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Comparison of Articular Eminence Steepness in Patients With Temporomandibular Joint Disc Disorders

Temporomandibular Eklem Disk Bozukluğu Olan Hastalarda Artiküler Eminens Dikliğinin Karşılaştırılması

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ABSTRACT

Objective: This study aimed to investigate the articular eminence steepness in patients with temporomandibular joint (TMJ) disc disorders (DD) and control group patients.

Methods: This study was designed retrospectively. A total of 22 patients with disc dislocation with reduction (DDWR), 26 patients with disc dislocation without reduction (DDWOR), and 24 control patients were included in the study. The steepness of the posterior slope of the articular eminence and the eminence height were measured using cone-beam computed tomography (CBCT) images. In addition, the articular eminence steepness was classified as steep, moderate, and flat.

Results: There was no significant difference in terms of age and gender between the study groups (P >.05). Articular eminence angle measured by best-fit line and top-roof line methods was found to be significantly higher in controls than in patients with DDWOR and in patients with DDWR, respectively (P <.05). The frequency of steep articular eminence inclination (>60°) was observed to be higher in controls than in joints with DDWOR and those with DDWR (P >.05), respectively. There was no significant difference between patients with DD and control patients in terms of articular eminence height (P >.05). There was a significant and negative correlation between age and top-roof line method values (r = −.230, P <.05). As the age increased, the eminence inclination values for the top-roof line method decreased.

Conclusion: In light of the results of this study, it can be said that an increase in eminence steepness does not appear to be a causative factor but may be a factor that worsens the progression of DD.

Keywords: Temporomandibular joint; articular eminence inclination; articular eminence height; cone-beam computed tomography

ÖZ

Amaç: Bu çalışmanın amacı, temporomandibular eklem (TME) disk hastaliği (DH) olan hastalarda ve kontrol grubu arasında artiküler eminens dikliğini karşılaştırmaktır.

Yöntemler: Bu çalışma retrospektif olarak tasarlandı. Çalışmaya redüksiyonlu disk dislokasyonu (R'luDD) olan 22 hasta ve redüksiyonsuz disk dislokasyonu (R'suzDD) olan 26 hasta dahil edildi. Artiküler eminensin posterior eğiminin dikliği ve eminens yüksekliği konik ışınlı bilgisayarlı tomografi (KIBT) görüntüleri kullanılarak ölçüldü. Ayrıca eklem eminens dikliği dik, orta ve düz olarak sınıflandırıldı.

Bulgular: R'luDD hastaları ile R'suzDD hastaları arasında yaş ve cinsiyet açısından anlamlı fark yoktu (p>0,05). Best-fit-line yöntemi ile ölçülen artiküler eminens açısı R'luDD hastalarında R'suzDD hastalarına ve kontrol grubuna göre sırasıyla anlamlı derecede düşük bulundu (p<0.05). Dik artiküler eminens R'suzDD olan eklemlerde R'luDD olan eklemlere göre daha sık gözlendi (p>0.05). Artiküler eminens yüksekliği açısından DH grubu ile kontrol grubu arasında anlamlı fark yoktu (p>0,05). Yaş ile top-roof-line yöntemi ölçüm değerleri arasında anlamlı ve negatif bir ilişki vardı (r=-0.230; p<0.05). Yaş arttıkça top-roof-line ölçüm değerleri azalmaktadır.

Sonuç: Bu çalışmada R'luDD, R'suzDD ve kontrol hastalarında ayrıntılı bir KIBT incelemesi ve eklem eminens morfolojisinin karşılaştırılması yapılmıştır. Posterior eminens açısı DH grubunda kontrollere göre daha düşüktü.

Anahtar kelimeler: Temporomandibular eklem; artiküler eminens eğimi; artiküler eminens yüksekliği; konik ışınlı bilgisayarlı tomografi

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INTRODUCTION

Disc disorders (DD) are the most common disorders among temporomandibular disorders.[1] In a normal condyle-disk relationship, the thinnest and middle part of the articular disc, called the intermediate zone, is located on the condyle, and this position is stable in all movements of the mandible. Disc disorders describe the positioning of the disc anterior to the condyle, which deviates from the normal anatomical relationship when the mouth is closed.[2] If the condyle disc relationship changes to the normal anatomical position when the mouth is opened, this situation is called a disc dislocation with reduction (DDWR), and if it continues to be positioned anterior to the condyle, this situation is called a disc dislocation without reduction (DDWOR). Common symptoms of DD are pain, joint sounds, and problems with jaw functions.[2] According to the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD),[2] clinical diagnoses without imaging had sensitivity ranging from 0.34 to 0.80 and specificity ranging from 0.79 to 0.98.

Although there are many studies in the literature stating that articular eminence perpendicularity is a predisposing factor in DD,[3–5] there are also authors who do not support this view.[6-8] The greater the eminence steepness, the greater will be the rotation of the disc. The incidence of DD was found to be more common in patients with steep slopes.[9] On the other hand, it has been suggested that articular eminence flattening may be the result of internal DD.[10,11]

This study aimed to investigate the relationship between the articular eminence inclination and temporomandibular joint (TMJ) DD in comparison with the control group.

MATERIAL AND METHODS

This study was approved by the Ethics Committee of Ankara Yıldırım Beyazıt Üniversitesi (2022-982, 28/06/2022).

The study included adult patients who applied to the Ankara Yıldırım Beyazıt Üniversitesi Faculty of Dentistry at the Oral Diagnosis and Dento-maxillofacial Radiology Clinic between 2018 and 2021.

The study was designed as a comparative, retrospective study involving 72 patients selected from the archives of patients' Oral Diagnosis and Dento-maxillofacial Radiology Clinic folders. Patients' folders included patient history, extraoral and intraoral examination records, and cone-beam computed tomography (CBCT) examination reports. The study group consisted of 48 patients diagnosed with bilateral and/or unilateral TMJ DD (group II a) according to the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD)[2] by a single oral diagnosis and dento-maxillofacial radiology specialist (22 patients with DDWOR and 26 patients with DDWR). The control group included 24 patients, all of whom were admitted to the hospital for dental reasons. The criteria for inclusion in the study and control groups were to be in the adult age group (16 years and older) and had CBCT images with bilateral TMJ regions. Exclusion criteria for the study group were to be diagnosed with a neuromuscular disorder and/or collagen metabolism disease or to be diagnosed with psychiatric drug use and degenerative joint disease. The exclusion criterion for the control group was a history of TMJ complaints. Power analysis showed that 23 patients per group would be required for a power of .80 with an α error of 0.05.

Clinical Records

Patients' age, sex, and TMD diagnosis of each joint were noted.

CBCT Reviews

The CBCT images of the bilateral TMJs were obtained with planmeca, a Promax 3D (Planmeca Oy, Helsinki, Finland) device. The image acquisition protocols with an 8x15 cm field of view, including TMJs were done according to the manufacturer's instructions, which called for 9–14 mA, 90 kVp, and 12–14 seconds of scan time. The patients who were standing and biting their teeth were in the maximum intercuspal position. Reconstructed images were obtained with Romexis Viewer 2.7.0 software with 0.2- or 0.4-mm voxel sizes ranging from 0.2 to 1 mm slice thickness.

A dento-maxillofacial radiologist with at least 10 years of experience performed the radiological data twice, 2 weeks apart. Measurements were made blind to the characteristics of the patients in a dim room using a 19-inch LCD monitor (Dell Inc., Round Rock, TX, USA).

Healthy joints were excluded from the morphometric measurements. As a result, CBCT measurements of 32 joints with DDWOR, 33 joints with DDWR, and 48 control group joints were analyzed.

Morphometric Measurements of the Articular Eminence

The axial section in which the condyle appeared the widest mediolaterally was determined as the reference section. Sagittal and coronal reconstructive images were obtained by drawing a line perpendicular and parallel to the mediolateral axis in the center of the condyle. The slice thickness was determined to be 0.4 mm.

The following landmarks and lines were used.

Landmarks
Po: porion, the highest point of the meatus auditorium.
O: orbitale, the lowest point of the inferior border of the orbital rim.
HF: the highest point of the fossa.
LE: the lowest point of the articular eminence.

Lines
FH: the Frankfort horizontal, extending from the orbitale to porion point.
F1: a line parallel to the Frankfort horizontal, cutting the HF point.
F2: a line parallel to the Frankfort horizontal, cutting the LE point.
I1: a line drawing with the best-fit method that was tangent to the posterior slope of the articular eminence.
I2: a line extending from the HF point to the LE point.

The inclination of the posterior slope of the articular eminence was measured as the angle between the F2 and I1 (best-fit line method),[12] and the F2 and I2 (top-roof line method).[5, 8,10] Additionally, articular eminence inclination was classified as flat (<30°), moderate (30°-60°), and steep (>60°) according to Katsavrias et al.[8] The height of the articular eminence was measured between the lines of F1-F2 perpendicularly. The measurements and related landmarks and lines used in this study are presented in Figures 1 and 2.

The data obtained in this study were analyzed with the SPSS 22 package program (SPSS Inc., Chicago, IL). Intra-observer agreement was analyzed for the morphometric measurements with kappa (κ) statistics, and the level of consistency was accepted as at least 0.7. Since the data did not show normal distribution, the Mann-Whitney U test was used for comparisons of two groups, and the Kruskall-Wallis H test was used for comparisons of three or more groups. The chi-square test was used in the analysis of the relationship between categorical data. Descriptive statistical methods (mean, median, standard deviation, and minimum-maximum) were used while evaluating the research data. The significance level was 0.05.

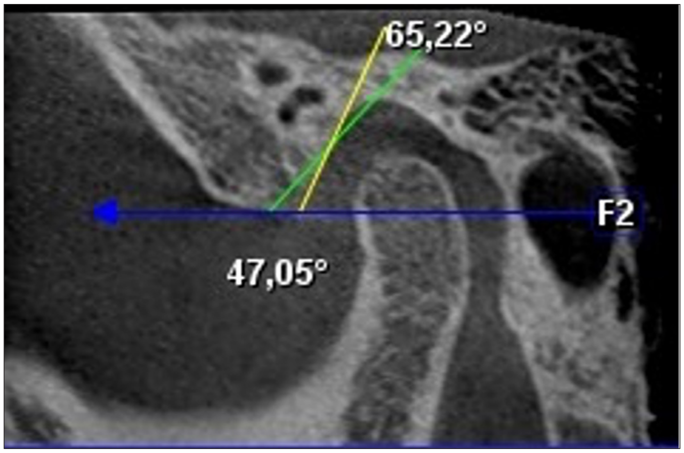

Figure 1.

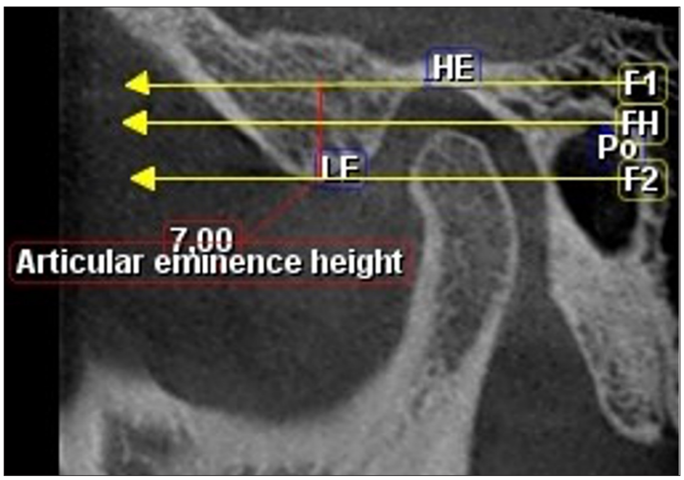

Figure 2.

Table 1. The distribution of age and gender of the study population

		DDWR		DDWOR		CONTROLS		Total		p
Age	Average	32.27		36.27		36.67		35.18		0.38
	Median	30		35.5		37.5		33		
	Minimum	18		19		16		16		
	Maximum	65		76		61		76		
	SD	11.79		15.14		12.03		13.13		
		n	%	n	%	n	%	n	%	
Gender	Female	18	81.8	17	65.4	17	70.8	52	72.2	0.342
	Male	4	18.2	9	34.6	7	29.2	20	27.8	
	Total	22	100.0	26	100.0	24	100.0	72	100.0	

DDWR, disc displacement with reduction; DDWOR, disc displacement without reduction; SD, standard deviation; n, noun.

Table 2 The CBCT variables of the eminence inclination and eminence height values in the patient and control groups

		n	Mean	Mediaan	Minimum	Maximum	SD	p
Best-fit line method (the angle between the F2 and I1)	DDWR	33	56.31	55.16	26.57	78.63	13.63	0.047
	DDWOR	32	60.13	61.02	36.87	77.62	10.44	
	CON-TROLS	48	63.59	64.37	0.00	87.00	13.77	
	TOTAL	113	60.48	63.03	0.00	87.00	13.12	
Top-roof line method (the angle between the F2 and I2)	DDWR	33	34.76	35.90	16.31	54.90	9.01	0.002
	DDWOR	32	38.61	38.75	24.97	48.23	5.64	
	CON-TROLS	48	40.48	39.67	28.86	56.69	6.44	
	TOTAL	113	38.28	38.55	16.31	56.69	7.42	
Height of glenoid fossa (mm)	DDWR	33	6.9	7.2	2.6	10.4	2.1	0.252
	DDWOR	32	7.6	7.6	4.6	10.8	1.2	
	CON-TROLS	48	7.2	7.2	4.0	10.0	1.6	
	TOTAL	113	7.2	7.4	2.6	10.8	1.7	
Classification of eminence inclination (best-fit line, angle between the F2 and I1)		Flat (<30°)	Moderate (30-60°)	Steep (>60°)	p			
		n	%	n	%	n	%	0.133
	DDWR	1	3	17	51.5	15	45.5	
	DDWOR	0	0	13	40.6	19	59.4	
	CON-TROLS	0	0.0	14	29.2	34	70.8	
	TOTAL	1	.9	44	38.9	68	60.2	

DDWR, disc displacement with reduction; DDWOR, disc displacement without reduction; SD, standard deviation; n, noun.

RESULTS

High consistency of intra-observer agreements was detected for all measurements (κ ≥ 0.90). The mean age of the study sample was 35.18 ± 13.13. There were no significant differences among controls, DDWR, and DDWOR patients in terms of age (Kruskall-Wallis H, *P* =.38 >.05) and gender (Chi-square, *P* =.36 >.05). The distribution of age and gender in the study population is shown in Table 1.

A total of 26 of 19 (73.1%) patients with DDWR and 22 of 12 (54.5%) patients with DDWOR showed unilateral involvement, whereas 7 of the patients with DDWR (26.9%) and 10 of the patients with DDWOR (45.5%) had bilateral involvement.

The CBCT variables of the joints were presented in Table 2. There was a significant difference among the study groups regarding articular eminence inclination measurements (analysis of variance [ANOVA], *P* = <.05). The eminence inclination measured via both best-fit line and top-roof line methods was higher in controls (63.59 by best-fit line and 40.48 by top-roof line) than in DDWOR (60.13 by best-fit line and 38.61 by top-roof line) joints and in DDWR joints (56.31 by best-fit line and 34.76 by top-roof line) (ANOVA, *P* <.05). There was no significant difference in the height of the articular eminence measurements between the study groups (ANOVA, *P* >.05). There were no significant differences in the frequency of articular eminence steepness classification variables among the groups (Chi-square, *P* >.05), whereas the frequency of steep articular eminence inclination (>60°) was higher in controls (70.8%) than in DDWOR joints (59.4%) and DDWR joints (45.5%).

Additionally, no statistically significant correlation was found between the eminence angle values for both the best-fit line method (r = −.098, *P* =.252 >.05) and height values (r = −.136, *P* =.111 >.05) and age. There was a significant and negative correlation between top-roof line method values and age (r = −.230, *P* =.007 <.05). As the age increased, the eminence inclination values for the top-roof line method measurements decreased.

DISCUSSION

Temporomandibular disorders were seen more frequently in females than in males.[13] In our study, 81.8% of the patients with

DDWOR and 65.4% of the patients with DDWR were female, and 18.2% of the patients with DDWOR and 34.6% of the patients with DDWR were male, which agrees with the literature.[13-15]

Many studies have used different methods when measuring the articular eminence steepness.[16-19] It has been reported that the best-fit line method indicates the path in the translation of the condyle, whereas the top-roof line method indicates the morphological changes.[17] In this study, both measurement methods were used, as in the previous study.[17]

The use of CBCT in TMJ imaging has become popular recently.[17,18] The superpositions of anatomical structures that occur in conventional radiographs and panoramic radiographs do not occur when CBCT is used. It has a lower radiation dose when compared with computed tomography (CT), and its spatial resolution is better than CT. Magnetic resonance imaging (MRI) [20,21] and ultrasonography[18] were also used for TMJ imaging, but these imaging modalities are good at visualizing soft tissues; hence, CBCT should be used to visualize the bone structure.

In this study, the mean inclination of the eminence was found to be higher in controls than in DD joints. Therefore, according to the results of the study, it can be said that an increase in eminence steepness does not seem to be a cause of DD. There are studies in the literature that found similar results to this study.[22] Some previous studies[17,23] found that the articular eminence steepness was higher in asymptomatic TMJ patients than in TMD patients. It was explained that the articular eminence steepness decreases as a result of remodeling in patients with DD[7] because degenerative changes of bone components were observed in TMJs with DD.[5,7,19] However, according to the current study, eminence flattening did not appear because of the result of degenerative changes but because the mean inclination of the eminence was found to be higher in DDWOR joints than in DDWR joints. Judging by the natural progression of the disease, degenerative changes should have been greater in DDWOR joints than in DDWR joints. There are some studies that did not support our results, while according to the results of studies by Gökalp et al.[21] and Özkan et al.[19], the eminence angle was found to be higher in DDWR joints than in DDWOR joints. Different results of studies may be due to differences in study population and methods. Unlike previous studies, this study used CBCT, not MRI. The results of eminence inclination classification according to Katsavrias et al.[8] variables were in accordance with mean inclination measurements in this study. The number of steep articular eminence (>60°°) was observed to be higher in healthy joints than in DDWOR joints and in DDWR joints.

In this study, we found a significant and negative correlation between age and articular eminence steepness. As the age increased, the eminence inclination values decreased. In contrast, it has been reported that eminence steepness is not associated with age.[24-26] However, multiple factors can play a role in the remodeling process, and dissimilar results may be related to the difference in the age of the study population.

One of the limitations of this study was that MRI was not used in the diagnosis of patients with DD. However, MRI is an expensive technique and should be used if the results of the diagnosis or treatment of TMJ disorders change. In this study, standardization was achieved by using DC-TMD criteria in the diagnosis of patients with DD. In addition, because a single clinician examined the patients, possible imbalances in diagnosis were prevented.

In conclusion, a detailed examination and comparison of the articular eminence morphology in DDWR, DDWOR, and control patients were made in this study. The outputs of this study are as follows:

There were no significant differences between patients with DDWR patients with DDWOR, and controls in terms of age and gender.

There was a significant difference between the DD joints and control joints regarding articular eminence inclination. The mean eminence angle values were significantly higher in controls than in DDWOR joints and DDWR joints.

There was no significant difference regarding the height of the articular eminence measurements among the study groups.

There was a significant and negative correlation between age and top-roof line method values ($r = -.230$, $P < .05$). As the age increased, the eminence inclination values for top-roof line method measurements decreased.

In light of the results of this study, it can be said that increased eminence steepness does not cause disc disorders but may be a factor that worsens the progression of the disease.

Ethics Committee Approval: This study was approved by the Ethics Committee of Ankara Yıldırım Beyazıt University (Date: June 28, 2022; Decision No: 2022-982).

Declaration of Interests: The authors have no conflicts of interest to declare.

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