2	1.4	8	5.6	0.103[b]
No nutrition canal	142	98.6	136	94.4	

N: number of patient; Chi-squarea and fisher exactb test was used for statistical analysis; p <0.05 indicates statistical difference

In temporomandibular joints with DBC, glenoid fossa discontinuity and nutrition canal were found to be 11.3% and 3.2%, respectively, while the same variables were found to be 18.1% and 3.2% in non-DBC TMJs, respectively. The frequencies of discontinuity and nutrition canal were not statistically significant between these groups with and without DBC (p>0.05) (Table 2). TMJ DBC frequencies were not statistically significant (p>0.05) between TMD female, non-TMD female, and the combination of these two groups and TMD male, non-TMD male, and the combination of these two groups (Table 2).

Table 2. Comparison of the frequency of glenoid fossa discontinuity, nutrition canal, and genders according to the degenerative changes of TMJ

	Degenerative changes		No degenerative changes		p value
	N	%	N	%	
Glenoid fossa discontinuity	22	11.3	17	18.1	0.142[a]
No glenoid fossa discontinuity	172	88.7	77	81.9	
Nutrition canal	7	3.6	3	3.2	1[b]
No nutrition canal	187	96.4	91	96.8	
Female	102	71.8	40	28.2	0.132[a]
Male	92	63	54	37	
TMD female	58	80.6	14	19.4	0.838[a]
TMD male	56	77.8	16	22.2	
Non TMD female	44	62.9	26	37.1	0.096[a]
Non TMD male	36	48.6	38	51.4	

N: number of patient; Chi-squarea and fisher exactb test was used for statistical analysis; p<0.05 indicates statistical difference

The frequencies of TMJ glenoid fossa discontinuity and nutrition canal were not statistically significant (p>0.05) between TMD female, non-TMD female, and the combination of these two groups and TMD male, non-TMD male, and the combination of these two groups (Tables 3 and 4).

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Table 3. Comparison of the frequency of genders distributions according to the glenoid fossa discontinuity

	Glenoid fossa discontinuity		No glenoid fossa discontinuity		p value
	N	%	N	%	
Female	22	15.5	120	84.5	0.391
Male	17	11.6	129	88.4	
TMD female	12	16.7	60	83.3	0.207
TMD male	6	8.3	66	91.7	
Non TMD female	10	14.3	60	85.7	1
Non TMD male	11	14.9	63	85.1	

N: number of patient; Chi-square test was used for statistical analysis; p<0.05 indicates statistical difference

Table 4. Comparison of the frequency of genders distributions according to he nutrition canal in glenoid fossa roof

	Nutrition canal		No nutrition canal		p value
	N	%	N	%	
Female	6	4.2	136	95.8	0.537
Male	4	2.7	142	97.3	
TMD female	1	1.4	71	98.6	1
TMD male	1	1.4	71	98.6	
Non TMD female	5	7.1	65	92.9	0.485
Non TMD male	3	4.1	71	95.9	

N: number of patient; Fisher exact test was used for statistical analysis; p<0.05 indicates statistical difference

The mean GFMT size was 0.873 mm in TMD patients and 0.853 mm in non-TMD patients and this value was not statistically significant between the two groups (p>0.05) (Table 5). The mean GFMT dimension was 0.92 mm in patients with DBC in the TMJ on CBCT images and this value was 0.738 mm in TMJs without DBC. The GFMT dimension in TMJs with DBC was statistically significantly higher (p<0.05) (Table 5). The mean GFMT dimension was 0.78 mm in female (TMD female and non TMD female) patients and 0.955 mm in male (TMD male and non TMD male) patients. There was a significant statistical difference between these two values (p<0.05) (Table 5). The mean GFMT dimension was 0.79 mm in female patients with TMD and 0.98 mm in male patients with TMD and there was a statistically significant difference between these two values (p<0.05) (Table 5). The mean GFMT dimension was 0.77 mm in female patients with non TMD and 0.932 mm in male patients with non TMD and there was no statistically significant difference between these two values (p>0.05) (Table 5).

Table 5. Comparison of minimum thickness of glenoid fossa roof according to TMD, degenerative changes and genders

	Minimum thickness of glenoid fossa roof				p value
	Mean (mm)	Min	Max	SD	
TMD	0.873	0	6	0.736	0.815
Non TMD	0.853	0	3	0.624	
Degenerative changes	0.92	0	6	0.701	**0.049**
No degenerative changes	0.738	0	3.3	0.628	
Female	0.78	0	6	0.682	0.012
Male	0.955	0	3.6	0.67	
TMD female	0.79	0	6	0.817	**0.02**
TMD male	0.98	0	3.6	0.633	
Non TMD female	0.77	0	2.5	0.512	0.195
Non TMD male	0.932	0	3	0.708	

Min: minimum, max: maximum, sd: standard deviation; Mann Whitney U test was used for statistical analysis; p<0.05 indicates statistical difference

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Discussion

In an early study on the accuracy of CBCT linear measurements, the reliability of the measurements was determined. Digital caliper measurements made at 11 anatomical points in the dry human skull were compared with CBCT and concluded to be accurate [17]. In another early study, glenoid fossa thickness measurements in Japanese cadavers were compared with micrometer and CBCT and no statistically significant difference was found and CBCT was found to be reliable in glenoid fossa measurement [18].

In this study, the mean GFMT was 0.853 mm in asymptomatic Turkish population and 0.874 mm in those with TMD. This finding was 0.75 mm in asymptomatic Koreans [15], 0.97 mm in asymptomatic Europeans [19], 1.12 mm in non-TMD Iranians [12], and 1.91 mm in Iranians with TMD [12]. In the Iranian study, GFMT was significantly higher in patients with TMD than in non-TMD patients [12]. In another study, GFMT values were compared between edentulous, dentulous, and partially edentulous patients and no statistically significant difference was found [20]. In our study, no significant difference was found between TMD and non-TMD. The values of asymptomatic patients we found were compatible with the literature.

In a study evaluating asymptomatic patients, no difference was found between GFMT dimensions between men and women [15]. In studies in which images of asymptomatic patients, patients with and without DBC were evaluated, no difference was found between GFMT dimensions between men and women [1,10,19]. In a study comparing TMD and non-TMD groups according to gender, GFMT was found to be higher in men in TMD patients and no difference was found in non-TMD patients [12]. In our study, GFMT was found to be higher in male patients in patients with TMD and higher in male patients in the total population of TMD and non-TMD. However, no statistical difference was found in asymptomatic patients without TMD, although it was higher in males.

In one study, GFMT dimensions were not statistically significant between TMD and non-TMD [12]. In some studies, it was found that GFMT dimensions with degeneration findings were higher than TMJs without degeneration [1,4,19]. In our study, there was no difference in GFMT between patients with TMD and non-TMD. However, there was a difference between patients with degeneration findings and those without and GFMT was larger in patients with degeneration. The reason for the increase in the size of the glenoid fossa roof in degenerative changes has been explained as inadequate shock absorption due to altered retrodiscal tissue or perforated discs increasing bone thickness [6].

It has been reported that intracranial abscesses may drain into the TMJ region due to thinning of the glenoid fossa and the condyle may be displaced into the intracranial area if there is thinning of the glenoid fossa in rare cases of trauma [21]. There is also a risk of spread of ear infections to the cranial area through the glenoid fossa. Malignant otitis externa may progress to the TMJ with penetration through Huschke's foramen, Santorini fissures, squamotympanic fissure or TMJ capsule or cranial base osteomyelitis involving the glenoid fossa [22,23]. However, no case of ear infection spreading to the skull base only through the TMJ or glenoid fossa has been encountered [16]. There are very few studies on discontinuity in the roof of the glenoid fossa in the literature. In a case report, discontinuity was demonstrated in the CBCT image of an asymptomatic 22-year-old patient [16]. In one study, discontinuity in TMD and nonTMD was found to be 10% in total, 8.6% in the TMD group and 1.4% in the non-TMD group. In this study, it was found to be statistically significantly higher in the TMD group [12]. In our study, the frequency of discontinuity was not statistically significant between TMD (12.5%) and non-TMD (14.6%), between those with degenerative findings (11.3%) and those without (18.1%) and between genders. According to our study, it was concluded that although degenerative changes increased GFMT dimension, they had no effect on discontinuity loss. In addition, in our study, the nutritional canals in the roof of the glenoid fossa, which appeared to be discontinuity, were evaluated separately. The frequency of nutritional canals was not statistically significant between TMD (1.4%) and non-TMD (5.6%), between those with degenerative findings (3.6%) and those without (3.2%), and between genders. In glenoid fossa with discontinuity, the risk of complications such as the aforementioned possibility of infection spread and posttraumatic displacement of the condyle to the skull base [21-23] may be higher in thin GFMT. In addition, more care should be taken during surgical procedures in patients with discontinuity and nutritional canal. Although important radiologic results regarding the glenoid fossa were obtained in our study, clinical studies are needed in this regard.

Conclusion

In degenerative changes in the TMJ condyle, the thinnest glenoid fossa thickness was found to increase, whereas no difference was observed in patients with TMD. It was found that the bone tissue discontinuity in the glenoid fossa was not affected by degenerative findings and TMD. The thickness of the glenoid fossa roof was found to be higher in men.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
The İnönü University Health Sciences Non-Interventional Clinical Research Ethics Committee approved this study (2024/5820).

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