Original Article / Özgün Araştırma

Assessment of Morphological Alterations of Temporomandibular Joint Articular Surfaces in Patients with Temporomandibular Dysfunction

Temporomandibular Disfonksiyonlu Hastalarda Temporomandibular Eklem Yüzeylerindeki Morfolojik Değişikliklerin Değerlendirilmesi

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Abstract

Objective: This study aimed to examine the distribution of condyle and articular fossa shapes in patients with temporomandibular joint dysfunction (TMD) and their relationship with each other using cone-beam computed tomography (CBCT) images.

Materials and Methods: CBCT scans of 134 patients (268 joints) with TMD were evaluated retrospectively. In the coronal and sagittal views, condyles were classified based on the following basic shapes: round, oval, flattened, and triangular. Shapes of the articular fossa were classified as oval, triangular, angled, and trapezoidal. The evaluation was made in the sagittal and coronal sections where the articular fossa and mandibular condyle were most clearly seen. Data were analyzed using the chi-square test.

Results: Sagittal-oval and coronal-flattened condyles were seen more frequently than other shapes. Identical sagittal and coronal condyles were observed in 83 joints (30.97%). In sagittal sections, the shapes of the articular fossa were oval in 128 (47.8%), angular in 68 (25.4%), trapezoid in 50 (18.7%), and triangular in 22 (8.2%) patients. The most common fossa shape was oval in each shape of the condyles in sagittal and coronal sections. No relationship was found between gender or age groups and shapes of the articular fossa and condyle in all sections.

Conclusion: Knowledge of condyle and fossa shapes may help clinicians understand morphological bone changes in patients with TMD. CBCT can be used as an accurate diagnostic tool when three-dimensional examinations of TMJ bone surfaces are necessary.

Öz

Amaç: Çalışmanın amacı, temporomandibular eklem (TME) bozukluğu olan hastalarda kondil ve artiküler fossa şekillerinin dağılımını ve birbiriyle ilişkisini konik ışınlı bilgisayarlı tomografi (KIBT) görüntüleriyle incelemektir.

Gereç ve Yöntemler: Bu çalışmada, TME bozukluğu olan 134 hastanın (268 eklem) KIBT görüntüleri geriye dönük olarak değerlendirildi. Koronal ve sagittal kondil

şekillerinde kullanılan sınıflandırma yuvarlak, oval, düz ve üçgen şeklindeydi. Artiküler fossa şekilleri oval, üçgen, açılı, trapezoid şeklinde sınıflandırıldı. Artiküler fossa ve mandibular kondilin en net görüldüğü sagittal ve koronal kesitlerde değerlendirme yapıldı. Veriler ki-kare testi kullanılarak değerlendirildi.
Bulgular: Sagittal kesitlerde oval ve koronal kesitlerde düz şekil diğer şekillere göre daha sık görüldü. Sadece 83 eklemde (%30,97) sagittal ve koronal kondil şeklinin aynı olduğu tespit edildi. Sagittal kesitlerde eklem fossa şekilleri 128'inde (%47,8) oval, 68'inde (%25,4) açılı, 50'sinde (%18,7) trapezoid ve 22'sinde (%8,2) üçgen şeklindeydi. Sagittal ve koronal kesitlerde her kondil şekli grubunda en yaygın fossa şekli ovaldi. Cinsiyet veya yaş grupları ile artiküler fossa ve kondil şekilleri arasında anlamlı ilişki saptanmadı.
Sonuç: Kondil ve artiküler fossa şekillerinin bilinmesi, klinisyenlerin TME bozukluğu olan hastalardaki morfolojik kemik değişikliklerini anlamalarına yardımcı olabilir. KIBT, TME kemik yüzeylerinin üç boyutlu muayenesi gerektiğinde doğru tanı aracı olarak kullanılabilir.

Introduction

The temporomandibular joint (TMJ) is an important and complicated joint in the human body. This joint performs speaking, chewing, and swallowing with the harmony of many soft and hard tissues. The degenerative diseases affecting bone metabolism and trauma can cause morphologic changes in mandibular condyle and articular fossa of temporal bone (1,2). Bone changes occurring in the TMJ, such as subchondral sclerosis, osteophyte formation, surface erosion, flattening can be the causes and the findings of TMJ dysfunction (3).

Temporomandibular joint dysfunction (TMD) is a multifactorial and complex disorder which is common in population. TMD defines the impaired relationship between the articular disc, articular eminence, articular fossa, and mandibular condyle, with symptoms such as joint pain and sounds, headache, restricted jaw movements, and muscle pain (4). Diagnosis of TMD is based on detailed anamnesis, clinical and radiological examination (5).

Radiographic examination is an important diagnostic tool in the evaluation of TMD which identifies bony changes, position of articular disc and spatial relationships of the condyle and the fossa (6,7). Conventional radiography techniques such as panoramic radiography, transcranial-oblique radiography, Reverse Towne's radiography only provides limited sectional images of the bony components of the TMJ. These techniques provide superimpositions because of the complexity of TMJ anatomy (8,9). Cone-beam computed tomography (CBCT) technology which is using in dentistry for many years, produces high resolution images with high specificity and sensitivity in diagnosis of TMJ bone changes (10,11). The other hand, magnetic resonance imaging has great advantages that its ability to depict soft tissue changes of the TMJ (12).

Detection of abnormal morphologic changes of TMJ bone tissues is possible with the appropriate imaging method. In the present study, we examined the CBCT images of patients who were previously diagnosed as TMD by the clinical examination. The purpose of the present study was to determine the shape of mandibular condyle and articular fossa according to age, gender.

Materials and Methods

This study was approved by the Aydın Adnan Menderes University Faculty of Medicine Non-Invasive Clinical Research Ethics Committee on Human Research (protocol no: 2020/31, date: 20.02.2020). In the present study, CBCT scans of 134 patients (268 joints) with TMJ dysfunction which performed between July 2016 and October 2019 were evaluated retrospectively. All of patients were scanned with CBCT because of TMD diagnosis and had clinical symptoms such as TMJ pain, noise during jaw movements, mouth-opening limitation, and non-harmonic movements of the joint. The presence of congenital craniofacial abnormalities, history of facial trauma, orthodontic treatment and any systemic conditions that may affect the bone tissues and CBCT images with artefacts that preventing optimal evaluation were excluded from the study.

All CBCT images were acquired by Planmeca Promax 3D (Planmeca, Helsinki, Finland) with standard TMJ mode (field of view 8x5 cm^2, 90 kV, 8 mA, 12 s, voxel size: 0.2 mm) and examined Romexis software v3.83. Radiological assessments were analyzed by 2 experienced dentomaxillofacial radiologists independently. Differences in interpretation of the images were solved by consensus.

The condylar shapes and fossa shapes were categorized according to Cortés et al. (13), Katsavrias (14) and Yasa and Akgül (15) previously reported classification. The basic shapes used for classification included round, oval, flattened, and triangular for the condyles in a coronal and sagittal view (Figure 1, 2) articular fossa shapes were classified as oval, triangular, angled, trapezoidal (Figure 3). Evaluation was made in the sagittal and coronal sections where the articular fossa and mandibular condyle were most clearly seen.

Statistical Analysis

Statistical analyses were conducted with SPSS software (SPSS 22.0 for Windows; SPSS Inc., Chicago, IL, USA). Differences in condyle and fossa shapes between the groups were evaluated by chi-square test followed by a Bonferroni post-hoc test. Values of $p<0.05$ were considered to indicate statistical significance.

Results

In 134 patients with TMD, 268 joints (38 males and 96 females; mean age, 41.60±16.07 years) were examined. The distribution of the condyle shapes in the coronal and sagittal sections are listed in Table 1. There was a significant statistical relationship between coronal and sagittal condyle shape

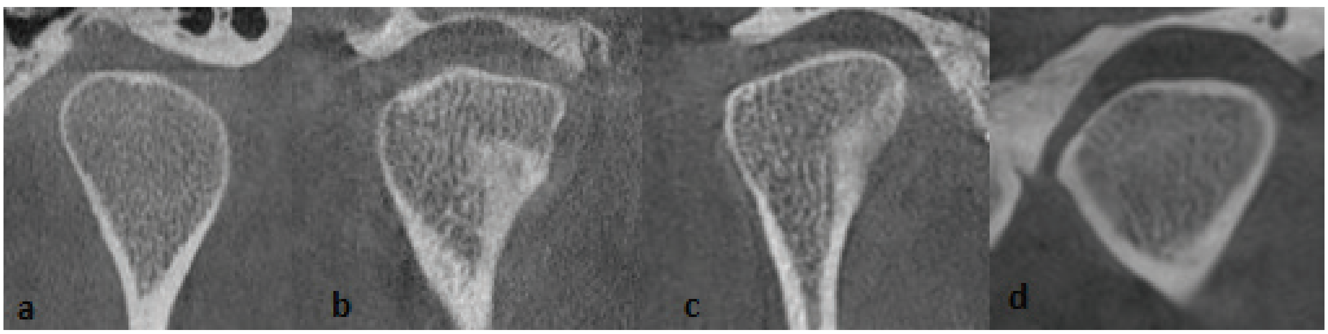

Figure 1. Four condyle shapes in a coronal section: oval (a), triangular (b), flattened (c), round (d)

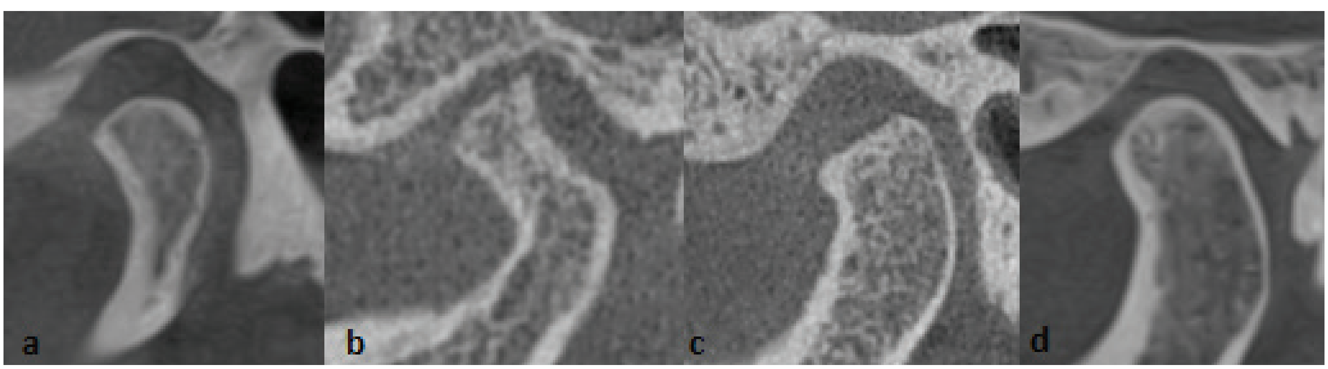

Figure 2. Four condyle shapes in a sagittal section: oval (a), triangular (b), flattened (c), round (d)

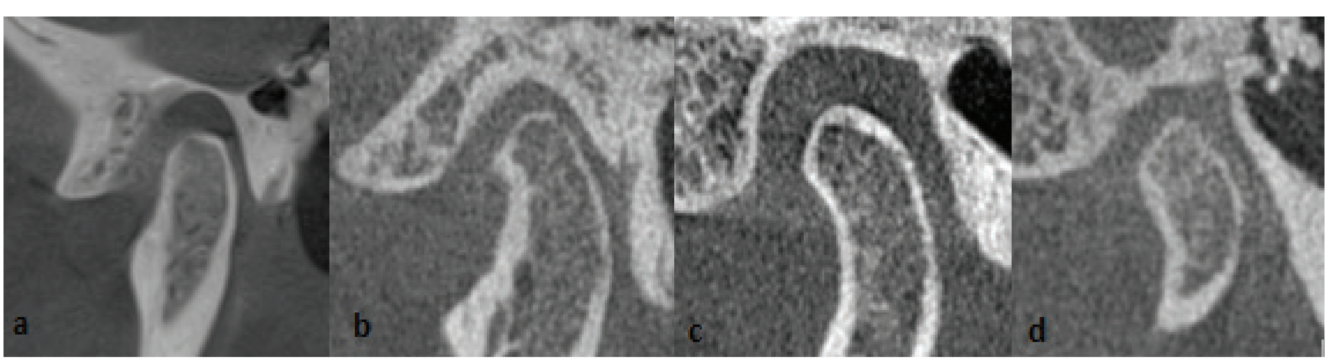

Figure 3. Four fossa shapes in a sagittal section: oval (a), triangular (b), angled (c), trapezoid (d)

(p=0.001). A sagittal-oval condyle shape (p=0.000) and coronal-flattened shape (p=0.009) were seen more frequently than other shapes. The post hoc test revealed that if sagittal condyle shape is oval, triangular shape is significantly less than round shape in coronal view. If sagittal condyle shape is flattened, round shape is significantly less than flattened and triangular shape in coronal view (Table 1). It was found that identical sagittal and coronal condylar shape occurred in only 83 joints (31%).

The distribution of the articular fossa shapes in the sagittal sections was presented in Table 2. The shapes of articular fossa in sagittal sections were oval in 128 (47.8%), angled in 68 (25.4%), trapezoid in 50 (18.7%) and triangular in 22 (8.2%). There was no significant difference between the shape of condyle in sagittal or coronal sections and the shape of articular fossa (respectively p=0.954, p=0.072). The most common fossa shape was oval in each shape of the condyles in sagittal and coronal sections.

The distributions of shapes of condyle and fossa according to gender were shown in Table 2. There was no relationship between gender and shape of condyle in coronal and sagittal sections (p=0.273, p=0.412 respectively). In sagittal section, triangular articular fossa was significantly less than oval articular fossa in both genders (p=0.004).

The patient was grouped according to the age of the subjects (18-39, 40-59, 60-81 years). There were no significant differences between sagittal condyle shapes, coronal condyle shapes sagittal fossa shapes and age groups (respectively p=0.075, p=0.062, p=0.922).

Discussion

In this study, we investigated the distribution and relationship of condyle and fossa shapes in TMD patients. Knowledge of the specific morphological changes of TMJ are necessary for accurate diagnosis supported by clinical examination. There are limited studies in the literature examining the relationship between the shapes of condyle and articular fossa in patients with TMD (2,14-19). To the best of our knowledge, this is the first study to evaluate the relationship between coronal condylar shapes and sagittal condylar shapes. Findings of the present study may help clinicians to understand morphologic bone changes in TMD and to treat their patients accurately at the same time.

Table 1. Distribution of condyle shapes on coronal and sagittal sections

		Coronal view					p
		Round	Oval	Triangular	Flattened	Total	
Sagittal view	Round	12	10	4	5	31 (11.6%)	0.123
	Oval	50	29	20	41	140 (47.8%)	0.002*
	Triangle	5	3	8	5	21 (8.2%)	0.488
	Flattened	9	13	20	34	76 (28.4%)	0.000*
	Total	76 (28.4%)	55 (20.5%)	52 (19.4%)	85 (31.7%)	268 (100%)	-

*Chi-square test. P<0.05 was significant

Table 2. Association between genders and shapes of condyle and articular fossa

	Sagittal condyle shape				Coronal condyle shape				Sagittal fossa shape			
	Round	Oval	Flattened	Triangular	Round	Oval	Flattened	Triangular	Oval	Triangular	Angled	Trapezoid
Women	20	97	58	17	49	38	66	39	99	9	46	38
Men	11	43	18	4	27	17	19	13	29	13	22	12
Total	31	140	76	21	76	55	85	52	128	22	68	50
p	0.412				0.273				0.004*			

*Chi-square test. P<0.05 was significant

Clinical and radiological examinations are important in evaluating patients with TMD. Various radiologic methods have been used in previous studies to examine the morphologic changes of articular fossa and condyle (2,18,20,21). We examined TMJ bone surfaces with CBCT because of its superiorities in bone tissue imaging. Through the three dimensional imaging methods, CBCT has many advantages such as lower radiation dose, shorter exposure time and accessibility (22,23). So, CBCT can be used when the clinician suspects any changes in bone surfaces of TMJ which is limited in two-dimensional imaging.

Previous studies showed a higher prevalence of convex, rounded and angled condyles in patients with anterior disc displacement (17,24). In the research of Katsavrias (14), distribution of condyle shapes in coronal CBCT sections was oval in 60.4%, followed by round in 29.2%, flattened in 5.25%, triangular 5.2% of the patients with Class II Division 2 malocclusions in non-TMD population. In the same study, percentages for the fossa shapes were oval in 58.3%, triangular in 18.8%, trapezoidal in 15.6% and round in 7.3%. Cağlayan et al. (16) determined that there were differences in the mandibular condyle and fossa shapes among with and without TMJ disorder in CBCT sections. They reported the distribution of coronal condyle shapes in the TMJ disorder group were round in 45.2%, flattened in 26.0%, triangular in 5.8% and oval in 23.1% and the most common shape of condyle was oval in without TMJ disorder subjects. They also found that most common shape of articular fossa was round in both groups. In the study conducted by Yasa and Akgül (15), an oval-shaped condyle and fossa were the most common variant in both the asymptomatic group and the TMD group. Regarding the articular fossa morphology in the sagittal section, our findings were in agreement with Katsavrias (14) and Yasa and Akgül (15), but in the coronal sections, distribution of condyle morphologies were different. Our findings were compatible with Santos et al. (17) who observed a higher prevalence of flattened condyles in patient with TMD. Distribution the shapes of articular surfaces may change due to number differences in the selected patient population, genetic, age group or racial differences.

Matsumoto et al. (18) suggested that the disharmony between the condyle and fossa shape may cause anterior disc displacement. Katsavrias (14) matched articular fossa and condylar shapes in sagittal sections and revealed that 52.1% joint had identical shapes. In the present study, we did not compare fossa and condyle shapes with each other, but the most common fossa shape was oval in all condyle shapes. In the present study, when the shape of condyle in the sagittal and coronal section was matched, it was observed that the same appearance was observed in only 31% of condyles. In patients with TMD, different shapes of condyle and articular fossa can be observed in different sections due to different of biological and functional aspects.

In the study conducted by Tassoker et al. (19), it was found that there was no relationship between coronal condyle shape and gender. In the same study, it was indicated that the frequency of the flattened and angled coronal condyle shape increased with increasing age. Similarly, Yalcin and Ararat (2) found a correlation between age and coronal condyle shapes. However, in the present study no relationship was found between the shapes of articular surfaces, genders and age groups.

Conclusion

CBCT provides a three-dimensional image of the TMJ bone tissues without distortion and magnification. Because of increased accuracy in the diagnosis of cortical bone alterations, CBCT can be used for a dignostic tool when three dimensional examinations of TMJ bone surfaces needed. Our results will be suggestive when evaluating CBCT images of patients with TMD. Limitations of the present study were the absence of the non-TMD group and the non-known of clinical symptoms because this was a retrospective study. Further studies are needed to include larger TMD and non-TMD patient groups. This methodology is very simple, and more sophisticated methods such as geometric morphometric analysis should be used for shape studies.

Ethics

Ethics Committee Approval: This study was approved by the Aydın Adnan Menderes University Faculty of Medicine Non-Invasive Clinical Research Ethics Committee on Human Research (protocol no: 2020/31, date: 20.02.2020).

Informed Consent: Retrospective study.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Concept: R.S.A., Design: R.S.A., Supervision: E.K., Data Collection or Processing: R.S.A., Analysis or Interpretation: R.S.A., Literature Search: R.S.A., Writing: R.S.A., E.K., Critical Review: E.K.

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