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An analysis of meniscal extrusion and associated knee joint lesions by magnetic resonance imaging

Menisküs taşması ve beraberinde görülen diz eklemi lezyonlarının manyetik rezonans görüntüleme ile değerlendirilmesi

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Amaç: Menisküs yırtığı olan olgularda menisküs taşması (extrusion) sıklığı ve eşlik eden diz eklemi patolojileri manyetik rezonans görüntüleme (MRG) ile araştırıldı.

Çalışma planı: Diz eklemine yönelik MRG incelemesi ile menisküs yırtığı saptanan 100 hastanın (41 erkek, 59 kadın; ort. yaş 54±10; dağılım 27-76) 126 diz eklemi geriye dönük olarak değerlendirildi. Koronal görüntüde, tibia platosu kenarı ile menisküsün dış sınırı arasındaki mesafenin ≥3 mm olması menisküs taşması olarak kabul edildi. Tüm diz eklemlerinde, menisküs yırtığının ve taşmanın yeri, yırtığın tipi, eşlik eden eklem sıvısındaki artış, çapraz bağ patolojisi, kemik ve kıkırdak patolojileri araştırıldı.

Sonuçlar: Otuz bir diz ekleminde (%24.6) ortalama 3.72 mm ölçülen menisküs taşması görüldü. Taşma tüm menisküslerde medial menisküsün arka boynuzundaydı. Taşma görülen 31 menisküsün 18'inde (%58.1) radial, dokuzunda (%29) radial-oblik, ikisinde (%6.5) kompleks, ikisinde (%6.5) flep yırtık bulundu. Taşma olmayan menisküslerle karşılaştırıldığında, taşma görülen menisküslerde tüm yırtıkların medial menisküs arka boynuzunda olması (%100 ve %60) ve bu grupta radial yırtıkların daha sık (%58.1 ve %20) görülmesi anlamlı bulundu ($p<0.05$). Menisküs taşması olan ve olmayan yırtıklarda eşlik eden patolojilerin türü ve sıklığı anlamlı farklılık göstermedi ($p>0.05$).

Çıkarımlar: Menisküs taşması özellikle osteoartritli hastalarda sık görülen bir bulgudur ve genellikle medial menisküste ve en sık radial yırtık tipiyle birlikte görülmektedir. Bu nedenle, menisküs taşması özellikle menisküs köküne uzanan radial yırtık varlığı açısından uyarıcı olabilir.

Anahtar sözcükler: Diz yaralanması/tanı; manyetik rezonans görüntüleme; menisküs, tibial/yaralanma/patoloji; osteoartrit, diz/komplikasyon; yırtık.

Objectives: We investigated the frequency of meniscal extrusion and associated knee joint lesions by magnetic resonance imaging (MRI) in patients with meniscal tears.

Methods: We retrospectively evaluated MRI findings of 100 patients (41 males, 59 females; mean age 54±10 years; range 27 to 76 years) with meniscal tears in 126 knee joints. Using coronal images, extrusion was defined as a distance of ≥3 mm between the peripheral border of the meniscus and the edge of the tibial plateau. All the knees were assessed with respect to the localization and type of meniscal tear and extrusion, accompanying joint effusion, cruciate ligament pathologies, and degenerative bone and cartilage changes.

Results: Meniscal extrusion was detected in 31 knee joints (24.6%), with a mean extrusion of 3.72 mm. All extrusions were found to be in the posterior horn of the medial meniscus and were associated with radial tears (n=18, 58.1%), radial-oblique tears (n=9, 29%), complex tears (n=2, 6.5%), and flap tears (n=2, 6.5%). Meniscal tears with extrusion differed significantly from those without extrusion with respect to the localization of all the tears being in the posterior horn of the medial meniscus (100% *vs*. 60%) and the higher frequency (58.1% *vs*. 20%) of radial tears ($p<0.05$). There were no significant differences in the types and frequencies of accompanying pathologies seen in meniscal tears with and without extrusion ($p>0.05$).

Conclusion: Meniscal extrusion is a common finding particularly in osteoarthritis. It is mostly seen in the medial meniscus and accompanied by radial tears. Therefore, its presence should alert to the possibility of a radial tear extending to the meniscal root.

Key words: Knee injuries/diagnosis; magnetic resonance imaging; menisci, tibial/injuries/pathology; osteoarthritis, knee/complications; rupture.

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The menisci are fibrocartilaginous structures located between the femur and the tibia. They are also known as "semi-lunar" cartilages referring to their half-moon "C" shape. The arms of the "C" are the anterior and posterior horns, and the middle is the body. They extend on the cartilage surface of the tibial plateau. The main function of the menisci is to reduce the effect of vertical powers on the joint cartilage and to transmit and distribute the power between the femur and the tibia.[1] Meniscal injury causes instability and dysfunction. The disruption of meniscal collagen fibers caused by a tear leads to outward displacement of the meniscus on the tibia plateau. "Meniscal extrusion" is defined as significant (≥3 mm) medial displacement of the meniscus with respect to the central margin of the tibial plateau.[2]. In medical literature, it is also called as "meniscal subluxation".[3] Meniscal extrusion is caused by osteoarthritis in the elderly [4] and by trauma in young individuals.[5,6]

The aim of this study was to find the frequency of extruded menisci in patients with meniscal tear, the type of the tear, the most commonly extruded meniscus, changes in the associated bone and cartilage, accompanying cruciate ligament pathology, and joint effusion.

Material and methods

Magnetic resonance images (MRI) of 100 patients were assessed retrospectively between October 2007 and May 2008, in whom the diagnosis of menisceal tear had been suggested by the findings of joint pain, mechanical symptoms and swelling. A single knee in 74 patients and two knees in 26 patients were investigated, and a total 126 knee joints with menisceal tear were included in this study. The mean age was 54.32 ±10.25 years (range=27-76 years). 41 patients were male and 59 were female. The patients with previous knee operations and those with images of poor quality were excluded from the study. Of the 126 knee joints with meniscal tear, 31 had extruded menisci. The localization of the meniscal tear and extrusion, the type of the tear, joint effusion, and pathology of the cruciate ligaments, bone and cartilage were assessed. All the studies were performed with the 1.5 T MR (Symphony, Siemens) apparatus, using dedicated knee coils. First, T_1-weighted axial, sagittal and coronal plane images were obtained to define the localization. Then, proton density spin-echo (TR/TE: 3300/22, FOV: 160, Matrix: 180x256) sagittal and coronal, T_2-weighted, fat-suppressed coronal and axial (TR/TE:3300/88 FOV: 160, Matrix: 180x256) images were obtained. Linear signal changes extending to the joint surface in the anterior and posterior horns of the medial and lateral menisci were accepted as tears. If the distance between the margin of the tibial plateau of the torn meniscus and the outer margin of the meniscus measured in coronal images were ≥3mm, it was diagnosed as an extrusion. The data were analyzed using the SPSS 10.0 pocket program. The Pearson chi-square test was used for the findings of knee joints with meniscal tear with and without extrusion. The level of significance was set as $p<0.05$.

Results

Of the 126 meniscal tears, 31 (24.6%) had extrusion. The mean distance between the margin of the tibial plateau and the margin of the extruded meniscus was 3.72 mm (Figure 1). All extruded menisci were in the posterior horn of the medial meniscus. Of the extruded menisci, 18 (58%) were radial (Figure 2), nine (29%) were radial-oblique, two (6.4%) were complex (Figure 3), and two (6.4%) had flap tear. Of the 95 non-extruded meniscal tears, 57 were found in the posterior horn of the medial meniscus, 7 were found in the anterior horn of the medial meniscus, 19 were in the posterior horn of the lateral meniscus, and 12 were found in the an-

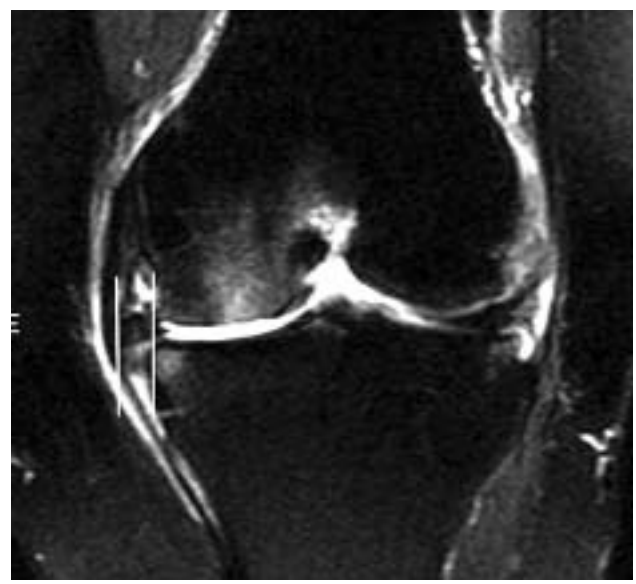

Figure 1. There is a 6 mm extrusion in the medical meniscus in the coronal fat-suppressed image of the knee joint on the MRI image passing through the femoral intercondylar midline. Extrusion is defined as the distance between the two lines –outer margin of the tibial plateau and the outer margin of meniscus- being more than 3 mm.

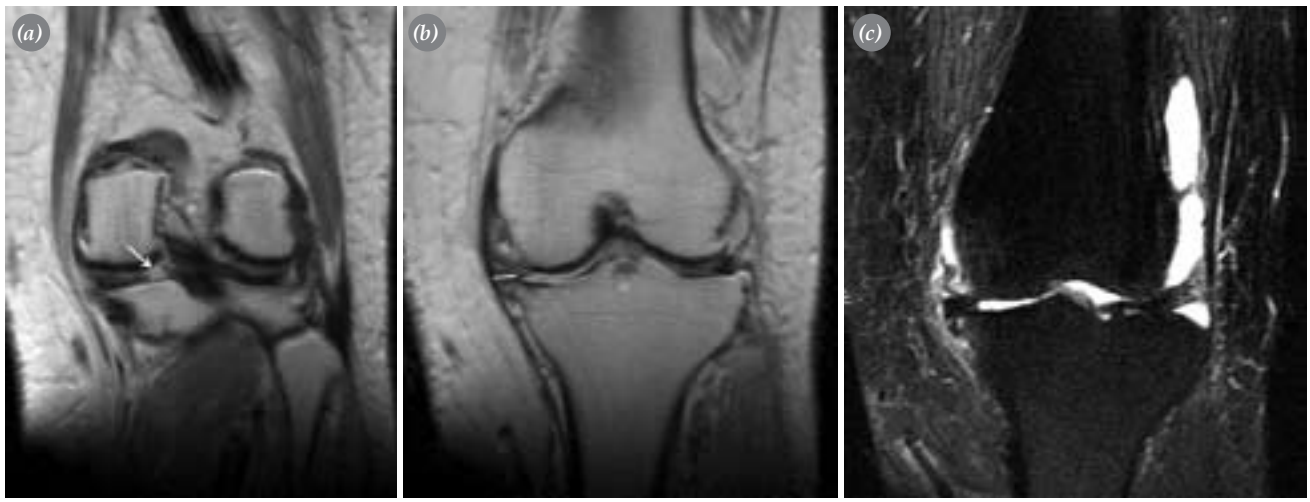

Figure 2. Proton-weighted coronal MRI images **(a)** the radial tear (white arrow) in the medial meniscus posterior horn, in the meniscal root. In slices of the same sequence, but more anteriorly, from the level of the body of the meniscus **(b)** meniscal extrusion of approximately 5.4 mm (small horizontal line) caused by tear. In fat-suppressed image **(c)** there is joint effusion accompanying the extruded meniscus.

terior horn of the lateral meniscus. Of these tears, 19 were radial, 21 were horizontal, 39 were oblique, and 16 were complex tears (Table 1).

There was joint effusion with meniscus extrusion in 16 (52%) cases (Figure 2c). Although the most common accompanying condition in extruded tears was the joint effusion, it was not significant. There was partial or complete tear in the anterior cruciate ligament in eight (26%) knees (Figure 3c). There was no significant relationship between tear of the anterior cruciate ligament and extrusion. There were loss of cartilage adjacent to the extruded meniscus, subcortical erosion and edematous changes in medullar bone in 14 (45%) knees (Figure 3a). There was partial or complete layer anterior cruciate ligament tear in 30 knees, cartilage and bone erosion in 36, and joint effusion in 40 knees with non-extruded menisceal tear (Table 2). We compared the findings of knee joints with meniscal tear with or without extrusion and we found that there was a significant relationship between all tears being in the posterior horn of the medial meniscus and extrusions being frequent in radial tears. There was no significant relationship between anterior cruciate ligament tear accompanying extrusion, bone and cartilage changes and joint effusion.

Table 1. Localization, type of tears and pathologies accompanying meniscal tears with or without extrusion

	With extrusion (n=31)		Without extrusion (n=95)	
	Number	Percent	Number	Percent
Localization				
Medial meniscus				
Posterior horn	31	100.0	57	60.0
Anterior horn	-		7	7.4
Lateral meniscus				
Posterior horn	-		19	20.0
Anterior horn	-		12	12.6
Type of tear				
Radial	18	58.1	19	20.0
Oblique	9	29.0	36	37.9
Complex	2	6.5	16	16.8
Flap	2	6.5	-	
Horizontal	-		21	22.1
Pathologies accompanying				
Anteriorcruciate ligament tear	8	25.8	30	31.6
Bone and cartilage changes	14	45.2	36	37.9
Joint effusion	16	51.6	40	42.1

Discussion

The most important function of the meniscus in the knee joint is to facilitate the distribution of load, to increase the joint lubrication, and to ensure stabilization. The meniscus increases the contact surface following the movements of the femur and the tibia in order to preserve the joint integrity during functional knee movements and to distribute the power on the joint surface effectively.[7] The meniscus is attached to the tibial medial eminence medially by the anterior and posterior horns, and the medial meniscus is attached to the

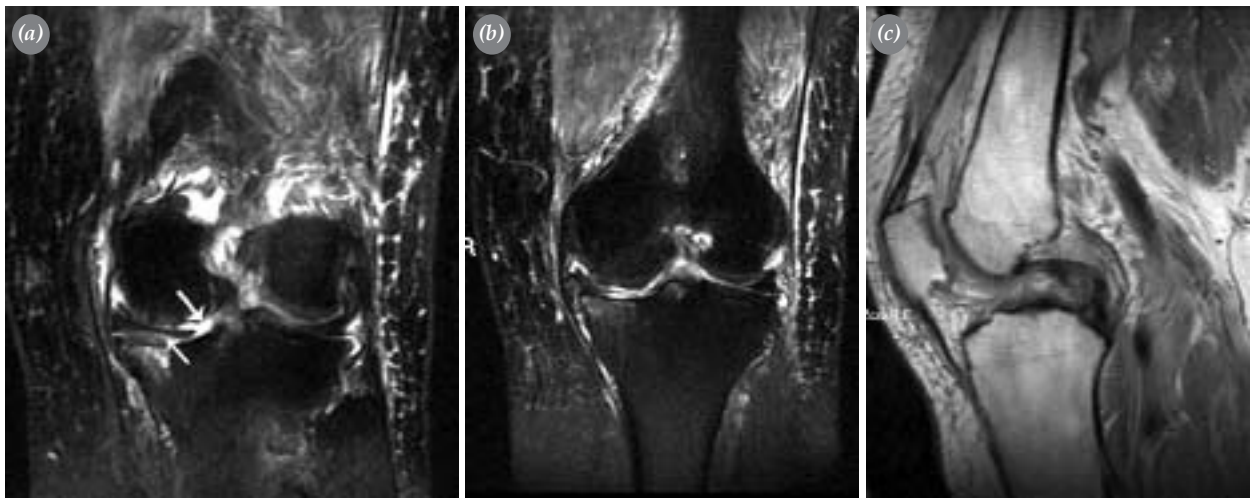

Figure 3.Coronal fat-suppressed image **(a)** complex tear (white arrows) affecting the meniscal root and body in the posterior horn of the medial meniscus. There are edematous changes in the subcortical medullar bone in the femur and the tibia in the adjacent structures of the torn meniscus. There is little joint effusion. **(b)** View of extrusion, in which the distance between the margin of the tibial plateau of the torn meniscus and the outer margin of the meniscus was ≥3mm in the slices passing more anteriorly in the same sequence. The proton-weighted sagittal MRI image of the same case shows **(c)** loss of continuity due to anterior cruciate ligament tear.

transverse ligament and the joint capsule. At the midpoint, the medial meniscus attaches more firmly to the femur and the tibia by the ligament known as the deep medial collateral ligament. It is attached to the tibia, especially the posterior horn adjacent to the tibial spine at the point which is known as the "meniscal root" or "central attachment".[7] On the contrary, the lateral meniscus is attached to the joint capsule in the periphery at the level of the posterior and anterior horns. It has been suggested that this difference in the attachment to the joint capsule may render the medial meniscus more susceptible to subluxation and injury, as the capsule may change place more often in the medial due to osteophyte or effusion.[6] Miller et al. [8] concluded that there was no clear relationship between menisceal extrusion and degeneration; however, degenerative changes are seen on the MRI in the extruded meniscus in the early period. Costa et al.[9] reported that the degree of extrusion was significantly related to meniscal degeneration. Magee et al.[10] studied extrusion using arthroscopy in their study and found that in patients older than 50 years, medial meniscal extrusion may be due to stretching related to degeneration without any tear detected in arthroscopy. The presence of tear in all the extruded menisci in our study primarily suggests the association of tear-extrusion. In our study, we found that menisceal extrusion was most frequently seen in the medial meniscus, especially the posterior horn. In their study, Costa et al.[9] reported that the most common extrusion was in the medial meniscus. Ding et al.[11] stated that increased body mass index, previous knee trauma and osteophytes may play roles in extrusion of the medial meniscus. The reason for extrusion being more common in the medial meniscus may be related to the anatomical structure and the medial meniscus being the point of weight-bearing. Puig et al.[12] compared the MRI and arthroscopy results in extruded menisci and concluded that extrusion was most commonly seen in the medial meniscus; however, while the MRI was performed, the patients were in a lying position and were not in a body weight bearing position, and hence stated that this result was less reliable, and that extrusion was more commonly encountered in the anterior horn.

The most common site for extrusions in our study was in radial tears and the second most common site was in oblique tears. The reason for this may be that radial tears extend to the meniscal roots at the point of attachment to the tibia. In their study in which they investigated the severity of extrusion in the medial meniscus, Costa et al.[9] reported that radial tears were responsible for major extrusions. They reported that minor tears were caused mainly by oblique and less commonly by radial tears. In another study assessing the dynamics of the meniscus, Vedi et al.[7] stated that

meniscal root or central tibial attachment points had greater tendency towards trauma and that radial tears causing extrusion were often seen at these points. In their study evaluating extrusion using arthroscopy, Magee et al.[10] reported that radial and complex tears involving the meniscal root were closely related to extrusion. In osteoarthritis, meniscal extrusion may be seen in addition to findings of osteoarthritis. In their study where the degree of damage was assessed by measuring the cartilage loss quantitatively in osteoarthritic knee joints, Sharma et al.[4] found that there were degenerations accompanied by extrusion in the medial meniscus. Ding et al.[11] emphasized that cartilage loss and subchondral bone changes were responsible for meniscal extrusion, especially in osteoarthritis cases with a history of more than two years. Berthiaume et al.[13] suggested that meniscal tear and extrusion were related to the progression of the symptomatic osteoarthritis. The mean age of our patients was high (54.3 years). It was found that 45% of knee joints with extrusion had cartilage loss and adjacent subchondral bone changes due to osteoarthritis. Similar to that in the literature, these findings demonstrate that meniscal extrusion is closely related to bone and cartilage changes in osteoarthritis.

In our study, we found that 52% of knee joints with meniscal extrusion had joint effusion. Of the knee joints without extrusion but only meniscal tear, only 40% were found to have effusion. These rates suggest that meniscal extrusion and joint effusion may be seen together; however, effusion can also be seen in meniscal tears without extrusion. Rennie et al.[6] emphasized that in sportsmen, effusion was not a predisposing factor for extrusion; however, subluxation or extrusion which may frequently be seen in the medial meniscus, may be closely related to the increase in tension in the joint capsule due to effusion or presence of an osteophyte. Lerer et al. [2] stated that joint effusion was not related to meniscal extrusion. Of the knee joints with meniscal extrusion in our study, 26% had tears of the anterior cruciate ligament. This rate was 30% for knee joints with meniscal tear but without extrusion. There was no significant difference between these two groups. Rennie et al.[6] stated in their study with sportsmen that tear of the anterior cruciate ligament was not related to extrusion. In conclusion, we can say that the definition and diagnosis of meniscal extrusion in knee MRI investigations is a new expression in the literature of today. It is usually seen in the medial meniscus and is most commonly caused by radial tears. Therefore, in the presence of an extruded meniscus, special attention should be paid to radial tears extending to the meniscal root. The most common accompanying pathology in meniscal tear with or without extrusion is joint effusion. On MRI, special attention should be paid to anterior cruciate ligament tear, bone and cartilage damage.

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