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Original Research Article

ANALYSIS OF MRI FINDINGS IN PATIENTS DIAGNOSED WITH KNEE OSTEOARTHRITIS: AN INSTITUTIONAL BASED STUDY

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ABSTRACT

Background: Osteoarthritis of the knee is a common degenerative joint disorder and an important cause of pain, stiffness, restricted mobility, and functional disability. Magnetic resonance imaging is useful in the evaluation of knee osteoarthritis because it provides detailed assessment of articular cartilage, subchondral bone, menisci, ligaments, synovium, and joint fluid. MRI can detect early and advanced structural abnormalities that may not be completely assessed on routine radiography. The aim is to analyze MRI findings in patients diagnosed with knee osteoarthritis.

Materials and Methods: This hospital-based observational study was conducted in the Department of Radio Diagnosis, Malla Reddy Institute of Medical Sciences, Hyderabad, Telangana, India. A total of 74 patients with clinical features suggestive of knee osteoarthritis were included. Patients of either sex presenting with knee pain, stiffness, swelling, crepitus, restricted movement, or functional limitation underwent MRI examination of the symptomatic knee. MRI was performed using standard sequences in sagittal, coronal, and axial planes. Findings were assessed for cartilage loss, osteophytes, joint effusion, meniscal degeneration, meniscal tear, bone marrow edema, subchondral cysts, synovial thickening, ligament abnormalities, and Baker's cyst. Data were analyzed using IBM SPSS Statistics. Frequencies, percentages, and appropriate statistical tests were applied, and a p-value of less than 0.05 was considered statistically significant.

Results: The majority of patients were in the 51–60 years age group, 24 patients, 32.43%, followed by 61–70 years, 21 patients, 28.38%. Females were more commonly affected, 41 patients, 55.41%, than males, 33 patients, 44.59%. Moderate osteoarthritis was the most common MRI grade, seen in 34 patients, 45.95%, followed by severe osteoarthritis in 22 patients, 29.73%, and mild osteoarthritis in 18 patients, 24.32%. Cartilage thinning/loss was the most frequent MRI finding, observed in 60 patients, 81.08%, followed by osteophytes in 48 patients, 64.86%, joint effusion in 45 patients, 60.81%, meniscal degeneration in 42 patients, 56.76%, and meniscal tear in 36 patients, 48.65%. Increasing age showed a statistically significant association with MRI severity of osteoarthritis, p=0.001. Bone marrow edema, joint effusion, meniscal tear, synovial thickening, and subchondral cysts were significantly associated with advanced MRI severity.

Conclusion: MRI is a valuable modality for comprehensive evaluation of knee osteoarthritis. It helps in detecting cartilage loss, meniscal abnormalities, subchondral bone changes, synovial involvement, and joint effusion, and is useful for assessing disease severity.

Keywords: Knee Osteoarthritis; Magnetic Resonance Imaging; Cartilage Loss; Meniscal Tear; Joint Effusion.

INTRODUCTION

Osteoarthritis of the knee is one of the most common chronic musculoskeletal disorders and is an important cause of pain, disability, reduced mobility, and impaired quality of life, particularly among middle-aged and elderly individuals. It is no longer considered only a disease of articular cartilage wear, but rather a whole-joint disorder involving cartilage, subchondral bone, menisci, synovium, ligaments, periarticular soft tissues, and the inflammatory microenvironment of the joint. The knee joint is especially vulnerable because it is a major weight-bearing articulation exposed to repetitive mechanical stress, altered biomechanics, obesity-related loading, ageing-related tissue degeneration, previous injury, and metabolic influences. These factors may act together to produce progressive structural damage and clinical symptoms such as pain, stiffness, swelling, crepitus, deformity, and limitation of daily activities.[1] Conventional radiography remains widely used as the initial imaging modality for suspected knee osteoarthritis because it is inexpensive, easily available, and useful for assessing joint space narrowing, osteophytes, sclerosis, malalignment, and advanced bony changes. However, radiographs provide only an indirect assessment of cartilage loss through joint space narrowing and have limited ability to demonstrate early cartilage abnormalities, meniscal pathology, synovitis, bone marrow lesions, ligament changes, and intra-articular soft tissue abnormalities. As a result, radiography may underestimate the extent of disease, particularly in early or clinically symptomatic patients with minimal radiographic changes. MRI overcomes many of these limitations by allowing direct visualization of multiple joint structures in different planes without ionizing radiation.[2] Magnetic resonance imaging has become an important tool for comprehensive assessment of knee osteoarthritis because it provides excellent soft tissue contrast and enables evaluation of the whole joint as a single functional unit. MRI can detect articular cartilage thinning, fissuring, focal defects, full-thickness cartilage loss, osteophyte formation, subchondral cysts, bone marrow edema-like lesions, meniscal degeneration, meniscal tears, meniscal extrusion, ligament degeneration, synovial thickening, joint effusion, Baker's cyst, and loose bodies. These findings are relevant because knee osteoarthritis often affects multiple tissues simultaneously, and structural abnormalities visible on MRI may explain symptoms better than radiographic findings alone. MRI is therefore useful not only for diagnosis but also for grading severity, identifying associated internal derangements, and understanding the pattern of compartmental involvement.[3] Cartilage loss is one of the central pathological features of knee osteoarthritis. MRI allows direct evaluation of cartilage morphology, including surface irregularity, partial-thickness loss, deep fissuring, and full-thickness defects with exposed subchondral bone. The ability to identify cartilage damage in the medial tibiofemoral, lateral tibiofemoral, and patellofemoral compartments is clinically important because disease distribution may influence symptoms, functional impairment, mechanical alignment, and treatment planning. In addition to cartilage assessment, MRI can demonstrate osteophytes and subchondral bone changes, which represent the osseous response to chronic joint degeneration and altered load transmission. These abnormalities help in recognizing both established and progressive osteoarthritis.[4] Subchondral bone involvement is increasingly recognized as an important component of knee osteoarthritis. Bone marrow edema-like lesions seen on MRI may reflect increased mechanical stress, microtrabecular injury, bone remodeling, local inflammation, or altered bone-cartilage interaction. Subchondral cysts and sclerosis may also be seen in more advanced disease and often coexist with cartilage loss. These changes are important because osteoarthritis progression is not limited to cartilage erosion alone; the subchondral bone plays an active role in the degenerative process. MRI is particularly valuable for identifying these bone-related abnormalities, which are not always visible on plain radiographs, especially in earlier stages of disease.[5] Meniscal abnormalities are frequently associated with knee osteoarthritis and may contribute to altered joint mechanics, increased focal loading, and acceleration of cartilage damage. MRI is highly useful for evaluating meniscal degeneration, intrasubstance signal changes, tears, maceration, and extrusion. Meniscal extrusion is especially important because it reduces the load-distributing function of the meniscus and may increase contact stress on articular cartilage. Ligament degeneration or sprain may also be detected on MRI, particularly in patients with chronic instability or degenerative joint disease. Evaluation of these structures helps to distinguish isolated degenerative osteoarthritis from osteoarthritis complicated by internal derangement.[6]

MATERIALS AND METHODS

This was a hospital-based observational study conducted in the Department of Radio Diagnosis, Malla Reddy Institute of Medical Sciences, Hyderabad, Telangana, India. The study was designed to evaluate magnetic resonance imaging findings among patients diagnosed with osteoarthritis of the knee. MRI was used to assess articular cartilage, subchondral bone, menisci, ligaments, synovium, joint effusion, and other associated structural abnormalities of the knee joint. The study included 74 patients with clinical features suggestive of knee osteoarthritis who were referred for MRI evaluation of the knee. Patients of either

sex presenting with knee pain, stiffness, restricted movement, swelling, crepitus, or functional limitation were considered for inclusion. All patients underwent detailed clinical assessment followed by MRI examination of the affected knee.

Inclusion Criteria

Patients with clinical diagnosis or suspicion of osteoarthritis of the knee, patients aged above 18 years, and patients willing to undergo MRI examination were included in the study. Patients with unilateral or bilateral knee symptoms were considered; however, MRI findings were recorded for the symptomatic knee as per the study protocol.

Exclusion Criteria

Patients with a history of recent knee trauma, previous knee surgery, inflammatory arthritis, infective arthritis, neoplastic lesions involving the knee joint, congenital or developmental knee deformities, and patients with contraindications to MRI such as metallic implants, pacemakers, cochlear implants, or severe claustrophobia were excluded from the study.

Methodology

MRI Technique and Protocol: MRI of the knee was performed using a dedicated knee coil with the patient placed in the supine position. The affected knee was positioned comfortably with slight external rotation, and immobilization was ensured to reduce motion artifacts. Standard MRI sequences were obtained in multiple planes, including sagittal, coronal, and axial planes. The protocol included T1-weighted images, T2-weighted images, proton density fat-suppressed sequences, short tau inversion recovery sequences, and gradient echo sequences wherever required. Slice thickness, field of view, matrix size, and interslice gap were optimized to obtain high-resolution images of the knee joint structures.

MRI Parameters Assessed: MRI findings were evaluated systematically for features of osteoarthritis. Articular cartilage was assessed for thinning, surface irregularity, fissuring, focal defects, and full-thickness cartilage loss. Subchondral bone was evaluated for bone marrow edema, subchondral cysts, sclerosis, and osteophyte formation. Menisci were assessed for degeneration, extrusion, and tears involving the medial or lateral meniscus. Cruciate and collateral ligaments were evaluated for degeneration, sprain, partial tear, or complete tear. Joint effusion, synovial thickening, Baker's cyst, loose bodies, periarticular soft tissue abnormalities, and alignment-related changes were also recorded. The compartment involved, including medial tibiofemoral, lateral tibiofemoral, and patellofemoral compartments, was documented.

Grading of Osteoarthritis on MRI: The severity of osteoarthritic changes was graded based on MRI features such as cartilage loss, osteophyte formation, subchondral marrow changes, meniscal abnormalities, and joint space involvement. Cartilage defects were categorized as mild when there was focal superficial cartilage irregularity or partial thinning, moderate when there was extensive partial-thickness cartilage loss, and severe when full-thickness cartilage loss with exposed subchondral bone was present. Meniscal lesions were classified according to signal intensity and extension to the articular surface. Bone marrow lesions, synovitis, and joint effusion were graded as absent, mild, moderate, or severe based on their extent and distribution.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics. Categorical variables such as sex, affected side, cartilage loss, osteophytes, meniscal tears, bone marrow edema, joint effusion, and synovitis were expressed as frequencies and percentages. Continuous variables such as age were expressed as mean and standard deviation. The chi-square test or Fisher's exact test was used to assess associations between categorical variables. Independent sample t-test or one-way analysis of variance was used for comparison of continuous variables where applicable. A p-value of less than 0.05 was considered statistically significant.

RESULTS

In the present study, a total of 74 patients with osteoarthritis of the knee were evaluated using MRI. [Table 1] shows the demographic distribution of the study participants. The largest proportion of patients belonged to the 51–60 years age group, comprising 24 patients, which accounted for 32.43% of the total study population. This was followed by the 61–70 years age group with 21 patients, representing 28.38%. Patients aged 41–50 years constituted 17.57%, while those above 70 years formed 13.51%. The least number of patients were aged ≤40 years, accounting for 8.11%. With regard to sex distribution, females were more commonly affected than males. Out of 74 patients, 41 were females, contributing 55.41%, while 33 were males, accounting for 44.59%. This shows a slight female predominance among patients with knee osteoarthritis in the present study. In terms of side affected, the left knee was involved in 38 patients, accounting for 51.35%, followed by the right knee in 30 patients, representing 40.54%. Bilateral symptoms were present in 6 patients, contributing 8.11%.

[Table 2] shows the MRI severity grading of knee osteoarthritis. Moderate osteoarthritis was the most common grade, observed in 34 patients, accounting for 45.95% of the study population. Severe osteoarthritis was seen in 22 patients, representing 29.73%, while mild osteoarthritis was observed in 18 patients, accounting for 24.32%.

[Table 3] presents the distribution of major MRI findings among patients with knee osteoarthritis. Cartilage thinning or cartilage loss was the most common MRI abnormality, observed in 60 patients, accounting for 81.08%. Osteophytes were noted in

48 patients, representing 64.86%, while joint effusion was seen in 45 patients, contributing 60.81%. Meniscal degeneration was present in 42 patients, accounting for 56.76%, and meniscal tear was observed in 36 patients, representing 48.65%. Bone marrow edema was identified in 34 patients, accounting for 45.95%, while subchondral cysts were seen in 26 patients, representing 35.14%. Synovial thickening was observed in 22 patients, contributing 29.73%. Ligament degeneration or sprain was found in 18 patients, accounting for 24.32%, and Baker's cyst was the least common finding, noted in 12 patients, representing 16.22%.

[Table 4] shows the association between age group and MRI severity of knee osteoarthritis. Among patients aged ≤40 years, most had mild osteoarthritis, with 5 out of 6 patients showing mild changes and only 1 patient showing moderate changes. No severe osteoarthritis was observed in this age group. In the 41–50 years age group, mild and moderate osteoarthritis were equally distributed, with 6 patients each, while only 1 patient had severe osteoarthritis. In the 51–60 years age group, moderate osteoarthritis was most common, seen in 13 patients, followed by severe osteoarthritis in 6 patients and mild osteoarthritis in 5 patients. Among patients aged 61–70 years, moderate osteoarthritis was observed in 10 patients and severe osteoarthritis in 9 patients, while only 2 patients had mild disease. In patients aged above 70 years, severe osteoarthritis was the most frequent finding, observed in 6 patients, while 4 patients had moderate disease and none had mild disease. The association between age and MRI severity was statistically significant, with a p-value of 0.001, indicating that the severity of osteoarthritis increased significantly with advancing age.

[Table 5] shows the association of selected MRI findings with severity of osteoarthritis. Bone marrow edema was observed in 4 patients with mild osteoarthritis, 16 patients with moderate osteoarthritis, and 16 patients with severe osteoarthritis. The association was statistically significant, with a p-value of 0.006. Joint effusion was present in 7 patients with mild osteoarthritis, 20 patients with moderate osteoarthritis, and 18 patients with severe osteoarthritis. This association was statistically significant, with a p-value of 0.021, suggesting that joint effusion increased with increasing severity of osteoarthritis. Meniscal tear was seen in 5 patients with mild disease, 18 patients with moderate disease, and 19 patients with severe disease. The association was highly significant, with a p-value of 0.001, showing that meniscal tears were more frequent in advanced osteoarthritis. Synovial thickening was observed in 2 patients with mild osteoarthritis, 10 patients with moderate osteoarthritis, and 14 patients with severe osteoarthritis, with a statistically significant p-value of 0.002. Subchondral cysts were seen in 1 patient with mild disease, 8 patients with moderate disease, and 13 patients with severe disease. This association was also statistically significant, with a p-value of 0.001.

Table 1: Demographic distribution of study participants

Variable	Category	Frequency	Percentage
Age group	≤40 years	6	8.11%
	41–50 years	13	17.57%
	51–60 years	24	32.43%
	61–70 years	21	28.38%
	>70 years	10	13.51%
Sex	Male	33	44.59%
	Female	41	55.41%
Side affected	Right knee	30	40.54%
	Left knee	38	51.35%
	Bilateral symptoms	6	8.11%

Table 2: MRI severity grading of knee osteoarthritis

MRI severity grade	Frequency	Percentage
Mild	18	24.32%
Moderate	34	45.95%
Severe	22	29.73%
Total	74	100.00%

Table 3: Distribution of major MRI findings

MRI finding	Frequency	Percentage
Cartilage thinning/loss	60	81.08%
Osteophytes	48	64.86%
Joint effusion	45	60.81%
Meniscal degeneration	42	56.76%
Meniscal tear	36	48.65%
Bone marrow edema	34	45.95%
Subchondral cysts	26	35.14%
Synovial thickening	22	29.73%
Ligament degeneration/sprain	18	24.32%
Baker's cyst	12	16.22%

Table 4: Association between age group and MRI severity

Age group	Mild	Moderate	Severe	Total	p-value
≤40 years	5	1	0	6	
41–50 years	6	6	1	13	
51–60 years	5	13	6	24	
61–70 years	2	10	9	21	
>70 years	0	4	6	10	
Total	18	34	22	74	0.001

Table 5: Association of selected MRI findings with severity of osteoarthritis

MRI finding	Mild n=18	Moderate n=34	Severe n=22	p-value
Bone marrow edema	4	16	16	0.006
Joint effusion	7	20	18	0.021
Meniscal tear	5	18	19	0.001
Synovial thickening	2	10	14	0.002
Subchondral cysts	1	8	13	0.001

DISCUSSION

In the present study, knee osteoarthritis was more common in older patients, with the highest proportion in the 51–60 years age group, 24 patients or 32.43%, followed by 61–70 years, 21 patients or 28.38%. Only 6 patients, 8.11%, were aged ≤40 years. This age distribution supports the degenerative nature of osteoarthritis, where structural damage increases with advancing age. Felson et al. (1987), in the Framingham Osteoarthritis Study, also reported that radiographic knee osteoarthritis increased with age, from 27.00% in subjects below 70 years to 44.00% in subjects aged 80 years or above.[7]

In the present study, females were more commonly affected than males, with 41 females, 55.41%, and 33 males, 44.59%. This female predominance was comparable with Muraki et al. (2009), who reported in the ROAD study that radiographic knee osteoarthritis was more prevalent in women than men, with prevalence rates of 70.20% in women and 47.00% in men. The slightly lower female predominance in the present study may be due to its hospital-based design and smaller sample size, but both studies indicate that female sex is an important associated factor in knee osteoarthritis.[8] In the present study, moderate osteoarthritis was the most common MRI grade, seen in 34 patients, 45.95%, followed by severe osteoarthritis in 22 patients, 29.73%, and mild osteoarthritis in 18 patients, 24.32%. This pattern suggests that most patients presented after structural disease was already established. Link et al. (2003) also showed that MRI findings increased with radiographic severity; in their study, 13 of 16 knees with Kellgren-Lawrence grade 4 showed full-thickness cartilage lesions and bone marrow edema pattern. The present study similarly found that advanced MRI grades were associated with more frequent structural abnormalities, supporting the role of MRI in detecting disease severity.[9]

Cartilage thinning or cartilage loss was the most common MRI finding in the present study, observed in 60 patients, 81.08%. Osteophytes were the second most common finding, present in 48 patients, 64.86%. Park et al. (2013), in their study on a practical MRI grading system for knee osteoarthritis, reported that cartilage loss and osteophytes were the most prevalent MRI features, being present in 98.00% and 92.00% of knees, respectively. Although the percentages in the present study were lower, the order of frequency was similar, confirming that cartilage loss and osteophyte formation are the major MRI features of knee osteoarthritis.[10]

Joint effusion was observed in 45 patients, 60.81%, in the present study, and its frequency increased with MRI severity, being present in 7 mild cases, 20 moderate cases, and 18 severe cases, with a statistically significant association, p=0.021. Hill et al. (2001) reported moderate-to-large effusions on MRI in 56.40% of patients with knee pain and radiographic osteoarthritis, which is close to the 60.81% observed in the present study. These findings suggest that joint effusion is a frequent associated feature of symptomatic knee osteoarthritis and may reflect active intra-articular inflammation or synovial irritation.[11]

Meniscal abnormalities were also common in the present study. Meniscal degeneration was seen in 42 patients, 56.76%, while meniscal tear was observed in 36 patients, 48.65%. Meniscal tear showed a significant association with increasing MRI severity, being present in 5 mild cases, 18 moderate cases, and 19 severe cases, with p=0.001. Englund et al. (2008), in a population-based MRI study, reported that meniscal damage was frequent in knees with osteoarthritis and was also seen in older individuals, even without symptoms. Compared with their observations, the high proportion of meniscal tears in the present study supports the close relationship between meniscal pathology and osteoarthritic structural damage.[12]

Bone marrow edema was identified in 34 patients, 45.95%, in the present study and was significantly associated with disease severity, being present in 4 mild cases, 16 moderate cases, and 16 severe cases, with p=0.006. Lo et al. (2009), using data from the Osteoarthritis Initiative, reported that 44.00% of knees with medial meniscal derangement had large medial bone marrow lesions, whereas none of the

knees without medial meniscal derangement had large bone marrow lesions. The present study similarly demonstrated that bone marrow edema was more frequent in moderate and severe osteoarthritis, suggesting that subchondral bone involvement is an important marker of advanced disease.[13]

Subchondral cysts were seen in 26 patients, 35.14%, in the present study, and their frequency increased with severity, being present in 1 mild case, 8 moderate cases, and 13 severe cases, with p=0.001. Guymer et al. (2007) studied 176 adult women and showed that subchondral bone marrow lesions were associated with knee structural abnormalities, including cartilage defects and reduced cartilage volume. Although their study focused mainly on bone marrow lesions rather than cysts alone, both studies support the concept that subchondral bone changes are closely related to progressive cartilage damage in knee osteoarthritis.[14]

Synovial thickening was observed in 22 patients, 29.73%, in the present study and showed a statistically significant association with MRI severity, being present in 2 mild cases, 10 moderate cases, and 14 severe cases, with p=0.002. Felson et al. (2016), in the MOST study, reported that synovitis was associated with incident knee osteoarthritis, and higher synovitis scores increased the risk of developing osteoarthritis, with an adjusted odds ratio of 1.60 for synovitis scores ≥3. The present study is consistent with these findings, as synovial thickening was more frequent in severe osteoarthritis and may represent an inflammatory component of disease progression.[15]

CONCLUSION

MRI is a valuable imaging modality for comprehensive evaluation of knee osteoarthritis, as it detects cartilage loss, osteophytes, joint effusion, meniscal abnormalities, bone marrow edema, synovial thickening, and subchondral cysts.

In the present study, moderate osteoarthritis was the most common MRI grade, and cartilage thinning/loss was the most frequent MRI finding. Increasing age was significantly associated with greater MRI severity of osteoarthritis. MRI findings such as meniscal tear, bone marrow edema, joint effusion, synovial thickening, and subchondral cysts were significantly associated with advanced disease severity.

REFERENCES

1. Hsu H, Siwiec RM. Knee osteoarthritis. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025. https://www.ncbi.nlm.nih.gov/books/NBK507884/.
2. Roemer FW, Demehri S, Omoumi P, Link TM, Kijowski R, Saarakkala S, et al. State of the Art: Imaging of osteoarthritis—revisited 2020. Radiology. 2020;296(1):5-21. doi: 10.1148/radiol.2020192498.
3. Sukerkar PA, Doyle Z. Imaging of osteoarthritis of the knee. Radiol Clin North Am. 2022;60(4):605-616. doi: 10.1016/j.rcl.2022.03.004.
4. Roemer FW, Guermazi A, Demehri S, Wirth W, Kijowski R. Imaging in osteoarthritis. Osteoarthritis Cartilage. 2022;30(7):913-934. doi: 10.1016/j.joca.2021.04.018.
5. Ehmig J, Engel G, Lotz J, Lehmann W, Taheri S, Schilling AF, et al. MR-imaging in osteoarthritis: current standard of practice and future outlook. Diagnostics (Basel). 2023;13(15):2586. doi: 10.3390/diagnostics13152586.
6. Piccolo CL, Mallio CA, Vaccarino F, Grasso RF, Zobel BB. Imaging of knee osteoarthritis: a review of multimodal diagnostic approach. Quant Imaging Med Surg. 2023;13(11):7582-7595. doi: 10.21037/qims-22-1392.
7. Felson DT, Naimark A, Anderson J, Kazis L, Castelli W, Meenan RF. The prevalence of knee osteoarthritis in the elderly: the Framingham Osteoarthritis Study. Arthritis Rheum. 1987;30(8):914-918. doi: 10.1002/art.1780300811.
8. Muraki S, Oka H, Akune T, Mabuchi A et al. Prevalence of radiographic knee osteoarthritis and its association with knee pain in the elderly of Japanese population-based cohorts: the ROAD study. Osteoarthritis Cartilage. 2009;17(9):1137-1143. doi: 10.1016/j.joca.2009.04.005.
9. Link TM, Steinbach LS, Ghosh S, Ries M, Lu Y, Lane N, et al. Osteoarthritis: MR imaging findings in different stages of disease and correlation with clinical findings. Radiology. 2003;226(2):373-381. doi: 10.1148/radiol.2262012190.
10. Park HJ, Kim SS, Lee SY, Park NH, Rho MH, Chung EC, et al. A practical MRI grading system for osteoarthritis of the knee: association with Kellgren-Lawrence radiographic scores. Eur J Radiol. 2013;82(1):112-117. doi: 10.1016/j.ejrad.2012.02.023.
11. Hill CL, Gale DG, Chaisson CE, Skinner K, Kazis L, Gale ME, et al. Knee effusions, popliteal cysts, and synovial thickening: association with knee pain in osteoarthritis. J Rheumatol. 2001;28(6):1330-1337.
12. Hunter DJ, Zhang YQ, Niu JB, Tu X, Amin S, Clancy M, et al. The association of meniscal pathologic changes with cartilage loss in symptomatic knee osteoarthritis. Arthritis Rheum. 2006;54(3):795-801. doi: 10.1002/art.21724.
13. Lo GH, Hunter DJ, Nevitt M, Lynch J, McAlindon TE. Strong association of MRI meniscal derangement and bone marrow lesions in knee osteoarthritis: data from the Osteoarthritis Initiative. Osteoarthritis Cartilage. 2009;17(6):743-747. doi: 10.1016/j.joca.2008.09.006.
14. Guymer E, Baranyay F, Wluka AE, Hanna F, Bell RJ, Davis SR, et al. A study of the prevalence and associations of subchondral bone marrow lesions in the knees of healthy, middle-aged women. Osteoarthritis Cartilage. 2007;15(12):1437-1442. doi: 10.1016/j.joca.2007.04.018.
15. Felson DT, Niu J, Neogi T, Goggins J, Nevitt MC, Roemer F, et al. Synovitis and the risk of knee osteoarthritis: the MOST Study. Osteoarthritis Cartilage. 2016;24(3):458-464. doi: 10.1016/j.joca.2015.09.013.