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Degenerative disease of knee joint: a clinico-radiological correlation

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ABSTRACT

Background: This study was done from January 2014 to July 2016, in 128 patients of knee joint osteoarthritis. We assessed epidemiology of osteoarthritis of knee and various MRI findings.

Methods: In all the 128 patients radiographs (anteroposterior) were taken in extended and weight bearing position. Staging of osteoarthritis of knee was done using Kellgren-Lawrence scoring system and then we performed magnetic resonance imaging of the knee. All these patients were then interviewed about their clinical symptoms and osteoarthritis of knee was graded by WOMAC scale.

Results: Osteoarthritis has a positive correlation with age, female sex and BMI. However occupation of the patient was not associated with any statistical significance. No association was seen between cartilage defects, bone marrow edema, sub chondral cysts, subchondral sclerosis, Baker's cysts subluxations of tibia and synovitis with clinical features. The patellofemoral compartment of knee joint mostly contributed to the clinical symptoms of the patients in our study population though not being statistically significant (P > 0.05). In tibiofemoral compartment a statistically significant correlation was seen between most of the MRI findings and KL score, however in patellofemoral compartment this correlation is poor.

Conclusions: Clinical findings and plain radiographs are still important in evaluating osteoarthritis of knee, MRI plays an important role in imaging the bony and soft tissues of knee as a whole organ, thereby helping in better management and outcome of the disease. Also MRI plays an important role in depicting early changes of osteoarthtis.

Keywords: Knee, KL score, MRI, Osteoarthritis, WOMAC scale

INTRODUCTION

Osteoarthritis is among the most prevalent chronic conditions which lead to physical impairment and it is also the most common form of arthritis in the whole world. Prevalence of osteoarthritis (OA) is very high and it is expected to increase considerably as population is ageing. ^{1,2} Risk factors common for knee osteoarthritis are older age (>50 years), obesity, joint immobilization, history or history of joint injury, prolonged occupational

or sports stress, joint instability or hypermobility etc. Secondary osteoarthritis is sequelae of other arthropathy.

Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) is used to assess pain, stiffness, and physical function in patients with knee osteoarthritis.³ Since long, radiography has been the primary imaging modality for evaluation of osteoarthritis. However, its limitations regarding severity of disease and clinical outcome are well established. As knee joint is complex three dimensional structure and radiographs are

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its two dimensional composite, so radiographs have limited sensitivity for observation of features such as osteophytes, subchondral sclerosis and bone eburnation. The tomographic viewing perspective, tissue contrast and spatial resolution of magnetic resonance imaging provide a capability to display soft tissue, cartilage and bone abnormalities which is required for whole organ evaluation of the knee. Therefore, MRI plays an important role to detect early osteoarthritis which is important clinically as therapeutic agents for modifying early osteoarthritis are recently in focus. In several larger longitudinal and cross sectional studies, investigators evaluated multiple magnetic resonance imaging defined parameters with encouraging results, although the populations in these studies typically included older subjects, who had relatively advanced osteoarthritis of knee.⁴⁻⁸ In clinically suspected early osteoarthritis of knee, more clinical trials of MRI with additional parameters are required to establish it as primary imaging modality.

Dr. Peterly, chief medical officer and Co-founder, was the first to develop whole organ magnetic resonance imaging scoring (WORMS) for the knee. It combines semiquantitative assessments of a total of 11 structural features including subarticular marrow edema, articular cartilage, bone attrition in eight different locations in the knee; the medial and lateral menisci; osteophytes along sixteen articular margins; medial and lateral collateral ligaments; and the anterior and posterior cruciate ligaments.⁹

MRI can evaluate all parameters of disease component in degenerative which includes changes in bone, bone marrow, cartilage, menisci, ligaments, tendons, joint fluid and joint capsule.

METHODS

Inclusion criteria

Patient with knee osteoarthritis who were diagnosed by Clinico-Radiological American Rheumatism Association Criteria, which is as follows

- Osteophytosis
- Knee pain
- Age > 40 year
- Joint stiffness <30 minutes
- Crepitus.

Presence of 1, 2 and one of 3, 4 or 5 is necessary for the diagnosis of osteoarthritis of knee.

Exclusion criteria

- Patient with at least one contra-indication
- Claustrophobic or non -cooperative patient
- Patients having obvious joint inflammation
- Operated knee or post traumatic knee joint

- Patients with ipsilateral hip joint pathology
- Patients with peripheral neuropathy or fibromyalgia
- Ulcer / wound around knee joint
- Patients with non-compatible MR implant.

Sampling

128 patients were included as a study group. In all the patient's radiographs (anteroposterior) were taken in extended and weight bearing position. Staging of osteoarthritis of knee was done using Kellgren-Lawrence scoring system and then we performed magnetic resonance imaging of the knee. All these patients were then interviewed about their clinical symptoms and osteoarthritis of knee was graded by WOMAC scale.

The patients were interviewed regarding the amount of knee pain and stiffness experienced by them and to answer the questions a scale was used which included five points (none, slight, moderate, severe and extreme pain).

WOMAC scores were assessed which was based on their answers. The scores had range from zero to 96. The WOMAC (Western Ontario and McMaster Universities) index is used to assess patients with osteoarthritis of the hip or knee using 24 parameters.

Radiographic assessment

In all the patients, by using standard radiographic technique knee radiographs (anteroposterior) were taken in extended and weight bearing position. Then all the radiographs were graded on the basis of Kellgren–Lawrence grading system.

"This Kellgren-Lawrence score was based on osteophyte formation, joint space narrowing, sclerosis, and joint deformity characteristics according to the five-level scale defined as follows: grade 0, normal; grade 1, doubtful osteoarthritis; grade 2, minimal osteoarthritis; grade 3, moderate osteoarthritis; or grade 4, severe osteoarthritis. The anteroposterior views characterize osteoarthritis of the knee in the medial and lateral femorotibial compartments, with exclusion of the patellofemoral compartment.

MRI findings

We performed MRI of knee with 1.5T Magnetom Siemens MRI scanner using immobilisers for knee joints. Surface coils were used for better signal reception.

Cartilage defect

location, size and severity of cartilage defect were assessed in three compartments (lateral femorotibial, medial femorotibial and in patellofemoral compartment) and in seven surfaces (medial and lateral articular surfaces of femur and tibia; patellar medial and lateral facets and trochlea). On the basis of Noyes arthroscopic system severity scoring was done and the system was modified for MRI. Cartilage was graded as Grade 0-cartilage was normal; grade I was assigned to altered internal signal; grade IIA, when defect was <50%; grade II B 50-99% cartilage defect; grade III A, cartilage defect 100% without any bone ulceration; grade III B was 100% with ulceration in bone.

Subchondral trabecular bone marrow edema (BME)

Site and severity of BME lesions were assessed and graded as; Grade 0 was normal; Grade I, when largest diameter of the lesion was <10 mm; Grade II, when the lesion was >10mm in its largest diameter.

Marginal osteophytes

Grades were assigned to osteophytes as Grade 0 was assigned to normal, osteophytes absent; Grade I, Osteophytes <5mm; Grade II, >5mm.

Subchondral cysts

These were graded as follows: Grade 0, was normal; Grade I, when diameter was <10mm; Grade II, when diameter was >10mm.

Subchondral sclerosis

This was graded in all the copmpartments as: Grade 0, no sclerosis; Grade I, when depth of sclerosis extending <5mm or Grade II, when depth of sclerosis extending >5mm.¹¹

Joint effusion

It was graded as: Grade 0, no evidence of joint effusion; Grade I, small amount of effusion; or Grade II, when the effusion was moderate to large.

Baker's cyst/Synovial cyst

Synovial cysts were graded as: grade 0, was normal; grade 1, mild; grade 2, moderate to marked.30

Synovitis

It was graded as follows: Grade O, no synovitis; Grade I mild synovitis or Grade II, moderate to marked synovitis.54,55

Meniscal abnormalities

Frank tears and intrameniscal abnormalities were graded as: Grade 0, either normal or intrasubstance globular abnormalities; Grade II, non-displaced tear; or Grade III, complex displaced tear.

Ligaments abnormalities

In case of cruciate ligament Grade 0 was no abnormality seen; Grade I, intraligamentous or periligamentous increased edema however with normal course of ligament and atleast with few intact fibres; or Grade II, when tear of ligament was complete.

In case of collateral ligaments: Grade 0 was normal ligament; Grade I, ligament was intact but presence of periligamentous or intrasubstance edema; Grade II ligament partially torn; Grade III ligament completely torn.

From January 2014 to June 2016, our study was conducted in 128 patients referred to our department for MRI. To achieve randomization every third patient visiting to our MRI centre for MRI scan of knee joint is included in the study. Proper clinical history of the patients was taken and accordingly WOMAC score was calculated. KL score of the patient was also calculated after carefully studying the X-ray of the patients. Then patients were subjected to MRI scans of the most symptomatic knee according their history.

During the analysis of magnetic resonance imaging findings, the knee which was the most symptomatic was included in the study. For all statistical tests, a statistically significant difference was demonstrated with p values less than 0.05 and 95% confidence intervals. The results of MRI were compared with patient's clinical profile and KL scores.

RESULTS

A statistically significant association was noted between the presence of osteophytosis in the tibiofemoral compartment of knee joint and age of the patients (p = 0.001, 0.022 respectively in medial and lateral condyles of femur) and (p = 0.022, 0.032 respectively in medial and lateral condyles of tibia), between bone marrow edema in both condyles of tibia and age of the patients (p = 0.013 and 0.008 respectively) and between subchondral cysts in medial tibial condyle and the age of the patients (p = 0.016).

In our study female population comprising of 96 ladies much higher incidence of osteoarthritis was seen in 40-45 years age group and only a slightly higher incidence in female population in more than 45 years of age. Female population had peak prevalence of osteoarthritis at a lower age as compared to males.

No significant statistical association was found between occupation/lifestyle of the patients and development of osteoarthritis of knee joint in our study. A slight positive correlation was seen between the occupation of the patients and synovitis (p = 0.09).

In our study population 50 patients (39.0%) had mass index less than 25, and 78 patients (60.93%) had body mass index more than 25. Thus we can say that osteoarthritis is more common in patients with a high body mass index.

Table 1: Distribution according to age.

Ago	No. of cases	Sex		
Age		Male	Female	
40-45	48	4	44	
46-50	8	4	4	
51-55	24	12	12	
56-60	24	4	20	
61-65	12	8	4	
66-70	8	4	4	
71-75	4	0	4	
Total	128	36	92	

Medial femoral condyle was the most common site of the osteophytosis and medial tibial condyle was the second most frequent site of osteophytes (Table 2).

Medial femoral condyle was the most frequent site of subchondral cysts and second most common site was medial tibial condyle (Table 3).

Table 2: Incidence osteophytes at different sites.

Sites	No. of patients	Percentage
Medial femoral condyle	120	96.8%
Lateral femoral condyle	90	70.3%
Medial tibial condyle	104	81.25%
Lateral tibial condyle	88	68.75%
Patella medial facet	100	78.13%
Patella lateral facet	57	44.53%
Femur trochlea	45	35.15%

Table 3: Incidence of subchondral cyst at different sites.

Sites	No. of patients	Percentage
Medial femoral condyle	88	68.75%
Lateral femoral condyle	67	52.34%
Medial tibial condyle	68	53.12%
Lateral tibial condyle	40	31.25%
Patella medial facet	44	34.37%
Patella lateral facet	20	15.62%
Femur trochlea	40	31.25%

Medial condyle of femur was the most frequent site of bone marrow edema lesions and the medial tibial condyle was the second most common site (Table 4).

Most common site of subchondral sclerosis was medial condyle of tibia (100 patients, 78.12% of study subjects)

followed by medial condyle of femur (80 patients i.e. 62.50% of study subjects (Table 5).

Table 4: Incidence of bone marrow edema at different sites.

Sites	No. of patients	Percentage
Medial femoral condyle	105	82.03%
Lateral femoral condyle	65	50.78%
Medial tibial condyle	86	67.18%
Lateral tibial condyle	64	50.00%
Patella medial facet	52	40.62%
Patella lateral facet	50	39.06%
Femur trochlea	20	15.62%

Table 5: Incidence of subchondral sclerosis at different sites.

Sites	No. of patients	Percentage
Medial femoral condyle	80	62.50 %
Lateral femoral condyle	12	9.37%
Medial tibial condyle	100	78.12%
Lateral tibial condyle	7	5.40%
Patella medial facet	16	12.5%
Patella lateral facet	25	19.50%
Femur trochlea	5	3.90%

Table 6: Incidence of cartilage defects at different sites.

Sites	No. of patients	Percentage
Medial femoral condyle	120	93.75%
Lateral femoral condyle	128	100%
Medial tibial condyle	118	92.10%
Lateral tibial condyle	120	93.75%
Patella medial facet	103	80.46%
Patella lateral facet	88	68.75%
Femur trochlea	90	70.30%

In the study group cartilage defects were present in almost all the patients. Cartilage defects were more common in tibiofemoral compartment than in patellofemoral compartment (Table 6).

Medial meniscus signal abnormality was observed in 116 patients (90.62% of total cases) of which 40 patients (31.25%) showed evidence of grade I signal, 60 patients (46.87% of total cases) had grade II signal and 16 patients (12.5% of total cases) showed grade III signal.

Lateral meniscus signal abnormality was seen in 124 patients (96.87% of total cases of which 40 patients (31.25% had grade I signal, 68 patients (53.13% of total cases), had grade II signal and 16 patients (12.5% of total cases) showed evidence of grade III signal (Table7).

Anterior cruciate ligament signal abnormality was seen in 28 patients (22% of total cases). 24 patients (18.75% of

total) showed grade I signal and 4 patients (3.1% of total) showed grade II signal.

Table 7: Incidence of meniscal tear.

	0	%	1	%	2	%	3	%
Medial	12	9.38	40	31.25	60	46.88	16	12.50
Lateral	4	3.13	40	31.25	64	53.13	16	12.50

Table 8: Incidence of cruciate ligament signal abnormality.

	0	%	1	%	2	%	
Anterior	100	78.13	24	18.75	4	3.13	
Posterior	86	67.19	42	32.80	0	0.00	

Table 9: Incidence of joint effusion, baker's cyst and synovitis.

	0	%	1	%	2	%	
Joint effusion	30	23.45	75	58.59	23	17.96	
Baker cyst	72	56.25	32	25.00	24	18.75	
Synovitis	100	78.13	28	21.87	0	0.00	

Table 10: Incidence of osteochondral bodies.

	Absent	%	Present	%
Osteochondral body	99	77.34	29	22.65

42 patients showed signal abnormality in posterior cruciate ligament. 42 patients (32.80% of total) showed grade I signal and no patients show grade II signal (Table 8).

Joint effusion was seen in 98 patients (76.56%) of study population. 56 patients showed varying grades of Baker's cyst. Presence of synovitis was seen in 28 patients (Table 9).

29 patients were having osteochondral bodies ~22.65% of our study population and all of them showed mild grade of synovitis (Table 10).

In tibiofemoral compartment KL score is showing high correlation with severity of ostephytes in MRI. As the MRI severity of osteophytes increases, the KL score also increases (p value = 0.000 and 0.098 for medial and lateral condyles of femur respectively and p = 0.000 and 0.001 for medial and lateral condyles of tibia respectively). The correlation coefficients between KL score and MRI detected osteophytes in patellofemoral were not significant (p >0.05).

A positive association was diagnosed between subchondral cysts in the tibia at its medial and lateral articulating surfaces and lateral articulation surface of femur by radiographic osteoarthritis (p = 0.002 and 0.056 and 0.066 respectively).

No significant statistical association was seen between subchondral sclerosis and KL score and many patients who were diagnosed to have a higher KL score on plain radiographs were diagnosed to have a lower grade of subchondral sclerosis on MRI.

A statistically significant correlation was seen between cartilage defects in tibiofemoral compartment in both lateral and medial aspect and KL score (p=0.048 and 0.038 in medial and lateral condyles of femur respectively and p = 0.028 and 0.002 in medial and lateral condyles of tibia respectively).

Statistically significant association was seen between medial meniscus injury and KL score (p=0.000). Baker's cysts are significantly associated with KL score (p = 0.05). Most severe pain symptoms were produced by femur trochlear osteophytes (mean WOMAC pain score 5.79). Most severe stiffness was produced by femur trochlear osteophytosis (mean WOMAC stiffness score 1.67). Maximum functional disability was produced by osteophytes in medial articulating surface of femur (mean WOMAC functional disability score 21.35).

Considering the mean total WOMAC score in different compartments of knee, we got high test mean WOMAC score in osteophytes in medial articulating surface of femur. (28.72). A positive correlation was seen between osteophytes in medial compartment of femur and knee stiffness (P value = 0.0093).

Considering the mean total WOMAC score in different compartments of knee, we got highest mean WOMAC score in association with subchondral cysts in lateral condyle of femur (28.8).

Bone marrow edema in patellar lateral and medial facet (mean WOMAC pain score 5.60) followed by those in lateral tibial condyle and femur trochlea were seen in association with most severe pain symptoms.

Most severe stiffness was seen in association with bone marrow edema in lateral articulating surface of femur (mean WOMAC stiffness score 1.56). Maximum functional disability was seen in bone marrow edema present in femur trochlea (mean WOMAC functional disability score (21.37) followed by bone marrow edema in lateral condyle of tibia (21.27), patella medial facet (21.18) and medial condyle of femur (21.03).

Considering the mean total WOMAC score in different compartments of knee, we got highest mean WOMAC score in femur trochlea (28.35) followed by lateral condyle of tibia (27.15). Most severe pain symptoms were seen subchondral sclerosis in lateral condyle of femur (mean WOMAC pain score 5.71).

Most severe stiffness symptoms were associated with subchondral sclerosis in femur trochlea and medial facet (mean WOMAC disability score 20.38), followed by medial condyle of tibia (20.30).

Considering the mean total WOMAC score in different compartments of knee, we got highest mean WOMAC score in subchondral sclerosis at medial condyle of femur (mean total WOMAC score 27.21). Most severe pain symptoms were seen in association with cartilage defects at femur trochlea (mean WOMAC pain score 6) followed by cartilage defect at patella lateral facet (mean WOMAC pain score 5.55).

Most severe stiffness was found in association with cartilage defect at medial and lateral articulating surface of femur (mean WOMAC stiffness score 1.47). Maximum functional disability was observed in association with cartilage defects in femur trochlea and patella medial (mean functional disability score 21 at both sites) followed by cartilage defects in medial condyle of tibia (mean WOMAC disability score 20.9).

Considering the mean total WOMAC score in different compartments of knee, we got highest mean WOMAC score in cartilage defect at femur trochlea and patella medial facet (mean total WOMAC score 28 at both sites). The symptoms of knee pain were more in association with lateral meniscus injury than medial meniscus injury while stiffness and physical disability are more seen in medial meniscus injury. No significant statistical association was seen between joint effusions and pain, stiffness or physical disability in knee joint (p>0.05). However the patients in our study had higher WOMAC

pain, stiffness, physical disability and total scores with increasing severity of joint effusions.

A statistically significant association was seen between functional disability and stiffness in knee joint (considering WOMAC functional disability and stiffness scores) and the presence of osteochondral bodies (p = 0.01). Positive correlation was also seen between total WOMAC score and the presence of osteochondral bodies (p = 0.0009).

DISCUSSION

The aim of the study was to evaluate MRI in patients with findings of degenerative disease of knee and to correlate them with clinical and radiography finding while taking in view the KL score and WOMAC score.

All the structures of the knee joint involved in the disease process can be examined on MRI with greater sensitivity. While cartilage was the main focus of the previous MRI literature, in latest studies there is more and more inclination towards whole organ evaluation osteoarthritis of knee and also including features such as bone marrow edema, synovitis and pathologies of ligaments and menisci. All the anatomical structures involved in the disease process can be visualized with MRI due to unparalleled tissue contrast provided by it. In our study, results show that in evaluation of osteoarthritis of knee, MRI is an excellent diagnostic modality due to multi planar viewing perspective. With the help of MRI, we were able to correlate objective imaging findings in osteoarthritis and clinical subjective symptoms of the patients.

In our study, MRI findings were also compared with radiographic findings and results showed that MRI was better to evaluate the soft tissue and bone changes in the disease process as compared to radiographs.

A statistically significant association was noted in osteophytosis in the tibiofemoral compartment of knee joint and age of the patients and as the age increases the severity of osteophytes in the tibiofemoral compartment also increased (p = 0.001 and 0.022 in medial and lateral femoral condyles respectively and p value of 0.042 and 0.032 in medial condyle and lateral condyle of tibia respectively). Statistically significant association was also noted between bone marrow edema in lateral and medial tibial condyles and age of the patients. (p= 0.008 and 0.013 respectively). Statistically significant association was also seen between subchondral cysts in medial condyle of tibial and the age of the patients (p= 0.016).

It suggests an increased prevalence of knee osteoarthritis in females. Women experience earlier and more severe osteoarthritis as compared to male. No significant statistical association was found between occupation or lifestyle of the patients and development of osteoarthritis of knee joint in our study.

Osteoarthritis is more common in patients with a high body mass index. In the longitudinal study by Framingham, high body mass index predicted the disease development in later life and in the same cohort women analysis, it was shown that in women with high body mass index who lose weight, incidence of the disease is lower as compared to the women who do not lose weight. 11,12

We found a statistically significant association between BMI and osteophytes in medial condyle of femur (p<0.05). In our study it was found that the tibiofemoral compartment was, more severely and frequently involved in the disease as compare to patellofemoral compartment. In western population, the patellofemoral compartment was more severely and frequently involved which could be explained, by the fact that Indian population is accustomed for sitting in squatting posture which exposes the medial articular cartilage to excessive mechanical strains.¹³

In our study most severe pain symptoms were produced by femur trochlear osteophytes (28.95%), followed by osteophytes in articulating surface of medial femur (28.20%). Most severe stiffness was produced by osteophytes in femur trochlea. Maximum functional disability was produced by osteophytes in medial articulating surface of femur (31.40%) followed by osteophytes in patellar lateral facet (30.71).

Thus we found that the presence, frequency or severity of bone marrow edema did not show any statistically significant association with pain or knee stiffness. Studies by Sowers et al and Link et al support these findings, we found the tibiofemoral compartment was more frequently involved as compared to patellofemoral compartment. Most frequent and most severe (grade III B) cartilage defects were present in patellofemoral compartment in the results of study by Hayes CW et al; again the prolonged squatting in Indian populations could be the reason for this difference.^{14,15}

Maximum functional disability was observed in patients with cartilage defects in femur trochlea and medial facet followed by cartilage defects in medial condyle of tibia. In our study tibiofemoral joint showed more incidence of subchondral sclerosis and cysts as compared to patellofemoral compartment. Hayes CW et al reported in their study that most of the subchondral cysts and sclerosis were present in patellofemoral compartment. Prolonged squatting in Indian populations could be the reason for this difference. ¹⁶

Association between joint effusion and joint pains has a controversy in literature. Hill et al found in their study that moderate to severe joint effusions were more frequent in the patients came with joint pain but Link et al found no significant association between these features, however they found an inclination towards higher scores of pain in patient came with joint effusion.

It was found a statistically significant association between functional disability and stiffness in knee joint (considering WOMAC functional disability and stiffness scores) and the presence of osteochondral bodies (P = 0. 01).

KL score

Majority of anatomical changes in tibiofemoral compartment showed strong correlation between MRI and radiographic findings (correlate coefficients <0.05 in all sites), however this correlation was poor in patellofemoral compartment.

Strong correlation between osteophytes detected by MRI and radiographs, was seen in our study (p value = 0.000,0.000 for medial articulating surfaces of femur and tibia respectively and p = 0.098 and 0.001 for lateral femoral condyle and lateral tibial condyle respectively).

Subchondral cysts in both condyles of tibia and femoral lateral condyle showed a positive association with radiographic osteoarthritis (p = 0.002 and 0.056 and 0.066 respectively). Bone marrow edema in lateral condyles of femur and tibia and medial condyle of tibia (p = 0.017, 0.029 and 0.001 respectively).

A correlation was seen between cartilage defects in tibiofemoral compartment in both lateral and medial aspect and KL score ($P=0.058,\,0.058,\,0.080$ and 0.002 in medial femoral condyle, medial tibial condyle, lateral femoral condyle and lateral tibial condyle respectively

Injury at medial meniscus and K L score also showed statistically significant association (p = 0.00).No significant association was between lateral meniscus, collateral ligaments and cruciate ligament injury and KL score.

CONCLUSION

In summary, although, clinical findings and plain radiographs are still important in evaluating osteoarthritis of knee in Indian context, MRI plays an important role in imaging the bony and soft tissues of knee as a whole organ, thereby helping in better management and outcome of the disease. Also, MRI plays an important role in depicting early changes of osteoarthtis.

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