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Efficacy of Panoramic Radiography in Determining Bony Changes in Temporomandibular Joint

Panoramik Radyografinin Temporomandibular Eklem Kemik Değişikliklerini Belirlemedeki Etkinliğinin Değerlendirilmesi

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This study was presented as a poster at 16th European Congress of Dentomaxillofacial Radiology, 13-16 June 2018, Switzerland.

ABSTRACT Objective: To investigate the utility of panoramic radiography in determining bony changes in temporomandibular joint (TMJ) based on cone-beam computed tomography (CBCT) images. **Material and Methods:** Two hundred eight TMJs on panoramic radiography and CBCT images of 104 (55 male, 49 female) patients were examined. Erosion, flattening, subcortical sclerosis or cyst, osteophyte, loose joint bodies, generalized sclerosis and deviation in form on the mandibular condyle, flattening, subcortical sclerosis and erosion of the articular eminence and articular fossa were evaluated both on CBCT and panoramic images. Data were scored as follows: false positive, false negative, true positive and true negative, and statistically analyzed with SPSS software using chi-square test (p<0.05), Cohen's kappa, receiving operating characteristic curve analysis. **Results**: Flattening (51.4% on CBCT, 24% on panoramic) and erosion (50% on CBCT, 15.9% on panoramic) was most commonly detected on the condylar head (p<0.05). In the articular eminence, flattening in 2.4% and erosion in 12.5% and the articular fossa flattening in 1% and erosion in 20.2% were detected on CBCT. Flattening and erosion of the articular eminence and articular fossa could not be determined by panoramic radiography. Bony change that the most (38.5%) scored as the false negative was erosion. Accuracy values of panoramic radiography for the detection of any osseous change was poor compared with CBCT images (≤50%). **Conclusion:** Panoramic radiography was inadequate for detecting bony changes in TMJ especially in articular eminence and articular fossa. Therefore, radiological examination should be supported with more reliable imaging modalities like CBCT to examine hard tissues of TMJ.

Keywords: Cone-beam computed tomography; osteoarthritis; radiography; panoramic; temporomandibular joint disorders

ÖZET Amaç: Bu çalışmanın amacı, konik ışınlı bilgisayarlı tomografi (KIBT) görüntüleri baz alınarak, panoramik radyografinin temporomandibular eklemde (TME) görülen kemik değişikliklerini saptamadaki etkinliğinin değerlendirilmesidir. **Gereç ve Yöntemler:** Panoramik radyografi ve KIBT görüntüleri üzerinde 104 hastaya (55 erkek, 49 kadın) ait 208 TME incelendi. Mandibular kondilde erozyon, düzleşme, subkortikal skleroz veya kist, osteofit, serbest cisimler (loose bodies), generalize skleroz ve kondil başında deviasyon ile artiküler eminens ve artiküler fossada düzleşme, subkortikal skleroz ve erozyon varlığı değerlendirildi. Veriler yanlış pozitif, yanlış negatif, doğru pozitif ve doğru negatif olarak skorlandı ve ki-kare testi (p<0,05), Cohen kappa ve alıcı işlem karakteristik analizi kullanılarak SPSS yazılımı ile istatistiksel olarak analiz edildi. **Bulgular:** Mandibular kondilde en sık düzleşme (KIBT'de %51,4; panoramikte %24) ve erozyon (KIBT'de %50; panoramikte %15,9) saptandı (p<0,05). KIBT görüntülerinde artiküler eminenste %2,4 oranında düzleşme ve %12,5 oranında erozyon, artiküler fossada %1 oranında düzleşme ve %20,2 oranında erozyon tespit edildi. Panoramik radyografi görüntülerinde artiküler eminenste ve artiküler fossada düzleşme ve erozyon saptanmadı. Tüm parametreler için doğru negatif skorlama oranı en yüksekti. En çok (%38,5) yanlış negatif olarak skorlanan kemik değişikliği erozyondu. Kemik değişikliklerinin saptanmasında panoramik radyografinin doğruluk değeri, KIBT'ye oranla daha azdı (≤%50). **Sonuç:** Panoramik radyografinin, TME'de özellikle artiküler eminens ve fossada görülen kemik değişikliklerini saptamada yetersiz olduğu saptandı. Bu nedenle radyolojik inceleme, TME'nin sert dokularını incelemek için KIBT gibi daha güvenilir görüntüleme yöntemleriyle desteklenmelidir.

Anahtar Kelimeler: Konik ışınlı bilgisayarlı tomografi; osteoartrit; radyografi; panoramik; temporomandibular eklem bozuklukları

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Temporomandibular disorders (TMDs) are considered as a subdivision of musculoskeletal pathologies and affecting the temporomandibular joint (TMJ) and masticatory system. TMDs usually cause degenerative bone changes in TMJ such as erosion, flattening, subchondral bone sclerosis and pseudocysts, osteophytes. These findings are considered to be radiographic signs of osteoarthritis. Osteoarthritis can not be diagnosed until it becomes symptomatic, at this point structural alterations have already advanced. Previous studies reported that several patients with TMDs might have anatomical changes in bony and/or soft tissues of TMJ.[1-3] Alexiou et al. examined patients with degenerative joint disease and they found that flattening and resorption were observed in 56% and 43% of the cases respectively, whereas sclerosis was observed in 25% of the joints.[4] Al-Ekrish et al. detected that the percentage of joints with at least one type of osteoarthritic change (erosion, osteophyte, generalized sclerosis, etc.) was 78.6% in the patients with TMD.[5] The first three bony changes were erosion (94.0%), flattening (92.3%), and osteophytes (79.5%) in patients with TMJ osteoarthritis in another study.[6] Determination of these bony changes of TMJ is crucial for correctly diagnosing the dysfunctions associated with the TMD and adequate treatment planning.

A radiographic examination is a significant part of the clinical assessment routine in patients with TMD and it is used to determine degenerative bone changes in the joint structure.[7] TMJ anatomy can be evaluated by various imaging techniques including panoramic radiography (PR), transcranial, transfarengeal and transorbital projections, computed tomography (CT), cone-beam CT (CBCT), magnetic resonance imaging (MRI), ultrasonography, fluoroscopy, arthrotomography and scintigraphy.[8]

The PR is a useful tool for providing a general impression of TMJ and surrounding structures in a single projection and it is a simple, low dose, and low-cost method to evaluate the bony structures of the TMJ.[7,9] While some researchers reported that PR was an unreliable method to evaulate structures of TMJ accurately, Magnusson and Karlsson concluded that PR had a diagnostic value in patients with suspected TMD.[10,11]

CBCT, which provides three-dimensional imaging without superimpositions, allows for a more detailed analysis of changes in TMJ structures with minimal distortion and magnification.[3] CBCT is a reliable imaging method to assess the bony changes of the TMJ and provides a comprehensive radiographic inspection of the bony components of the TMJ.

The present study was conducted to determine the extent of agreement between data derived from PR and CBCT scans of the TMJ in determining degenerative bone changes in TMJ structures.

MATERIAL AND METHODS

This retrospective study was approved by the Clinical Research Ethics Committee of the University Hospital (Ethics committee approval number: 226). A total of 104 (55 male, 49 female) patients 18 years of age and above who had both PR and CBCT images and bony changes of the articular surfaces were included in this study and all patients signed approved consent forms. Two dentomaxillofacial radiologists (MB is five years' experienced, SSY is three years' experienced) assessed 208 TMJs of the patients whose images were taken due to various dental reasons (e.g. impacted teeth, cyst and tumor etc.). The radiologists independently interpreted the images on computer monitors housed in separate rooms. Before the evaluation, the two radiologists were calibrated by evaluating the lesions in consensus on 30 patients' panoramic and CBCT images. Observers evaluated the images of 30 patients again after a month.

All PR images had been acquired using same digital panoramic machine: Promax (Planmeca, Helsinki, Finland) device operating with 66 kV, 8 mA, exposure time 16s. All CBCT images had been acquired through a tomography machine: ProMax 3D Mid (Planmeca, Helsinki, Finland) device with a field of view of 50x43 cm, 0.40 mm voxel size, and approximately 13 seconds of acquisition time at 90 kV and 10 mA. Planmeca Romexis software was used for recording the images both PR and CBCT. The exclusion criteria were as follows: inflammatory joint diseases, congenital deformities or syndromes, facial growth disorders, histories of trauma, maxillofacial bone fractures or surgeries in the TMJ area and TMJ hypoplasia, hyperplasia or tumours.

Age, gender, medical history were recorded for each of the patients. Bony changes such as surface erosion (lack of regularity of articular cortex) (Figure 1), flattening of the articular surface (loss of the rounded contour of the articular surface), subcortical sclerosis (any elevated thickness of the cortical plate in the load bearing areas relative to the adjacent non-load bearing areas) or cyst (cavity below the articular surface that deviates from normal marrow pattern) (Figure 2), osteophytes (marginal hypertrophy in bones with sclerotic borders), generalized sclerosis (no definite trabecular orientation between the trabecular bone and the cortical layer that extends throughout the mandibular condylar head), loose joint bodies (a well-defined calcified formation that is not continuous with the bony structures of the TMJ or the articular disc) (Figure 2), and deviation in form on mandibular condyle (a separation from normal shape of condyle) (Figure 3) were evaluated on the mandibular condyle.[2] Furthermore, surface flattening, subcortical sclerosis, surface erosion of the articular eminence and articular fossa were evaluated. In order to avoid misinterpretation, bony changes had to be found in at least two consecutive slices.

Data obtained from both CBCT and panoramic images were scored as follows:

False positive: Not present in CBCT but present in PR.

False negative: Present in CBCT but not in PR.

True positive: Present both in CBCT and in PR.

True negative: Not present both in CBCT and in PR.

STATISTICAL ANALYSIS

SPSS software (SPSS 17.0 for Windows; SPSS Inc., Chicago, IL, USA) was applied for statistical analyses, $p<0.05$ was considered statistically significant. Comparison between PR and CBCT was performed using the chi-square test (Fisher's exact test). The intraobserver reliability between the two sessions and interobserver reliability between the two observers were assessed with Cohen's kappa. According to

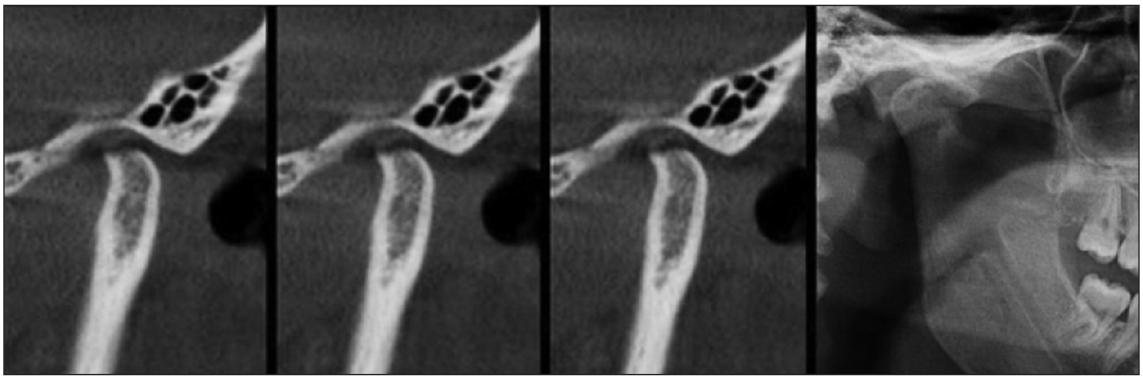

FIGURE 1: a-c) Condylar erosion on cross-sectional cone-beam computed tomography images in the right temporomandibular joint. **d)** Cropped panoramic image of right temporomandibular joint in the same patient.

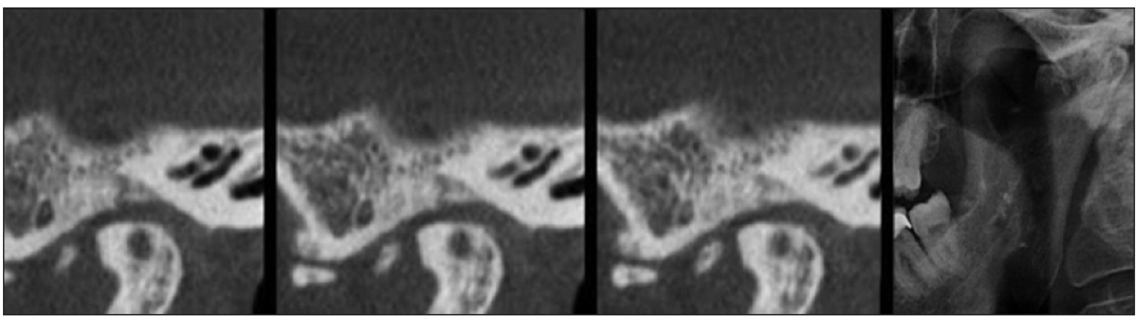

FIGURE 2: a-c) Condylar subcortical cyst and loose body on the cross-sectional cone-beam computed tomography images in the left temporomandibular joint. **d)** Cropped panoramic image of the left temporomandibular joint in the same patient (false negative image).

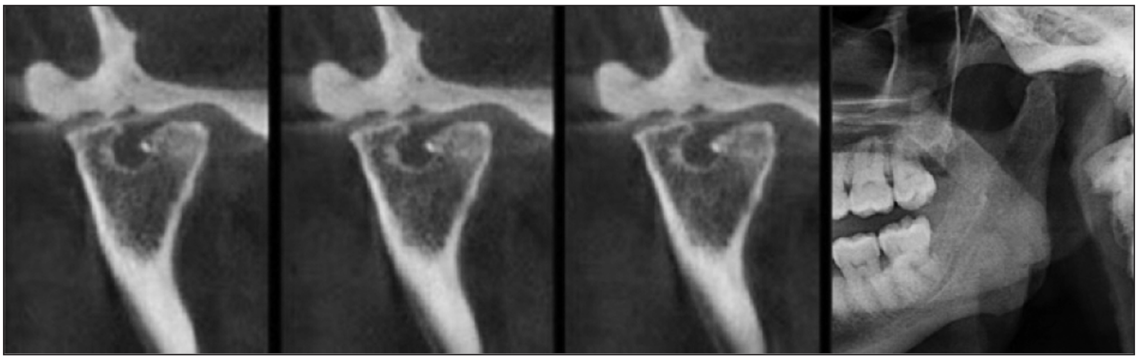

FIGURE 3: a-c) Deviation in form in the mandibular condyle on the cross-sectional cone-beam computed tomography images in the left temporomandibular joint. **d)** Cropped panoramic image of the left temporomandibular joint in the same patient (false negative image)

Maclure and Willett, a kappa value of 0-0.2 is interpreted as slight agreement, 0.2-0.4 as fair agreement, 0.4-0.6 as moderate agreement, 0.6-0.8 as substantial agreement, and 0.8-1.0 as almost perfect.[12]

Sensitivity, specificity and accuracy of PR findings to compare with diagnostic performance of CBCT were calculated by receiving operating characteristic (ROC) curve analysis.

RESULTS

Two hundred and eight TMJs in 104 patients (55 male, 49 female) were evaluated in this study. The mean age of study population was 43.5±16.32 (min: 18, max: 74). The most frequently determined condylar bony changes on both CBCT and PR were flattening [51.4% (n=107) on CBCT, 24% (n=50) on panoramic] and surface erosion [50% (n=104) on CBCT, 15.9% (n=33) on panoramic]. Condylar erosion (p=0.013 for CBCT, p=0.007 for PR) and flattening (p=0.554 for CBCT, p=0.467 for PR) were most commonly detected on the right side on both CBCT and PR. Flattening in 2.4% (n=5) and erosion in 12.5% (n=26) of the articular eminence were found on CBCT. There were flattening in 1% (n=2) and surface erosion in 20.2% (n=42) of articular fossa on CBCT. Flattening and surface erosion of the articular eminence and fossa could not be determined by PR (Table 1). Osteophyte (p=0.126), deviation in form (p=0.136) on mandibular condyle on CBCT images were determined more than men in females. Erosion on the articular eminence (p=0.201) and articular fossa (p=0.406) on CBCT were observed more in males than in females. Subcortical sclerosis (p=0.457) and cyst (p=0.493) were found equally in males and females on CBCT. The all of osseous changes evaluated in CBCT was observed more in the patients 41 years and over. Loose joint body (p=0.047) and deviation in form (p=0.046) on mandibular condyle was found statistically significant in individuals aged 41 and over (Table 2).

For diagnosis of bony changes on panoramic radiographs, the inter-examiner reliability of the radiologists was a moderate agreement ($0.41 \leq \kappa \leq 0.48$). The reliability of the radiologists was a substantial agreement ($0.62 \leq \kappa \leq 0.79$) when using CBCT images.

TABLE 1: Prevalence of osseous changes in TMJ on CBCT and panoramic images.

	Osseous changes	CBCT n (%)	Panoramic n (%)
Condylar head	Surface Erosion	104 (50)	33 (15.9)
	Articular Surface Flattening	107 (51.4)	50 (24)
	Subcortical Sclerosis	42 (20.2)	14 (6.7)
	Subcortical Cyst	28 (13.5)	8 (3.8)
	Osteophyte	42 (20.2)	7 (3.4)
	Loose Joint Body	6 (2.9)	3(1.4)
	Generalized Sclerosis	3 (1.4)	1 (0.5)
	Deviation in Form	10 (4.8)	2 (1)
Articular eminence	Articular Surface Flattening	5 (2.4)	-
	Subcortical Sclerosis	41 (19.7)	5(2.4)
	Surface Erosion	26 (12.5)	-
Articular fossa	Articular Surface Flattening	2 (1)	-
	Subcortical Sclerosis	19 (9.1)	1 (0.5)
	Surface Erosion	42 (20.2)	-

CBCT: Cone-beam computed tomography.

TABLE 2: Distribution of osseous changes in TMJ according to gender and age groups in CBCT.

		Gender			Age Groups		
		Male n (%)	Female n (%)	p value	18-40 years n (%)	41 years and over n (%)	p value
Condylar head	Surface Erosion	51 (24.5)	53 (22.6)	0.24	37 (17.8)	67 (32.2)	0.160
	Articular Surface Flattening	56 (26.9)	51 (24.5)	0.5	43 (20.7)	64 (30.8)	0.464
	Subcortical Sclerosis	21 (10.1)	21 (10.1)	0.45	15 (7.2)	27 (13)	0.357
	Subcortical Cyst	14 (6.7)	14 (6.7)	0.49	9 (4.3)	19 (9.1)	0.264
	Osteophyte	18 (8.7)	24 (11.5)	0.12	12 (5.8)	30 (14.4)	0.074
	Loose Joint Body	1 (0.5)	5 (2.4)	0.08	-	6 (2.9)	0.047*
	Generalized Sclerosis	1 (0.5)	2 (1)	0.47	1 (0.5)	2 (1)	0,657
	Deviation in Form	3 (1.4)	7 (3.4)	0.13	1 (0.5)	9 (4.3)	0,046*
Fossa/eminence	Articular Surface Flattening	3 (1.4)	2 (1)	0.53	1 (0.5)	4 (1.9)	0.345
	Subcortical Sclerosis	17 (8.2)	24 (11.5)	0.09	16 (7.7)	25 (12)	0.551
	Surface Erosion	16 (7.7)	10 (4.8)	0.2	9 (4.3)	17 (8.2)	0.378
Articular fossa	Articular Surface Flattening	-	2 (1)	0.23	2 (1)	-	0.154
	Subcortical Sclerosis	6 (2.9)	13 (6.3)	0.05	7 (3.4)	12 (5,8)	0.508
	Surface Erosion	23(11.1)	19(9.1)	0.4	16(7.7)	26(12,5)	0.495

*p<0.05.

In this study intra-examiner reliability ranged from slight-to-moderate agreement (0.12≤κ≤0.54) for two evaluators in panoramic images. This value was a κ value ranging from 0.65 to 0.79, which represents a substantial agreement in evaluation of CBCT images.

True negative score was the most determined in all of regions (Table 3). Osseous change that the most (38.5%, n=81) scored as the false negative was surface erosion on the condylar head. In terms of condylar erosion, there was a significant difference between sides. In all of our observed findings, accuracy values measured by the area under the ROC curve of PR for the detection of any osseous change in TMJ was poor compared with CBCT images (≤50%), sensitivity ranged from 0.62 % to 1 and specificity was quite low (≤0.1%) (Table 3).

DISCUSSION

A radiographic examination is a part of the clinical assessment routine for conditions of TMD which is a key role for decisive, differential, final diagnosis and treatment plan of several pathological conditions of the TMJ.[13,14] Radiographic imaging of TMJ is a rather difficult due to the complex anatomical structure of the bone, muscles and ligament structures in the TMJ region. Superimposition of the adjacent structures, different angulations of the condyle, limitation of mouth opening in some patients, and mandibular movements during the examination may prevent clear images of TMJ.[15] Numerous imaging modalities are used to evaluate the TMJ region, currently, PR, CT, CBCT, and MRI are the most commonly used radiographic techniques for TMJ imaging.

Nowadays, PR is often used for evaluating the TMJ readily. Although mandibular condyle, articular eminence, and articular fossa can visualize a PR image, mild osseous changes may be subtle or invisible in TMJ as a result of superimposition by the skull base, zygomatic arch, and structural distortion.[16,17] PR is used for the general evaluation of craniomandibular structures, but it is not a sensitive method for slight osseous changes.[18] PR is generally reported to be sufficient to detect major osseous changes such as erosions and displaced fractures in TMJ region.[19] Dahlström and Lindvall conclude that PR was useful in detecting bony changes in the condyle, but when the existence of these changes was suspected and panoramic radiograph of the patient was normal, it should to be supported by other radiographic techniques.[20]

CBCT is considered to be a dose-effective modality with high spatial resolution and it provides a three-dimensional image of the hard tissue and

TABLE 3: Distribution of data obtained from both CBCT and panoramic radiography according to true/false positive, true/false negative scores and accuracy, specificity, sensitivity values.

	Osseous changes	False positive n (%)	False negative n (%)	True positive n (%)	True negative n (%)	AC	SE	SP	p value
Condylar head	Surface Erosion	10 (4.8)	81 (38.9)	23 (11.1)	94 (45.2)	0.43	0.77	0,1	0.033*
	Articular Surface Flattening	10 (4.8)	67 (32.2)	40 (19.2)	91 (43.8)	0.36	0.62	0.09	0.001*
	Subcortical Sclerosis	8 (3.8)	36 (17.3)	6(2.9)	158 (76)	0.45	0.85	0.04	0.344
	Subcortical Cyst	-	20 (9.8)	8(3.8)	180 (86.5)	0.35	0.71	0	0.015*
	Osteophyte	-	36 (17.3)	7 (3.4)	165 (79.3)	0.43	0.85	0.01	0.171
	Loose Joint Body	-	3 (1,4)	3 (1.4)	202 (97.1)	0.25	0.50	0	0.037*
	Generalized Sclerosis	-	2 (1)	1 (0.5)	205 (98.6)	0.33	0.66	0	0.322
	Deviation in Form	1 (0.5)	9 (4.3)	1 (0.5)	197 (94.7)	0.45	0.90	0.01	0.613
Articular eminence	Articular Surface Flattening	-	5 (2.4)	-	203 (97.6)	0.50	1	0	1
	Subcortical Sclerosis	3 (1.4)	39 (18.8)	2 (1)	164 (78.8)	0.48	0.95	0.02	0.760
	Surface Erosion	-	26 (12.5)	-	182 (87.5)	0.50	1	0	1
Articular fossa	Articular Surface Flattening	-	2 (1)	-	206 (99)	0.50	1	0	1
	Subcortical Sclerosis	1 (0.5)	19 (9.1)	-	188 (90.4)	0.50	1	0.01	0.970
	Surface Erosion	-	41 (19.7)	-	167 (80.3)	0.50	1	0	1

*p<0.05. AC: Accuracy; SE: Sensitivity; SP: Specificity. False positive: There is not in CBCT but there is in panoramic radiography. False negative: There is in CBCT but there is not in panoramic radiography. True positive: There is both in CBCT and in panoramic radiography True negative: There is not both in CBCT and in panoramic radiography.

surrounding structures of TMJ with minimal distortion and it is considered to be a reliable radiographic technique for examining bone components of TMJ.[13,21,22] It is used in the determination of pathological bony changes such as osteophyte, erosion, fractures, ankylosis, developmental anomalies and evaluation of condyle position in open and closed mouth position.[23,24] The important advantage of CBCT is very low radiation dose compared to CT with low energy fixed anode tube as used in PR.[23] Katakami et al. reported that limited CBCT was superior to other imaging modalities such as helical CT and conventional CT in determining bone pathologies of TMJ region.[25] To determine the bone pathologies in the TMJ region, it has been reported that the dynamic analysis of CBCT images gives better diagnostic information than conventional images.[21,26]

In several studies osteoarthritic changes in TMJs are more common in women than in men.[4,27] It can be explained by the stimulation of a series of immunological responses in TMJ by the hormonal influence of oestrogen and prolactin, which can exacerbate degradation of cartilage and articular bone.[28,29] It may also be due to pain perception, differences of sex hormones, responses to stress and psychological factors.[30,31] However, in several studies any relationship have not been found between gender and degenerative changes in TMJ.[32,33] In addition, some studies reported a higher prevalence in men.[34,35] Our study showed that osteophyte, loose joint body, generalize sclerosis, deviation in form on mandibular condyle, flattening on articular fossa and subcortical sclerosis of articular eminence and articular fossa were determined more in women on the CBCT images ($p>0.05$). Results of the present study support that osteoarthritic changes in TMJ are more common in women.

The incidence of osteoarthritic changes in TMJ increases with age. Older age groups are expected to have more frequent severe bony changes in TMJ than younger age groups.[4,34,36,37] Especially in the fourth decade, osteoarthritic changes begin to increase, by 65 years the rates drastically increase and a majority will exhibit radiographic evidence of the disease.[38] Bäck et al. found that the prevalence of signs of osteoarthritis in the TMJ was 18% at ages around 40 and 47% at ages around 75 on panoramic radiographs.[39] Crusoé-Rebello et al. and Isberg et al. found that a greater number of individuals aged between 20 and 49 years showed bony changes of TMJ and they did not find an association between an increase in bony changes and increased age.[40,41] Different results may depend on the criteria in the sample selection, race, gender and imaging methods. In this study all of the bony changes evaluated in CBCT was observed more in the patients 41 years and over but there was no statistical difference between age and bony changes.

Dos Anjos Pontual et al. and Alexiou et al. reported that degenerative bone changes were more frequent in the condyle than in the articular eminence and articular fossa, which is in agreement with the results of the present study.[3,4] Gil et al. also found that bone changes were more common in the condyle and no bony changes were detected in the articular fossa.[42] The most common two bony changes were flattening (51.4% on CBCT, 24% on PR) and erosion (50% on CBCT, 15.9% on PR) in both PR and CBCT images in the present study. In certain studies with CBCT, erosion and flattening were found to be the most frequent radiographic findings of the condyle as in the present study.[4,6,17] However, there were studies found that sclerosis, erosion, surface irregularity and osteophyte were the most osseous changes in the condyle.[7,43] These controversial results may be related to the sample size and ethnic diversity, different imaging modalities and diagnostic criteria of bony changes.[42-44]

Honey et al. reported that the diagnostic accuracy of CBCT for detecting condylar cortical erosion was significantly greater than all other imaging modalities (PR, panoramic TMJ radiography, linear tomography) and PR was more accurate than panoramic TMJ radiography and linear tomography.[45] Im et al. who set CBCT as reference standart, found that panoramic TMJ radiography demonstrated limited diagnostic accuracy and acceptable reliability in detecting oseeosus changes of the TMJ, although it was better than PR.[17] CBCT was reference standart in the present study and PR demonstrated limited diagnostic accuracy.

Dahlström and Lindvall reported that the sensitivity and specificity values of PR for determining osseous changes of the condyle ranged from 0.29 to 0.60 and from 0.71 to 0.95, respectively.[20] Those values were 0.00-0.25 and 0.59-0.86, respectively, for determining changes of the articular eminence. Ladeira et al. evaluated the diagnostic validity of PR with CBCT used as a reference standard.[46] The sensitivity and specificity for PR to state flattening lesions were 0.33-0.35 and 0.77-0.80, respectively. Those values for determining osteophytes were 0.05-0.08 and 0.97-1.00, respectively. Sensitivity ranged from 0.62 % to 1 and specificity was quite low (≤0.1%) in this study.

CONCLUSION

Results of the present study revealed that PR is an inability when diagnosing degenerative bone changes in the TMJ, it causes to underestimate the bony changes of TMJ with higher prevalence especially in the articular eminence and articular fossa. Therefore, when it is suspected of degenerative bone changes in TMJ on PR images, radiological examination should be supported with more reliable imaging modalities like CBCT to examine hard tissues of TMJ. The disease might not be diagnosed by only using PR, and this may cause the progression of osteoarthritis.

Source of Finance

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

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