






A retrospective evaluation of condylar morphology using panoramic radiography in a sample of Turkish population

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Background: The temporomandibular joint is one of the most complex anatomic structures. It takes a great role in masticatory system and helps to make possible some functions such as speaking, chewing and swallowing. Clinicians should have sufficient anatomical knowledge to assess relationships of the hard and soft tissues, including the mandibular condyle, glenoid fossa, articular eminence of the temporal bone, the articular disc and its attachments. The aim of this study was to evaluate the frequency of different types of mandibular condyles and its distribution according to the age and gender. It was also evaluated whether the condyle types were bilaterally symmetrical or not.

Materials and methods: A total of 1315 digital panoramic images which obtained from the patients suffering from the dental problems were assessed. Demographic data, condylar morphology were noted. All obtained data were analysed by using descriptive statistics. Morphology of mandibular condyles were classified into four shapes as identified in other studies, namely: type I — oval shape, type II — diamond shape, type III — bird beak shape, type IV — crooked finger shape. Two independent examiners, who have 19 and 7 years of experience in oral and dentomaxillofacial radiology, made a consensus and evaluated all images.

Results: A total of 1315 digital panoramic images were assessed. Seven hundred sixty-seven [58.3%] the patients were female and 548 [41.6%] were male. The age range of patients was from 18 to 84 years. Right-left condyle types were found to be symmetrical in the range of 67% of the subpopulation examined in the study. For the consensus, ‘oval’ condyle was common on both the right and left, while ‘crooked finger’ condyle was the rarest.

Conclusions: The temporomandibular joint is the most important structure for all jaw functions such as speech, swallowing. In order for all these functions to continue in a healthy way, the anatomical structure should be known very well down to the finest detail. Identification of anatomical structures and their variations can play an important role in implant dentistry. Clinicians commonly prefer conventional radiologic methods to evaluate dentomaxillofacial region. Although the most of the variations are asymptomatic and require no treatment,

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correct identification of these findings will reduce unnecessary further diagnostic assessments and will provide more appropriate treatment plans. (Folia Morphol 2024; 83, 1: 192–199)

Keywords: mandibular condyle, anatomy, radiographic interpretation

INTRODUCTION

The temporomandibular joint (TMJ) is one of the most complex anatomic structures. It takes a great role in masticatory system and helps to make possible some functions such as speaking, chewing and swallowing [29]. Although TMJ has some common features with other joints, it has some differences such as anatomic complexity and close anatomical relationships make it specific among others in the body. TMJ has bony articular surfaces, articular capsule, synovial membrane, ligaments and also an articular disc [25]. Clinicians should have sufficient anatomical knowledge to assess relationships of the hard and soft tissues, including the mandibular condyle, glenoid fossa, articular eminence of the temporal bone, the articular disc and its attachments [11, 18, 20].

Improving the knowledge of dentomaxillofacial anatomy and the features of imaging modalities will lead practitioners to avoid misinterpretations and misdiagnosis. In this context, radiographic examination is necessary to evaluate TMJ structures, abnormalities, growth and bony changes. Choosing the most appropriate imaging technique is precious. Over the years, radiologists have used different oblique projections to overcome the limitations of standard conventional radiographic techniques. Recently, there are several imaging modalities available including conventional radiographic techniques, computerized tomography (CT) scanning, cone-beam CT (CBCT), arthrography, magnetic resonance imaging (MRI), computerized axiography, and ultrasonography [20].

Considering the advantages of the panoramic imaging technique, it is often used for dental reasons in the evaluation of the dentomaxillofacial area. Although panoramic imaging is one of the most common imaging techniques in dental practice, there are some limitations. These limitations including; magnifications, distortions and superimpositions make difficult to interpret the anatomical structures such as TMJ [21]. Despite these limitations some anatomical structures can be evaluated. One of these is condyle shape. A number of studies which were made in different populations by using panoramic imaging

technique are available in literature about the shape of the mandibular condyle. Some differences between several populations were found in prevalence [2, 5, 10, 26, 27, 31].

Condyle is a special part of TMJ, because it stimulates the growth of the mandible. Shape of mandibular condyle can differ among some individuals. Simple developmental variability, remodelling to accommodate developmental variations, malocclusion, trauma and other developmental abnormalities can cause morphological changes on the mandibular condyle [3, 8]. Additionally, the form and function can be considered closely linked. Due to this situation, morphology of TMJ may be related to functional forces [12]. Full understanding of the anatomy and the morphology of the TMJ is crucial to detect the normal and the abnormal condition [8]. Normal condylar head is assumed to have convex structure and to be of the same shape bilaterally in the same person [23]. Morphological changes of mandibular condyle are most commonly observed in elderly people due to the degeneration of TMJ [17]. Based on all these, the detection of changes in the condyle is important for the diagnosis of TMJ diseases and reduces misinterpretation [3].

The aim of this study was to examine the morphologies of the mandibular condyle and evaluate the frequency of different types of mandibular condyles and their distribution according to age and gender in a Turkish subpopulation. It is also revealed the frequency of the difference of bilateral occurrence if available.

Therefore the current study's hypothesis was that the right and left mandibular condyles in a person mostly would be in different types and age and gender does not affect condyle types.

MATERIALS AND METHODS

Study design

This study was authorized by the Local Research Ethics Committee (Protocol: 2021/278). The retrospective cross-sectional study was performed on digital panoramic images of 10287 patients who were

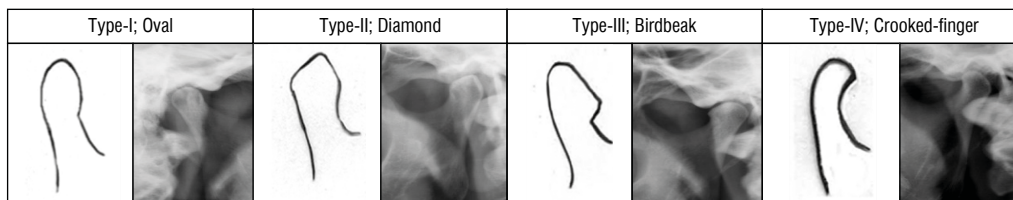


Figure 1. Four types of condyle shapes.

Table 1. Comparing the symmetry status of right and left condyles between both genders

	Symmetrical condyle types	Asymmetrical condyle types	Total	Does symmetry differ subject to gender? (no)
Female	526 (40%)	241 (18%)	767 (58%)	P = 0.789
Male	537 (28%)	176 (14%)	548 (42%)	

referred to the Department of Dentomaxillofacial Radiology at Gulhane Dentistry Faculty, University of Health Sciences, Ankara, Turkey, between 2021 and 2022. The panoramic images were performed using a Planmeca Promax digital panoramic system at 66 kVp, 8 mA and 15.8 s exposure settings (Planmeca, Helsinki, Finland).

All images were made with the same radiographic equipment (Planmeca, Helsinki, Finland) with the maximum KVP of 66, mA = 8. All radiography were carried out by the same technician. All of the images were evaluated on the same monitor (HP Compaq LE1711 LCD Monitor, Palo Alto, CA, USA).

The panoramic images which were obtained for dentomaxillofacial problems such as impacted teeth, pathological lesions, orthognathic problems, dental implant procedures, endodontic lesions, etc were evaluated in this study. Inclusion criterion consisted of individuals over 18 years of age undergoing a panoramic radiographic examination with adequate diagnostic quality. The images of patients who were under the age of 18 or had a history of surgery, trauma, or developmental deficiencies in the dentomaxillofacial region and that were with low quality were excluded from the study. The images were evaluated to have adequate diagnostic quality, with all examined anatomical structures being visualized correctly, without any artifacts such as blurring, streaking, or ghosting, and with suitable contrast and density. A total of 1315 images were evaluated, 767 (58.3%) of the patients were female and 548 (41.6%) were male.

Image evaluation

The images were evaluated by consensus by two radiologists who have experience over 10 years,

with ClearCanvas DICOM Viewer, version 1.0.0.0v4 (ClearCanvas Inc., Toronto, Ontario, Canada) on a standard computer with calibrated monitor (HP Compaq LE1711 LCD Monitor, Palo Alto, CA, USA). The contrast and brightness level of the images and zooming were left to the examiner’s choices.

Morphology of mandibular condyles were classified into four shapes as identified in other studies [2, 26]: type I — oval shape, type II — diamond shape, type III — bird beak shape, type IV — crooked finger shape shown in Figure 1.

Statistical analysis

Obtained data were analysed by descriptive statistics. The frequency of the condylar morphology types were calculated. All categorical variables were shown as number (%). The Pearson’s chi-square test was used to compare categorical variables. All statistical analyses were carried out using IBM SPSS Statistics 21.0 (IBM Corp., Armonk, NY, USA) and MS Excel 2007.

RESULTS

Total of 2630 condyles from 1315 panoramic radiographs were evaluated; 767 of panoramic radiographs were female’s and 548 of them were male’s. In the study, there were 784 patients over the age of 40 and 531 patients under the age of 40. The average age of the included individuals was 43.93 years, with an age range between 15 and 89 years.

According to the consensus, the condyles were highly symmetrical (Table 1). Oval condyles were detected at a rate of 66% of the patients whose condyle type was symmetrical in the panoramic images (Fig. 2). However, crooked finger condyles were in symmetry

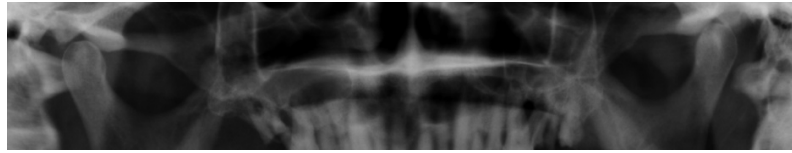


Figure 2. A panoramic radiograph which shows symmetry on right and left condyles as oval (type 1)-oval (type 1).



Figure 3. The most common asymmetrical combination seen in the study was bird-beak (type 3)-oval (type 1) for the right and left condyle.

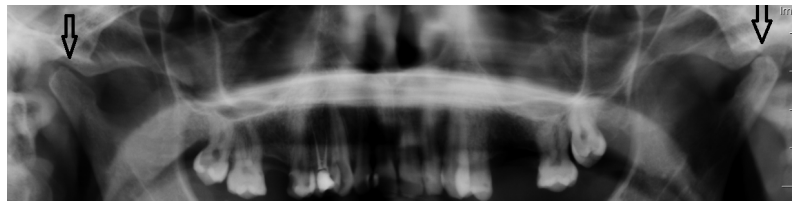


Figure 4. The rarest asymmetrical combination seen in the study was bird-beak (type 3)-crooked finger (type 4) for the right and left condyle.

Table 2. Comparing the symmetry status of right and left condyles between age groups

	Symmetrical condyle types	Asymmetrical condyle types	Total	Does symmetry differ subject to age? (no)
Under the age of 40	361 (28%)	170 (13%)	531 (41%)	P = 0.677
Over the age of 40	372 (40%)	247 (19%)	784 (59%)	

with the lowest level at a rate of approximately 10%. Most of the patients who exhibited asymmetry had a right condyle type 3 (diamond)-left condyle type 1 (oval) form (Fig. 3). The rarest combination of asymmetry was found to be either a right condyle type 3 (diamond)-left condyle type 4 (crooked finger), or a right condylar type 4 (crooked finger)-left condylar type 3 (diamond) (Fig. 4).

At first, symmetrical or asymmetrical status of condyles were evaluated. In the study conducted on panoramic images, the probabilistic value was 0.789 (Table 1). Therefore Pearson chi-square test results concluded that symmetry/asymmetry appearance was independent of gender for the consensus in 5% confidence interval. Similar to gender results, age group indicator had no impact on symmetry/asymmetry appearance with p-value of consensus 0.677 (Table 2). Although there was no significant relationship, the

study divided the data into two age groups: under and over 40 years of age. In study groups symmetry was observed in 68% of individuals over the age of 40 and 69% of individuals under the age of 40.

Type of condyles were studied with age groups and gender. The distribution of condyles with respect to age groups was interpreted. For the consensus, oval type of condyle was seen as the most common type and the crooked finger as the rarest one in both right and left condyles.

According to the results, a strongly significant relationship was found between the type of condyles and the age group ($p = 0.05$; Table 3). Moreover, a strongly significant relationship was found between gender and condyle types ($p = 0.00$; Table 4). For the consensus at right condyles, 54% of women had oval condyle, while the lowest proportion (13%) of women had crooked finger condyles, whereas in male

Table 3. Distribution of condyle types according to age

	Condyle type 1	Condyle type 2	Condyle type 3	Condyle type 4	Total	Does condyle type differ subject to age group? (no)
Under age of 40	609 (23.2%)	164 (6.2%)	155 (5.9%)	134 (5.1%)	1062 (40.4%)	P = 0.05
Over age of 40	915 (34.7%)	260 (9.9%)	256 (9.8%)	137 (5.2%)	1568 (59.6%)	
Total	1524 (57.9%)	424 (16.1%)	411 (15.6%)	271 (10.3%)	2630 (100%)	

Table 4. Distribution of condyle types according to gender

	Condyle type 1	Condyle type 2	Condyle type 3	Condyle type 4	Total	Does condyle type differ subject to gender? (no)
Female	848 (32.2%)	288 (10.9%)	202 (7.7%)	196 (7.5%)	1534 (58.3%)	P = 0.00
Male	676 (25.7%)	136 (5.2%)	209 (8%)	75 (2.8%)	1096 (41.7%)	
Total	1524 (57.9%)	424 (16.1%)	411 (15.6%)	271 (10.3%)	2630 (100%)	

patients, 62% of the patients had oval condyle and 7% had crooked finger condyle. In both genders, oval condyle was observed with a significant frequency on the right and crooked finger condyle was the rarest. Left condyles were similar to the right side; oval condyles were seen in 57% of women and 61% of men and crooked finger condyles were observed most rarely in both genders.

According to consensus, oval condyle was observed at the highest rate among all types when both sides were evaluated separately within themselves: 57% oval on right side, 59% oval on left side and when both sides were evaluated together, oval type was found at a rate of 58%. Type of crooked finger was found at a rate of ten percentage on both sides as the rarest.

DISCUSSION

The study was performed on percentages and quantitative data of mandibular condyle shapes according to gender or age like the similar ones. This is useful because it provides to compare different populations or subgroups within a population.

The morphological view of the mandibular condyle may vary significantly between different age groups and different individuals [9, 26, 30]. Condyle findings in panoramic radiographs need to be interpreted with extreme caution. It is necessary to know the limitations of panoramic radiography when describing condyle morphology [19].

Research on condyle shape goes back to the 1960's. Yale et al. [31–33] performed the first research on this subject within the scope of 4 basic shapes of condyle head. In the present study the condyle clas-

sification is based on the studies of Anussizuman et al. [2] and Shaikh et al. [26].

This research aimed to reveal the rate of condyle types in a Turkish subpopulation. Condyle types and their rate were assessed in relation to age and gender. The study findings about the most common condyle type were oval type (in the range of 57%) on both the right and the left side. Besides, condyle types differed significantly according to gender. Proportionally, the oval type was detected as more intense in males (61%). The most common combination of symmetry was seen as oval-oval.

The null hypothesis that the right and left mandibular condyles in a person mostly would be asymmetrical was rejected. The rate of asymmetry was found as 32%. This outcome may be due to the group of patients studied or the number of patients who didn't use the right and left sides of the jaw equally was less than expected.

Honda et al. [9] performed a study and reported that the panoramic radiography technique is beneficial on assessment of TMJ pathologies. It's an evidence that about 20 years ago the panoramic radiograph's competence about TMJ pathologies was proved.

In a similar study it was conducted in a different population, type of oval was the most common condyle type, while crooked finger was the least common like the current study. This prevalence was seen in all age groups and in both genders. In the same study it was found 74.2% of condyles as symmetrical with oval-oval type and it was the most commonly occurring among the other combinations. All the results of our study were consistent with the results of the study of Al-Saedi et al. [1].

Similar to present study, another one was carried out by Sonal et al. [28]; the highest proportion in a population at 60% was the oval type condyle and crooked finger type was the least common at 2%. In a study conducted in Bangladesh population the 'oval' was the most common type with 68%, and the 'crooked finger' was the rarest type. The most common combination both in male and female was 'oval-oval', the less common one was 'crooked finger-crooked finger' [2]. Consistent with literature, Shaikh et al. [26] found that oval type condyle was the most common. In the current study, the oval condyle type was the most common and the crooked finger type was the rarest. It was seen that despite different populations and countries, it turns out that usually the common condyle type is the oval type. Shaikh et al. [26], Choudhary et al. [6] and Ribeiro et al. [22], in their studies in different country populations, each showed that round-round combination was the most common in both genders. They used a different classification as 'flat', 'pointed', 'angled' and 'round' condyle types. 'Round' type express the same type as the oval type in the classification used in the present study.

In Ashwinirani's study [4], the most common condyle type was 'round' in female, but 'angled' in male, different results were observed in male and female. Ashwinirani [4] used a different classification. In another study round type of condyle was again found to be the most common [24]. Similarly Maqbool et al. [13], Al Saedi et al. [1] and Gindha et al. [7] revealed highly significant difference in condylar type between right and left sides in females and males.

Similar to this one, a significant relation was found between gender and condyle types in the current study. Thus the second hypothesis that there would be no correlation between condyle types and age and gender was also rejected. According to the consensus, for both sides (right and left) condyle type of oval was the most common in both genders. The rarest type was the crooked finger in both genders and sides.

Al Saedi et al. [1], Nagaraj et al. [15], and Ashwinirani et al. [1] found no significant difference between age groups and condyle types. Contrary to these studies, in the present study it was observed that there was a significant relationship between age groups and condyle types. The study was performed by Nalla et al. [16] revealed that toughness of bones decreases by approximately 40% from 40 to 100 years. Another study reported that morphological change of condyle is commonly seen

in patients over the age of 40 (90%) compared to under the age of 40 (64%) [14]. Based on present results, in this study, the patients were classified into two age groups: over the age of 40 and under the age of 40. According to the consensus, the most common oval condyle and the rarest crooked finger condyle were found both on the right and the left in examined patients. Similarly, Shaikh et al. [26] found a significant relation between condyle morphology and age; they revealed that diamond shape was more frequent in the 56 and older age group.

Al Saedi et al. [1] reported 64.8% of radiographs had bilateral occurrence of same type and most common combination was oval-oval (46%). Similar to Al-Saedi et al. [1], in another study, approximately two-thirds of the panoramic radiographs had the same type of condyles bilaterally [19]. In the current study, in line with the results of previous studies, most of the patients had a symmetrical condylar shape with most common oval-oval combination.

However in Oliveira-Santos's et al. [19] study, a more equal distribution between types is observed in older individuals, while a clear predominance of the 'round' type is observed among younger individuals. In the present study, condyle type of oval was seen distinctly more often in both age groups and the other types were seen approximately at the same rates in both age groups.

During the study, no evaluation was made according to the dentition and edentulous status. The fact that the edentulous state was not included in the study evaluation can be seen as a limitation of the study.

CONCLUSIONS

This study has demonstrated that evaluation of mandibular condyle shapes can be achieved through panoramic radiography.

According to the findings of this research, it has been concluded that there was no significant difference between bilateral occurrence of the same condyle shape depending on gender and age. However, it has also been found that age and gender do affect the types of condyles.

The oval shape of the condyle was most common for both genders and both age groups. The most common combination of symmetry was seen as oval-oval.

In future studies regarding this topic, clinical and radiological findings should be combined. By increas-

ing the study sample and including clinical parameters such as dentition or edentulism status of patients, how long this condition has been going on in the study, more reliable information about populations will be provided.

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Conflict of interest: None declared

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