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ORIGINAL ARTICLE
ORİJİNAL ARAŞTIRMA

Investigation of the Presence of Discoid Meniscus and Its Effect on Anatomic Structures in the Knee Joint by Magnetic Resonance Images, A Retrospective Study

Diskoid Menisküs Varlığının ve Diz Eklemindeki Anatomik Yapılar Üzerindeki Etkisinin Manyetik Rezonans Görüntüleri ile Araştırılması, Retrospektif Bir Çalışma

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ABSTRACT

Aim: We aimed to investigate the effect of the presence of discoid meniscus (DM) on the anatomical structures of the knee joint.

Material and Method: The knee magnetic resonance (MR) images of 144 (97 female, 47 male) individuals with DM and 159 (94 female, 65 male) individuals with normal meniscus were evaluated.

Results: DM was mostly seen on the left side (n=64). This was followed in decreasing order by right side and bilateral. The incidence of DM was higher in individuals aged 36 years and older than in 18 years and younger (p=0.003). Incomplete type DM was seen most frequently in both genders. Meniscopathy was most common (n=21) in the medial meniscus of people with DM. And also in individuals with normal meniscus, meniscopathy was also most common (n=31) medially. When the effected ligaments were examined, tearing and degeneration were most common (n=21) in the anterior cruciate ligament (ACL) in individuals with DM. On the other hand in the presence of DM, chondropathy (n=42) on adjacent joint surfaces was reported. It was determined that ligament damage was mostly (n=43) in ACL in normal menisci. In addition, the presence of chondropathy was observed on the bone surfaces adjacent to the joint (n=64) in normal menisci.

Conclusion: All DM cases were in the lateral meniscus. This was mostly accompanied by meniscopathy and ACL injury.

Keywords: Knee joint, discoid meniscus, anterior cruciate ligament, magnetic resonance imaging

ÖZ

Amaç: Diskoid menisküs (DM) varlığının diz ekleminin anatomik yapıları üzerindeki etkisini araştırmayı amaçladık.

Gereç ve Yöntem: DM'li 144 (97 kadın, 47 erkek) ve normal menisküslü 159 (94 kadın, 65 erkek) bireyin diz manyetik rezonans (MR) görüntüleri değerlendirildi.

Bulgular: DM en sık sol tarafta görüldü (n=64). Bunu azalan sırayla sağ taraf ve bilateral takip etmekteydi. DM insidansı 36 yaş ve üzeri bireylerde 18 yaş ve altı bireylere göre daha yüksekti (p=0.003). Her iki cinsiyette de en sık inkomplet tip DM görüldü. DM'li kişilerde en sık (n=21) medial meniskopati görüldü. Normal menisküsü olan bireylerde de meniskopati en sık (n=31) medialde görüldü. Etkilenen bağlar incelendiğinde, DM'li bireylerde yırtılma ve dejenerasyon en sık (n=21) ligamentum cruciatum anterior'da (LCA) görüldü. Diğer yandan DM varlığında komşu eklem yüzeylerinde kondropati (n=42) izlendi. Normal menisküslerde bağ hasarının en fazla (n=43) LCA'da olduğu tespit edildi. Ayrıca normal menisküslerde ekleme komşu kemik yüzeylerde kondropati varlığı (n=64) gözlendi.

Sonuç: Tüm DM olguları lateral menisküste idi. DM'ye çoğunlukla meniskopati ve LCA yaralanması eşlik etmekteydi.

Anahtar Kelimeler: Diz eklemi, diskoid menisküs, ligamentum cruciatum anterior, manyetik rezonans görüntüleme

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INTRODUCTION

The menisci are crescentic, intracapsular, fibrocartilaginous laminea. They serve widen and deepen the tibial articular surfaces that receive the femoral condyles. Their peripheral attached borders are thick and convex, and free inner borders are thin and concave. Their peripheries are vascularised by capillary loops from the fibrous capsule and synovial membrane, while inner regions are avascular and fed by diffusion. The medial meniscus is almost a semicircle in shape. The lateral meniscus forms approximately four-fifths of a circle, and covers a larger area than the medial meniscus (1). Discoid meniscus (DM) was described by Young in 1889 firstly for the lateral meniscus in cadaver studies (2). Later, Jones described the presence of a very rare anomaly, the medial DM, in a young patient (3). The prevalence of DM varies between different populations (4,5). In 1948, Smillie suggested the embryological theory about the formation of DM (6). But anatomical studies did not support that theory. Kaplan(7) stated that the discoid shape is an acquired feature developed secondary to increased meniscal motion due to lack of posterior tibial attachment. Several studies have suggested that this variation may be familial (8, 9). However, the etiology of DM is still unclear. In this study, we aimed to investigate the presence of DM and its effect on the anatomical structures of the knee joint using magnetic resonance (MR) images.

MATERIAL AND METHOD

The study was carried out with the permission of Tokat Gaziosmanpaşa University Clinical Research Ethics Committee (Date: 09.06.2022, Decision No: 22-KAEK-130). The images of individuals who applied to our hospital and underwent knee MRI between January 2017 and April 2022 for any reason were examined. Evaluations were made by examining patient reports and patient files through the Enlil and picture archiving and communication system (PACS) systems of our hospital. We analyzed 6570 individuals who underwent knee MRI. It was checked whether there was DM in the images. Those who had undergone knee joint surgery before MRI were excluded from the study. The presence of additional joint pathologies in DM were examined and individuals were grouped according to their age and gender. Whether it was symptomatic or not, on which side DM was more common, and additional pathologies in the presence of DM were evaluated.

Statistical Analysis

Descriptive statistics were made to give information about the general characteristics of the study groups. Data of continuous variables Mean±Standard Deviation; Data belonging to categorical variables were given as n(%). Differences between groups were analyzed with the Independent Sample T-Test or One-Way Analysis of Variance (Anova) for quantitative variables. Differences between groups for qualitative variables were evaluated with the Chi-Square Test. Ready-made statistical software was used in the calculations (IBM SPSS Statistics 19, SPSS inc., an IBM Co., Somers, NY). When p values were less than 0.05, they were considered statistically significant.

RESULTS

In the knee images of 6570 individuals analyzed in our study, the presence of DM was observed in a total of 144 individuals (2.19%), all in the lateral meniscus. Of the people with DM, 107 had unilateral and 37 had bilateral images. Images of 159 individuals with normal menisci were also evaluated to compare the accompanying pathologies. It was determined that 140 of the patients diagnosed with DM presented to the hospital with pain, 3 with swelling and 1 with locking. DM was found in the right knee of 59 patients, in the left knee of 64 patients, and in both knees of 21 patients. The mean ages of individuals with DM and normal meniscus are given in **Tables 1** and **2**, respectively. The presence of DM was detected in a higher number of individuals aged 36-65 years compared to the 18 and under age group (p=0.003).

Table 1. Distribution of female and male individuals with discoid meniscus by age groups

	Age groups [years, n (%)]					p
	18 and ↓	19-35	36-50	51-65	66 and ↑	
Gender						0,003*
Female	5 (5.2)[a]	18 (18.6)[ab]	42 (43.3)[b]	32 (33.0)[b]	-	
Male	10 (21.3)[a]	14 (29.8)[ab]	14 (29.8)[b]	8 (17.0)[b]	1 (2.1)[ab]	

Pearson Chi-Square Test. p<0.05 is statistically significant.

Table 2. Distribution of female and male individuals with normal meniscus by age groups

	Age [years, n (%)]					p
	18 and ↓	19-35	36-50	51-65	66 and ↑	
Gender						0,298
Female	10 (10.6)	17 (18.1)	35 (37.2)	23 (24.5)	9 (9.6)	
Male	11 (16.9)	9 (13.8)	16 (24.6)	19 (29.2)	10 (15.4)	

Pearson Chi-Square Test. p<0.05 is statistically significant.

It was seen that among our cases with normal meniscus, 140 individuals applied with pain, 12 with swelling, 4 with falling, 2 with redness and 1 with locking complaints. Of the 159 individulas with normal meniscus, 125 had unilateral and 34 had bilateral images.

The distribution of DM types according to gender is given in **Table 3**. The presence of unilateral incomplete type DM was observed most frequently in both genders.

Table 3. Type of Discoid Meniscus

	Gender		p
	Female n (%)	**Male n (%)**	
Unilateral Incomplet	52 (65.8)	27 (34.2)	0.855
Unilateral Complet	30 (68.2)	14 (31.8)	
Bilateral Incomplet	6 (75.0)	2 (25.0)	
Bilateral Complet	4 (57.1)	3 (42.9)	
Bilateral Complet-Incomplet	5 (83.3)	1 (16.7)	

Pearson Chi-Square Test. p<0.05 is statistically significant.

When the MR images were analyzed for the presence of meniscopathy, it was observed that medial meniscopathy was most common in individuals with DM and normal meniscus (n=21 and n=31, respectively), followed by lateral meniscopathy. Coexistence of medial and lateral meniscopathy was observed at the lowest rate. Out of 37 people who had MR images of both knees, 21 individuals had bilateral DM. Meniscopathy was observed in 16 of the individuals with bilateral DM. When evaluated in terms of ligament damage, ACL damage was most common in individuals with both DM and normal meniscus. ACL lesions were found to be more common in normal menisci (n=43) than those with DM (n=21). Distribution of additional ligament pathologies in individuals with DM and normal meniscus is given in **Table 4**, **Figure 1** and **2**. It was determined that the incidence of ACL damage increased in parallel with the increase in age.

Table 4: The distribution of additional knee joint ligament pathologies seen in individuals with discoid meniscus and normal meniscus

	DM (n)	NM (n)	p
Tear of the ACL	5	7	0.773
Degeneration of the ACL	9	20	
Mucoid degeneration of the ACL	7	16	
Degeneration of the PCL	1	5	
Degeneration of the MCL	1	5	

Pearson Chi-Square Test, DM: discoid meniscus, NM: normal meniscus, ACL: anterior cruciat ligament, PCL: posterior cruciat ligament, MCL: medial collateral ligament. p<0.05 is statistically significant.

It was observed that 64 of the individuals with normal meniscus and 42 of the individuals with DM had chondropathy (cartilage degeneration)(**Table 5**).

Table 5: The distribution of accompanying cartilage surface pathologies

	DM (n)	NM (n)	p
Degeneration of Medial Tibiofemoral Cartilage Surfaces	15	26	0.606
Degeneration of Lateral Tibiofemoral Cartilage Surfaces	11	12	
Degeneration of Retropatellar Cartilage Surfaces	10	20	
Degeneration of Patellofemoral Cartilage Surfaces	6	6	

Pearson Chi-Square Test, DM: discoid meniscus, NM: normal meniscus. p<0.05 is statistically significant.

DISCUSSION

The menisci contribute to the nourishment of the articular cartilage by enhancing synovial fluid distribution. At the same time, and perhaps the most important and clinically relevant role, they share the load on the knee joint with the articular cartilage. The presence and circumferential arrangement of collagen fibers are very important in these functions (10). DM is one of the most common variations of the knee joint (11,12). Its frequency varies according to races. The incidence rates have been reported in Greek 1.8%, Indians 5.8%, Koreans 9.5%, and Japanese 16.6% (5,11). The real incidence of discoid meniscus is difficult to estimate due to asymptomatic individuals. The rate we found in our study was 2.19%, which is very close to the rate in the Greeks. It is reported in the literature that DM is more likely to be seen bilaterally.(13,14) Kale et al. (15) examined 22 knee joints of 11 neonatal cadavers and reported a 77% incidence of lateral DM. In our study, we did not encounter any discoid appearance in the medial meniscus. However, in our study, most of the patients had radiologic imaging of only one knee. On the other hand, in accordance with the literature, we observed that DM was high in individuals who had imaging of both knees.

The reported incidence ranges from 0.4% to 17% for lateral DM and 0.06% to 0.3% for medial DM (11,14,16,17). Bilateral lateral DM has been described in 15% to 25% of cases (11-13,18). In our study, the rate of bilateral DM was 57%. The limitation of our study is that most individuals with lateral DM had MRI of only one knee. It is also difficult to estimate the true incidence of discoid meniscus because of asymptomatic individuals.

Watanabe et al., classified the discoid menisci as complete, incomplete, and Wrisberg types, depending on the presence or absence of a normal posterior attachment and the degree of tibial plateau coverage (19). Complete discoid shape, with full coverage of the tibial plate, mechanically stable, with normal posterior coronal insertions. Incomplete coverage of no more than 80% of the tibial surface, stable to palpation, with normal posterior coronal insertions. Wrisberg variant, normal or slightly discoid shape, with instability due to absence of posterior coronal fixation, only Wrisberg's ligament maintained (20). In contrast to studies reporting a higher incidence of complete type DM (5,13), our results showed a higher incidence of incomplete type DM, similar to the study of Kato et al (12).

In a study knee MR images of 675 children were evaluated, and all children with DM were male (21). In the literature, similar to our study, it was determined that DM was more common in women (5,12).

Figure 1. A and B: Complet lateral discoid meniscus (white arrow) C: Incomplet lateral discoid meniscus (white arrow). D, E and F: Total rupture of ACL. Incomplete discoid meniscus (white arrow) in the lateral meniscus in coronal pdT2A (proton density) image. E and F: ACL is not visible on sagittal pdT2A and sagittal T1A images (blue and white arrow). G, H and I: ACL degeneration: Incomplete discoid meniscus (white arrow) in the lateral meniscus in coronal pdT2A (proton density) image. Although ACL integrity is observed in sagittal pdT2A and sagittal T1A images, there is an increase in signal due to degeneration (white arrow). K, L and M: ACL mucoid degeneration: Incomplete discoid meniscus (white arrow) in the lateral meniscus in coronal pdT2A (proton density) image. ACL integrity is observed in sagittal pdT2A and sagittal T1A images, but there is a significant increase in volume and signal due to mucoid degeneration (white arrow).

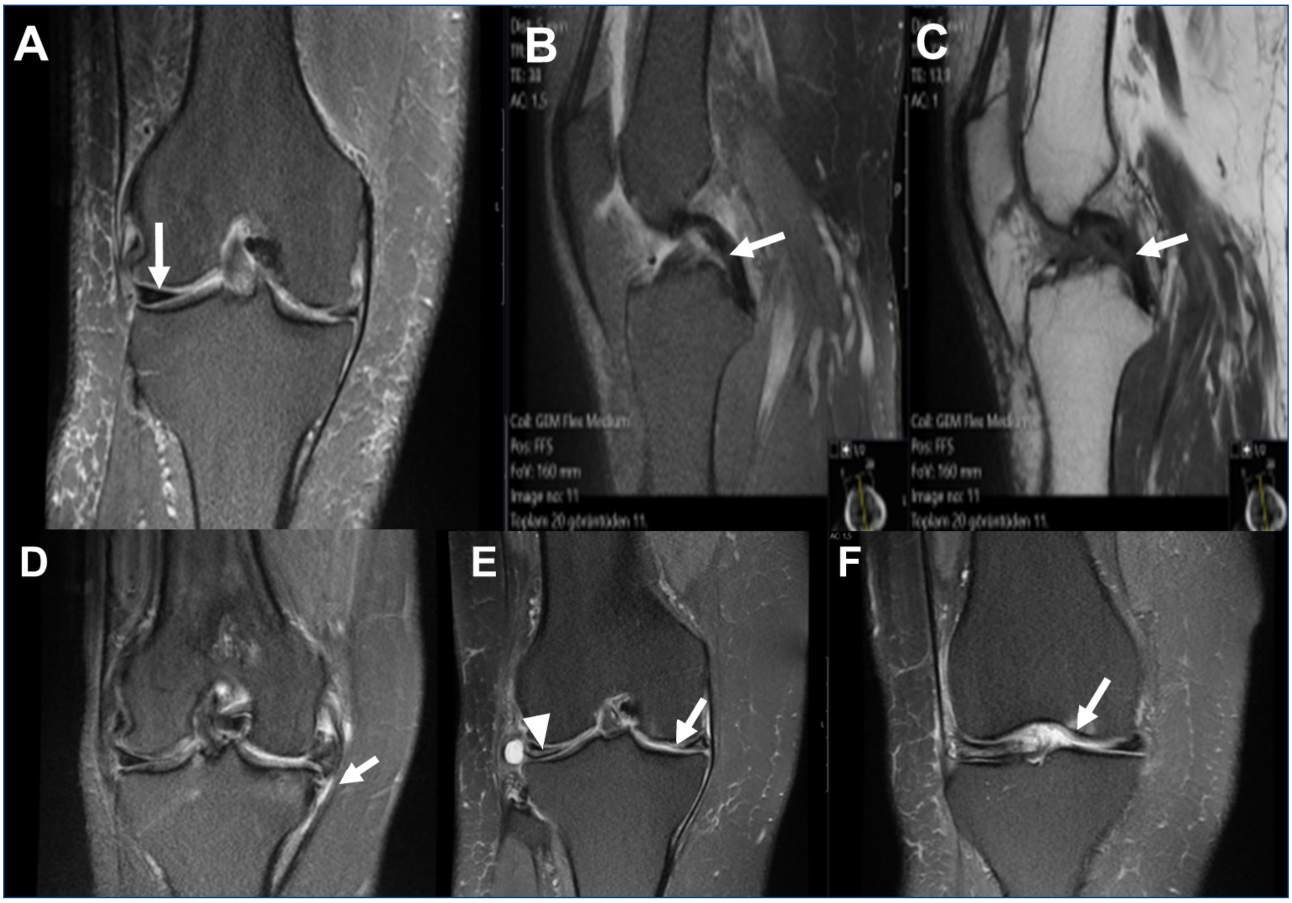

Figure 2. A, B and C: PCL degeneration: Incomplete discoid meniscus (white arrow) in the lateral meniscus in coronal pdT2A (proton density) image. Although PCL integrity is observed in sagittal pdT2A and sagittal T1A images, there are focal signal increases due to degeneration (white arrow). D: MCL degeneration: Signal and volume increase due to degeneration in incomplete discoid meniscus and MCL in lateral meniscus in coronal pdT2A (proton density) image. E and F: Chondropathic degeneration: In coronal pdT2A (proton density) image, incomplete lateral discoid meniscus (white triangle) and chondropathic signal pulses (white arrow) on the cartilage surfaces and subchonral edema in the adjacent bone structure (white arrow).

Knee pain is a common cause of hospital admission in patients of all ages with various etiologies. MRI is a common imaging method used to diagnose internal injuries of the knee, especially meniscus lesions (22). For this reason, we used MRI in our study. On the other hand, clinical examination has been reported to have higher sensitivity and specificity than MRI in diagnosis. It has also been reported that MRI has a lower sensitivity and specificity in children under 12 years of age (23). DM can cause mechanical complaints such as pain, swelling and locking in patients. DM is prone to rupture due to increased thickness, poor tissue quality, and instability. It is also reported that it causes early osteoarthritis in the joint (4). We also found that the complaints of patients with DM presenting to the hospital were similar to the literature. The collagen fiber organization in DM is different from the normal meniscus. It has been reported that due to this difference, the weight distribution on the knee joint changes and increased damage to the structures in the knee joint is observed (24). In our study, contrary to the literature, additional joint pathologies were observed slightly more frequently in normal meniscus than in DM. As long as a tear does not occur in the meniscus body, there are cases that remain asymptomatic for many years (4). But we found that all individuals with DM were symptomatic. MRI is mostly preferred to evaluate the meniscus and ligaments in the knee joint (4).

However it is reported that DM predisposes to meniscus damage. In a study, it was suggested that DM is prone to damage due to its structural feature. It has been reported that the collagen network is irregular and vascularization is poor in the presence of DM. Several studies have shown that the higher incidence of meniscal tears would also be associated with a larger meniscal size, thickness and weak posterior attachment to the joint capsule (7,21,25,26).

In patients with unilateral DM, even if there is no complaint in the opposite knee at first, the opposite knee also has a higher risk in terms of accompanying knee joint pathologies in the future (14). In our study, most of the patients with DM had unilateral knee imaging. This suggests that, similar to the literature, the complaints were initially one-sided. On the other hand, very few patients with DM had bilateral MRI images. However, in most of those with bilateral images, DM and meniscopathy were detected in both knees. In the literature it has been reported an almost twice as high incidence of ruptures or degenerative changes in DM compared to normal meniscus (27). Inconsistent with the literature, we found that individuals with normal meniscus had more meniscal pathology than individuals with DM. Maffulli et al. (28) evaluated 89 pediatric patients in their prospective arthroscopic study. They reported many pathologies including the presence of DM and ligament degeneration. However, they did not mention the association of DM and ligament tears. Although ACL injury increases with age in our study, we think that an accurate comparison cannot be made because there was only 1 patient in the DM group in patients older than 65 years.

In 1948, Smillie proposed that in the normal course of embryological development, a disc-shaped structure forms in the knee joint, and then in some individuals the central part of the disc fails to resorbs, leading to DM (6). Later studies, contrary to this theory, reported that the meniscus does not form a disc-shaped fibrocartilage structure at any stage of embryological development (29,30). Kaplan (7) stated that DM is related to increased meniscus movement secondary to posterior tibial attachment deficiency. In their study of more than 4.5 million individuals, Grimm et al. found that the prevalence of DM was 0.004 and that there was no significant association between gender, ethnicity, body mass index and DM. They also found that three quarters of individuals with DM were symptomatic (4). Kale et al. (15) reported that the primordial shape of the meniscus is discoid and that this form later transforms into other shapes and this transformation may begin in the early stages of intrauterine life. They explained the differences in meniscus shape with mesenchymal differentiation or vasculature development.

Limitations

Our study has several limitations. One of them is the number of individuals evaluated was not very large. Additionally, not all patients had bilateral images. Our other shortcomings are that we do not have information about patients' factors such as height, weight, body mass index, accompanying diseases, occupation, living conditions and familial predisposition.

CONCLUSION

We found a higher incidence of incomplete type DM. Contrary to our expectation, we saw more ligament and cartilage damage in the presence of normal meniscus. We think that our results will contribute to the literature.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Tokat Gaziosmanpaşa University Clinical Research Ethics Committee (Date: 09.06.2022, Decision No: 22-KAEK-130).

Informed Consent: All patients signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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