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EVALUATION OF THE RELATIONSHIP BETWEEN DEGENERATIVE BONE CHANGES IN TEMPOROMANDIBULAR JOINT AND KNEE OSTEOARTHRITIS

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ABSTRACT

Objective: *The aim of this study was to radiologically investigate whether the degenerative bone changes were seen in knee osteoarthritis (KOA) were related to degenerative bone changes seen in temporomandibular joint (TMJ).*

Material and Method: *In data of 28 patients, radiological changes in KOA patients were evaluated according to the Kellgren Lawrence staging. On the other hand, TMJs were examined for degenerative bone changes in the condyle and articular eminence structures of the joint by cone beam computed tomography (CBCT).*

Results: *A total of 28 female patients, 14 in the early stage KOA and 14 in the advanced stage KOA, were included in the study. When the groups were compared; all parameters of both TMJ condyles were observed at a higher frequency except for sclerosis in right TMJ in advanced stage KOA patients. There was no statistically significant difference although only pseudocysts and sclerosis were seen at a higher frequency and rate in articular eminence ($p > 0.05$). In addition, as a result of the evaluation of bilaterally all knee joints and TMJs together in the early and advanced knee osteoarthritis; the incidence of osteophytes in TMJ condyles was significantly higher in patients with advanced KOA ($p<0.05$).*

Conclusions: *Evaluation of TMJs in patients with KOA will be useful in early diagnosis and treatment, due to the possibility of a higher degenerative change in TMJ as a result of the increasing radiological severity of KOA.*

Keywords: *Cone beam computed tomography, knee osteoarthritis, temporomandibular joint.*

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TEMPOROMANDİBULAR EKLEMDEKİ DEJENERATİF KEMİK DEĞİŞİKLİKLERİ İLE DİZ OSTEOARTRITI ARASINDAKİ İLİŞKİNİN DEĞERLENDİRİLMESİ

ÖZET

Amaç: Bu çalışmanın amacı diz osteoartritinde (DOA) görülen dejeneratif kemik değişiklikleriyle temporomandibular eklemde (TME) görülen dejeneratif kemik değişikliklerin ilişkili olup olmadığını radyolojik olarak araştırmaktı.

Materyal ve Metod: 28 DOA hastasındaki radyolojik değişiklikler Kellgren Lawrence evrelemesine göre değerlendirildi. Öte yandan, TME'ler konik ışınlı bilgisayarlı tomografi (KIBT) ile kondil ve artiküler eminens yapılarındaki dejeneratif kemik değişiklikleri açısından incelendi.

Bulgular: Çalışmaya 14 erken evrede ve 14 ileri evrede olmak üzere toplam 28 kadın DOA hastası dahil edildi. Gruplar karşılaştırıldığında; ileri evre DOA hastalarında sağ TME'de skleroz artışı dışında her iki TME kondilinin tüm parametreleri daha yüksek bir frekansta gözlenmiştir. Artiküler eminenste sadece psödokistler ve skleroz daha yüksek sıklıkta ve oranda görülmesine rağmen istatistiksel olarak anlamlı bir fark yoktu (p>0,05). Ek olarak, erken ve ileri DOA hastalarında bilateral olarak tüm diz eklemleri ve TME'lerin birlikte değerlendirilmesi sonucunda; ileri DOA'lı hastalarda TME kondillerinde osteofit insidansı anlamlı derecede yüksekti (p<0,05).

Sonuç: DOA'nın artan radyolojik şiddeti ile TME'de daha yüksek bir dejeneratif değişiklik meydana gelmesi olasılığı nedeniyle DOA hastalarında TME'lerin değerlendirilmesi erken tanı ve tedavide yararlı olacaktır.

Anahtar kelimeler: Diz osteoartriti, konik ışınlı bilgisayarlı tomografi, temporomandibular eklem.

INTRODUCTION

Osteoarthritis (OA); is a chronic degenerative joint disease characterized by progressive cartilage destruction, osteophyte formation, increased subchondral sclerosis, synovial membrane and periarticular tissue degeneration caused by genetic, mechanical and biochemical factors.[1] Knee osteoarthritis (KOA) is the most common involvement symptomatically and is one of the leading causes of physical disability worldwide due to its high prevalence in the elderly population. Advanced age, female gender, obesity, genetic factors, muscle weakness, proprioceptive disorder, hypermobility, trauma, occupational and mechanical difficulties are among the risk factors. Joint pain, stiffness and limitation of motion are the most important symptoms of KOA.[2]

Temporomandibular joint dysfunction (TMD); characterized by a group of diseases affecting the masticatory muscles, temporomandibular joints (TMJ) and adjacent structures; and causes joint pain, muscle tenderness, limited mouth opening, clicking sound and crepitation. Degenerative changes may occur in TMJ due to stress and mechanical stress during parafunctional activities or by the effect of mastication forces. TMJ disorders are frequently associated with degenerative bone changes involving bone structures of TMJ.[3] Although TMD is common (25% of the population), its etiology is not well understood. Pain and dysfunction findings were found in 3% to 7% of the adult population.[4] Inflammatory or degenerative joint pathologies in TMD are more common after 50 years of age as in KOA. There are many risk factors in TMD that may be similar to KOA risk factors such as female gender, hypermobility, inflammation due to cytokines and genetic predisposition.[2-4] It has been reported that the incidence of TMD is high in OA patients, recently.[5] In a study; it was reported that the incidence of temporomandibular dysfunction is increased in generalized OA patients and that the possibility of degenerative changes such as decreased joint space and osteophytes in TMJs of OA patients may be higher.[6] In another study, they reported that TMJ functions could be impaired, especially in severe KOA patients, but they did not provide information about the frequency of radiological changes in the knee and TMJ joints and the relationship between them.[7] In our literature review, we did not find any radiological evaluation of TMJ dysfunction in KOA patients. Therefore, we think that our study is the first in the literature to investigate the possible radiological changes in both joints.

The aim of this study was to investigate whether bone changes in KOA are related to degenerative changes in TMJ.

MATERIAL AND METHOD

Patients

This retrospective study was carried out by Faculty of Medicine Department of Physical Medicine and Rehabilitation (FTR) and Faculty of Dentistry Dentomaxillofacial Radiology department. The study

protocol was approved by our ethics committee (29.11.2019/7;4). The study was conducted in accordance with the principles of the Declaration of Helsinki.

This study was performed on patients who were admitted to the outpatient clinic of physical medicine and rehabilitation with knee pain and diagnosed as knee osteoarthritis according to ACR diagnostic criteria after anamnesis, physical examination, clinical and radiographic examinations between September 2018 and September 2019. Records of 28 patients who were admitted to the outpatient clinic of Dentomaxillofacial Radiology due to pain and other complaints in the temporomandibular joint region and diagnosed as temporomandibular joint dysfunction were examined.[8]

Patients with a predisposing disease which may secondary causes of OA, chronic inflammatory rheumatologic disease, history of malignancy, trauma and occupational strain were not included in the study.

Study Design

Evaluation of Knee Osteoarthritis

Evaluation of radiological changes such as asymmetric narrowing of the joint space, osteophytes, subchondral sclerosis and pseudocyst in the KOA patients was done by using Kellgren Lawrence staging (Stage 0; normal, stage 1; suspicious, stage 2; mild, stage 3; moderate and stage 4; severe; OA). According to Kelgren Lawrance staging; stage 1 and 2 patients were evaluated as early stage and stage 3 and 4 patients were evaluated as advanced stage OA (Figure 1 and 2).[9]

Evaluation of Degenerative Bone Changes In Temporomandibular Joints

Degenerative bone changes in the condyle and articular eminens were examined in both TMJs which was examined by cone beam computed tomography (CBCT) (Quantitative Radiology, NNT Software version 2.21, Verona, Italy) in patients diagnosed as TMJ dysfunction. The bone changes evaluated are as follows (Figure 3)[10]:

- flattening (flat bone contour deviating from convex form),
- erosion (decrease in the density of cortical bone and loss of continuity),
- osteophyte (marginal bone protrusion on the condyle),

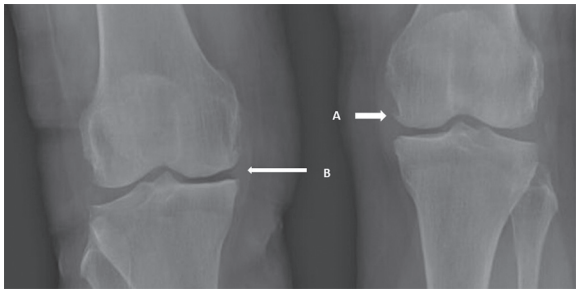

Figure 1. Degenerative knee osteoarthritis; early stage (grade 1-2). Small osteophytes (A), Suspicious contraction of joint space (B).

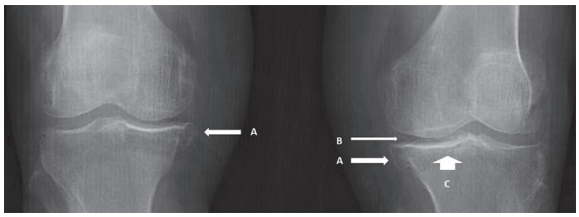

Figure 2. Degenerative knee osteoarthritis; advanced stage (grade 3-4). Moderate osteophytes (A), Contraction of joint space (B), subchondral sclerosis (C).

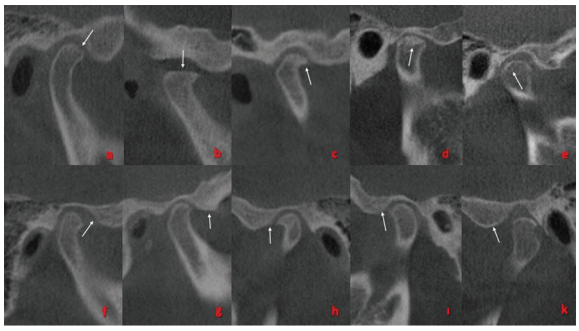

Figure 3. Degenerative bone changes in TMJ. Condylar erosion (a), flattening (b), osteophyte (c), increased sclerosis (d), pseudocyst (e); in articular eminence erosion (f), flattening (g), osteophyte (h), increased sclerosis (i), pseudocyst (k).

- sclerosis (increased cortical bone density extending to bone marrow)
- pseudocysts (subchondral cysts) (well-limited osteolytic area in the subcortical region without cortical bone destruction).

Statistical Analysis

The analyzes were performed by using IBM SPSS 20 statistics program. Data; mean, standard deviation, median, minimum, maximum were presented as percentage and number. The normal distribution of continuous variables was determined by Shapiro Wilk-W test when the sample size was <50; In case of >50, Kolmogorov Simirnov test was performed. In the comparison between two independent groups, the Independent Samples t test was used when the normal distribution condition was provided, and the Mann Whitney u test was used when it was not provided. In the 2x2 comparisons between categorical variables,

Table 1. Comparison of degenerative changes in the right and left temporomandibular joints of early (stage 1-2) and advanced stage (stage 3-4) patients with degenerative knee osteoarthritis according to Kelgren Lawrance staging

	Right knee stage 1-2 (n=14)	Right knee stage 3-4 (n=14)	Left knee stage 1-2 (n=14)	Left knee stage 3-4 (n=14)	*p*
Age±SD	59±8	60±7	59±8	60±7	0.684
BMI±SD	33±4	32±4	33±4	32±4	0.610
Right condyle					
Erosion (n, %)	12(%86)	14(%100)			0.481
Flattening (n, %)	4(%29)	7(%50)			0.246
Osteophyte (n, %)	7(%50)	11(%79)			0.115
Sclerosis (n, %)	4(29)	1(7)			0.326
Cyst (n, %)	1(%7)	3(%21)			1
Right eminentia					
Erosion (n, %)	10(%71)	8(%57)			0.43
Flattening (n, %)	1(%7)	-			1
Osteophyte (n, %)	-	-			-
Sclerosis (n, %)	-	1(%7)			1
Cyst (n, %)	-	1(%7)			1
Left condyle					
Erosion (n, %)			12(% 86)	13(%93)	1
Flattening (n, %)			5(%36)	6(%43)	0.699
Osteophyte (n, %)			5(%36)	9(%64)	0.131
Sclerosis (n, %)			1	3	0.280
Cyst (n, %)			-	1	1
Left eminentia					
Erosion (n, %)			7(%50)	6(%43)	0.705
Flattening (n, %)			-	1(%7)	1
Osteophyte (n, %)			1(%7)	1(%7)	1
Sclerosis (n, %)			-	-	1
Cyst (n, %)			-	3(%21)	0.222

n: patients number, **SD:** Standard deviation, **BMI:** Body mass index; * $p<0.05$,

the expected value (>5) was performed using the Pearson Chi-square test, and the expected value (3-5) using the chi-square yates test and the expected value (<3) using the Fisher's Exact test. $p<0.05$ was considered as statistically significant.

RESULTS

A total of 28 female patients were included in the study, including 14 patients in the early stage group with KOA and TMD dysfunction and 14 patients in the advanced stage group. The mean age was calculated as 59±8 (45-70 years) for early stage and 60±7 (42-72 years) for advanced stage while BMI values were calculated as (early stage mean BMI: 33) ±4 kg/m^2, advanced stage mean BMI: 32±4 kg/m^2).

Gender, age and BMI values of the groups were similar and the numerical and percentage values of changes in radiological parameters (erosion, flattening, osteophyte, sclerosis increase and pseudocyst) seen in TMJ are summarized in Table 1.

When the groups were compared; although the parameters evaluated in both TMJ condyles (except the increase in sclerosis in the right TMJ condyle) were found to be higher in patients with radiologically advanced stage KOA, no statistically significant difference was found between the groups ($p>0.05$) (Table 1).

The frequency and rate of erosion was higher in early stage KOA patients and increased pseudocyst and sclerosis were higher in advanced stage KOA patients. Flattening and osteophytes were seen in equal frequency and rate in both stages. However, there was no statistically significant difference ($p>0.05$) (Table 2).

In addition, a total of 56 knee joints in 28 patients; early (number of knee joints; 28) and advanced stage (number of knee joints; 28) classified as KOA and evaluated together with bilaterally TMJ; Osteophyte incidence in TMJ condyles was significantly higher in patients with advanced stage KOA ($p<0.05$). However, there was no significant difference between the groups in the other parameters ($p>0.05$) (Table 2).

DISCUSSION

No statistically significant difference was found between groups in terms of knee OA stages (early-advanced) despite the increased ratio and frequency of degenerative changes such as erosion, flattening, osteophyte, sclerosis and pseudocyst of TMJ condyle structure. However, when bilaterally all knee joints and TMJs were evaluated together in the early and advanced KOA patients; The incidence of osteophytes in TMJ condyles was significantly higher in advanced KOA patients.

Although radiological findings may be nonspecific in KOA disease, it is valuable in the diagnosis of OA. In recent researches; it has also been shown that there is a significant relationship between clinical symptoms and radiographic OA findings in patients with OA.[11] In TMJ dysfunction, it is accepted that CBCT is a more sensitive and accurate diagnostic method for demonstrating radiological changes that may occur in the bone structures of the joint.[10-12] In our study, we aimed to compare the radiographic severity of KOA patients with degenerative changes detected by CBCT images obtained from TMJ.

Degenerative changes in TMJ occurs through processes such as cartilage destruction, inflammation, and finally bone response. In order to repair damage caused by inflammation and cartilage destruction and to promote joint integrity, bone tissue responds by producing extra bone. In this context, radiological erosion, flattening / irregularities or deformation of the mandibular condyle surface, degenerative changes such as osteophyte, pseudocyst and increased bone sclerosis may be seen in TMJ.[12-14]

It is known that degenerative joint pathologies are most common after 50 years of age in KOA and TMD and that overweight is a risk factor for female gender and KOA in both diseases. In accordance with the literature, all patients in the study had female gender. In addition, the BMI values of both groups were overweight and the mean age of the groups was 59±8 years and 60±7 years, respectively. The absence of a significant difference in age and BMI in the groups is important in terms of neglecting the effect of these two factors on the degenerative changes in the comparison of the groups.

Although both KOA and TMD are common joint diseases, to our knowledge there is only one study examining the relationship between them. In the study which is published by Zhang *et al*., clinical signs and symptoms of TMJ were examined, but no radiological evaluation was performed.[7] In this study, it was reported that the frequency of impaired jaw movement in TMJs of both mild and severe KOA patients was significantly higher than the non-OA group, but there was no significant difference between mild and moderate KOA groups. In addition, it was stated that there was a significant deterioration of TMJ function in severe KOA group compared to non-KOA group and reported that TMJ functions and jaw movement may be adversely affected in patients with KOA. Therefore, we can conclude that impaired jaw movement due to limitation of mouth opening in KOA patients is a predisposition for TMD, and we can conclude that there is a relationship between the higher probability of impairment of TMJ function as KOA severity increases.[7] In addition, these findings may coincide with radiographic changes in the TMJ of patients with KOA. In conclusion, degenerative joint changes in TMJs may have a significant effect on the occurrence of these clinical symptoms.[15]

In our study; although there was no significant difference between the groups in terms of radiological degenerative changes in TMJs of patients with early and advanced KOA, it was observed that the frequency and rate of degenerative changes such as erosion, flattening, osteophyte and pseudocyst are increased especially when the radiological stage of KOA increases (Table 1). This suggests that the possible increase in stress, anxiety and pain sensitivity and some common hereditary that may occur with the progression of the disease may have affected TMJ. Therefore, if sufficient number of patients could be available, statistically significant results could be obtained in the light of these data. In our study, one of the results that support this idea; all of the knee joints and TMJs bilaterally were evaluated together and the frequency of osteophytes in TMJ condyles was significantly higher in patients with advanced KOA (Table 2).

Table 2. Comparison of degenerative changes in temporomandibular joints of early (stage 1-2) and advanced stage (stage 3-4) all patients with knee osteoarthritis according to Kelgren Lawrance staging

	Early stage (n:14 patients)	Advanced stage (n:14 patients)	*p*
Number of knee (right+left)	28	28	
Number of TMJ	28	28	
Condyle (right+left)			
Erosion (n, %)	24(%86)	27(%96)	0.352
Flattening (n, %)	9(%29)	13(%46)	0.274
Osteophyte (n, %)	12(%43)	20(%71)	0.031*
Sclerosis (n, %)	5(%18)	4(%14)	1
Cyst (n, %)	1(%4)	4(%14)	0.611
Eminentia (right+left)			
Erosion (n, %)	17(%61)	14	0.42
Flattening (n, %)	1(%4)	1(%4)	1
Osteophyte (n, %)	1(%4)	1(%4)	1
Sclerosis (n, %)	0	1(%4)	1
Cyst (n, %)	0	4(%14)	0.111

n: patients number, **SD:** Standard deviation, * $p<0.05$,

These radiological changes in joint structures may cause symptoms and findings in TMJ, such as joint pain, especially muscle pain, impaired jaw movement due to limitation of mouth opening, click sound, crepitation and dysfunction.[15] Because degenerative bone changes in TMJs mentioned above are considered radiological findings and have been proven in painful TMJs.[13,14]

In our study, when the severity of KOA increased, the higher rates of erosion, osteophytes and flattening were found. Erosion is the first stage of degenerative changes, which may indicate that TMJ is unstable and that changes in bone surfaces may occur, possibly causing changes during occlusion. Osteophytes, on the other hand, represent the newly formed cartilage areas occurring in the later stages of the degenerative changes to which the body adapts to repair the joint,

and stabilizes and enlarges the surface in order to improve the overload caused by occlusal forces.[16] In addition, flattening can also be explained by the possibility that it represents an adaptive process in bone replacement the first change of a progressive disease, or a degenerative change due to internal disorder.[17-21] Flattening is also seen as a degenerative change due to overload on TMJ and may also be associated with involvement of the masseter and temporal muscles.[22]

In the literature, in a study examining radiological changes in TMJ joint with CBCT, it was reported that the incidence of flattening and osteophyte was the highest in degenerative bone changes and similar changes were seen in the articular eminence much less frequently.[10] MRI was used in the study of by Güler *et al*. and CBCT was used by Alexious *et al*. and these studies revealed that the most common radiological findings in TMJ condyles were erosion, flattening and osteophytes, whereas Campos *et al*. reported that erosion was the most common finding.[20,23,24] In our study, it was found that erosion, flattening and osteophyte were seen at a higher rate and frequency in TMJ condyles, similar to the literature.

The radiological changes mentioned above may have been caused by several mechanisms in the TMJ of patients with KOA. First, KOA and TMD have some common hereditary sensitivities. Specific genetic risk factors for degenerative joint damage may also be present. Genetic studies have identified many risk alleles for OA, and mutations in these genes can directly cause widespread OA, including TMJ.[25,26] Secondly, OA pain may lead to depression due to fatigue and disability-forming effects, and may contribute to the increase in pain sensitivity and the development of TMD due to psychological complaints such as stress, fatigue, anxiety, depression and sleep disorders that occur afterwards.[27] Thirdly, the presence of similar factors such as anatomically bicondylar joint of both joints, presence of TMJ disc disorders, frequent exposure to mechanical stress, and also degenerative changes in joints are more common in women, elderly and hypermobility.[28] These changes can be seen in both joints significantly in the presence of risk factors.

The most important limitation of our study was the insufficient number of patients and the lack of a control group. For these reasons, further and comprehensive studies are needed by considering the shortcomings of our study.

CONCLUSION

In conclusion, we think that the evaluation of TMJs in KOA patients will be beneficial for early diagnosis and treatment of patients with TMJ dysfunction since the possibility of having degenerative changes in TMJ increases as the radiological severity of KOA increases.

*The authors declare that there are no conflicts of interest.

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