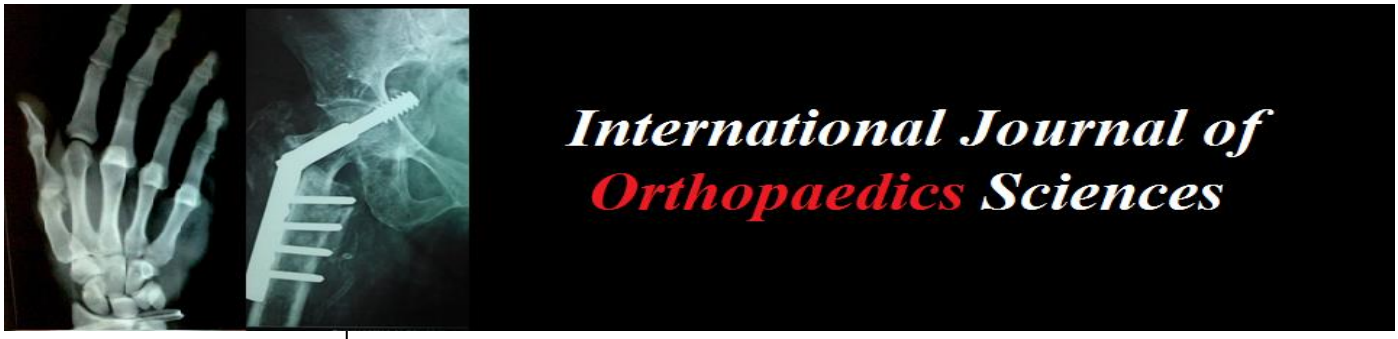

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Osteoarthritis of the knee: Comparison of MR imaging findings with radiographic severity measurements and clinical features in middle-aged women

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Abstract
To assess the value of MRI in detection of osteoarthritic changes of the knee and to correlate MRI findings and radiographic severity grading with the severity of patient's clinical complaints. It is a proposed study observed at Institute of Orthopedics and Traumatology, Rajiv Gandhi Government General Hospital, Madras Medical College, Chennai from May 2018-Jan 2019.Thirty knees of 30 female patients and their average age is 47.13 years attending Orthopedics outpatient were clinically assessed and examined by conventional radiographs prior to the patients undergoing knee MRI. Patients with knee pain for more than three months with varying grades of pain severity were included. Patients with a past history of knee surgery, knee infection, or knee trauma in the preceding three months of study and males were excluded. Patients were classified based on pain severity by VRS scale for pain. All the cases having pain in knee were subjected to standard radiograph of knee joint both antero-posterior and lateral views and classified based on Kellgren- Lawrence grading of osteoarthritic changes in knee joint. They were further subjected to MR imaging. The following parameters like defects of cartilage, subchondral bone marrow edema (BME), osteophytes, subchondral cysts, sclerosis, meniscal abnormalities, anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial and lateral collateral ligament abnormalities, joint effusion, synovial cysts and joint effusions were analyzed. Nineteen patients, representing 19 cases of knee pain (63.33%) classified as mild. Ten cases (33.33%) classified as moderate and one case (3.33%) under severe pain grade rays were classified based on KL criteria. They showed four knees (13.33%) with grade 0, thirteen knees (43.33%) under grade 1, eleven knees (36.66%) under grade 2 and two knees (6.66%) under grade 3 and no cases under grade 4. Increasing Kellgren-Lawrence severity grading and longer the duration of symptoms is associated with more severe defects of cartilage, meniscal tears, subchondral cysts, bone marrow edema and joint effusion. From this study, it is observed that among the middle-aged females there is proportionate co-relation between the pain duration, MRI parameters and radiologic screening of knees with osteoarthritis.

Keywords: MR - magnetic resonance, KL – kellgren lawrence

1. Introduction
Osteoarthritis (OA) is the most prevalent joint disease in older population, the knee being the most commonly involved. The prevalence is expected to increase substantially as greater proportion of the population exceeds 60 years of age [1, 2]. Often severe osteoarthritic changes of the knee result in patient undergoing joint replacement [3, 4]. Thus there has been great interest in imaging of osteoarthritis, particularly with respect to the knee. Historically, the primary modality for imaging evaluation of osteoarthritis has been radiography, with the limitations of radiographic parameters for osteoarthritis evaluation well documented [5-7]. Radiographically determined joint space narrowing is an indirect measure of articular cartilage status, because it includes only a small percentage of total articular surface. Because radiographs are two-dimensional composite of complex three-dimensional structures, the sensitivity for observation of features such as osteophytes, subchondral bone changes on them are limited. Recent focus on disease modifying therapeutic agents for osteoarthritis has emphasized the need for relevant early abnormalities in osteoarthritis over a relatively short time. The cross-sectional image display, spatial resolution with tissue contrast of MR imaging provides unique capability to display bone, cartilage and soft tissue abnormalities necessary

for the whole organ assessment of knee to find early osteoarthritis changes. Validation of MR imaging – defined parameters of the knee is necessary if MR imaging is to replace radiography in clinical trials. Thus, the purpose of this study is to prospectively compare MR imaging defined osteoarthritis parameters of knee and radiographic measurements of severity of osteoarthritis of the knee with the severity of patient self-reported pain.

1.1 Aim
To assess the value of MRI in detection of osteoarthritic changes of the knee and to correlate MRI findings and radiographic severity grading with the severity of patient's clinical complaints.

2. Materials and Methods
It is a proposed study observed at Institute of Orthopedics and Traumatology, Rajiv Gandhi Government General Hospital, Madras Medical College, Chennai from May 2018-Jan 2019.

2.1 Study Population
Thirty knees of 30 female patients belonging to middle age groups (35-60 years) with the mean age of 47.13 years attending Orthopedics outpatient were clinically assessed and examined by conventional radiographs prior to the patients undergoing knee MRI. Patients with knee pain for more than three months with varying grades of pain severity were included. Patients with a previous history of knee surgery, knee infection, or knee trauma in the preceding three months of study and males were excluded. Since females are not satisfied with the conservative treatment, we would like to know the anatomical changes the cartilage by MRI, because most of the X rays are normal.

2.2 Classification of Pain
A verbal rating scale (VRS) was employed in the classification of pain: grade 0 is no pain or occasional mild discomfort, grade 1 indicating tolerable, mild pain with day-to-day activities, grade 2 is moderate pain with impairment in daily activities and grade 3 is severe pain with significant restriction of daily activities.

2.3 X-ray Image Analysis
Anteroposterior radiographs of the knee were obtained in weight bearing extended position (standing) by using standard radiographic technique. The anteroposterior views characterize osteoarthritis of the knee in the medial and lateral femoral compartments with the exclusion of patellofemoral compartment. The Kellgrren- Lawrence scale was used to grade plain film radiographic findings of degenerative joint disease: normal knee were classified as grade 0; knees with spur like osteophytes but normal joint spaces were classified as grade 1 (suspicious for osteoarthritis): significant osteophytosis with mild joint space narrowing constituted grade 2 lesions (mild osteoarthritis); significant osteophytosis with severe joint space narrowing comprised grade 3 lesions (moderate osteoarthritis); grade 4 lesions exhibited multiple osteophytes and intra-articular bodies with subchondral sclerosis or cyst and severe narrowing or obliteration of joint spaces [8]

2.4 MR Imaging Assessment
Images were obtained using 3-Tesla imager. PD-FS sagittal, T1W sagittal, T2 IRM (STIR) coronal and T2W axial sequences were analyzed. Each knee was assessed globally and compartment wise for 13 MR imaging parameters. The following parameters like defects of cartilage, subchondral bone marrow edema (BME), osteophytes, subchondral cysts, sclerosis, meniscal abnormalities, anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial and lateral collateral ligament abnormalities, joint effusion, synovial cysts and joint effusions were analyzed.

Fig 1 MRI - relative thinning of articular cartilage of medial patella-femoral joint

Case 1: 40 years female with six months duration of left knee pain shows grade I OA changes and minimal joint effusion and relative thinning of articular cartilage of medial patella-femoral joint.

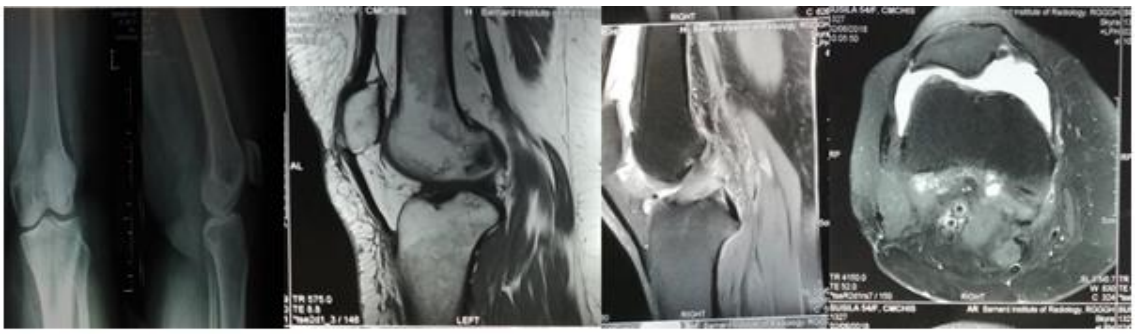

Fig 2: MRI - Mucoid degeneration of ACL, significant articular cartilage loss

Case 2: 54 years female with twelve months duration of right knee pain shows grade II OA changes with degenerative osteophytes, Mucoid degeneration of ACL, significant articular cartilage loss in medial condyle femur, medial joint space narrowing and moderate knee joint effusion.

2.5 Findings and Discussion

2.5.1 Classification of patient pain

Nineteen patients, representing 19 cases of knee pain (63.33%) classified as mild. Ten cases (33.33%) classified as moderate and one case (3.33%) under severe pain grade.

2.5.2 X ray Gradation by KL Criteria

X rays were classified based on KL criteria. They showed four knees (13.33%) with grade 0, thirteen knees (43.33%) under grade 1, eleven knees (36.66%) under grade 2 and two knees (6.66%) under grade 3 and no cases under grade 4. Since most of the patients give biased information on the severity of pain, we have analyzed the relationship between X ray grading, duration of symptoms with changes in MR Imaging. Patients were classified into two clinical groups based on OA severity grading in radiographs and clinical complaints.

Table 1: Clinical Group Vs Radiographic Severity

Clinical Group	Kellgren-Lawrence Scale				
	0	I	II	III	IV
OA with pain	-	13	11	2	-
No OA with pain	4	-	-	-	-

Table 2: Frequency of Non-Compartment specific MR Imaging findings (30 Knees)

Structures/Findings	No. Of Knees
ACL	14
PCL	1
MCL	6
LCL	3
Joint effusion	27
Synovitis	-

MR Imaging parameters with X ray grading

Table 3: X ray Vs Anterior Cruciate Ligament

Xray grade	Anterior Cruciate Ligament			
	Normal	strain	Mucoid degeneration	Tear
0	4	-	-	-
1	10	1	-	2(partial tear)
2	2	1	6	2
3	1	1	-	-
4	-	-	-	-
Total	17	3	6	4

Table 4: X ray Vs Posterior Cruciate Ligament

X ray grade	Posterior Cruciate Ligament			
	Normal	strain	Mucoid degeneration	Tear
0	4	-	-	-
1	-	1	-	-
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
Total	4	1	-	-

Table 5: X ray Vs Articular Cartilage

X ray grade	Articular Cartilage			
	Normal	Minimal loss	Moderate	Erosion
0	4	-	-	-
1	8	-	3-medial condyle femur 1-patello femoral	1-patello femoral
2	2	3-medial condyle femur 3- proximal tibia	1-patello femoral	2-medial condyle femur
3	1	1-media condyle femur	-	-
4	-	-	-	-
TOTAL	15	7	5	3

Table 6: X ray Vs Meniscal involvement

X ray grade	Meniscus				
	normal	strain	Mucoid degeneration	Tear	Extrusion
0	2	-	1	-	-
1	5	2	1	1	1
2	3	2	3	3	-
3	1	1	1	2	1
4	-	-	-	-	-
Total	11	5	6	6	2

Duration of symptoms Vs MR imaging

Table 7: Period of symptoms Vs Articular cartilage involvement

Duration		Articular Cartilage Involvement	
0-3	10	1-femur	1-femur, tibia
3-6	7	3- medial condyle femur 1-tibia	1-patella -femoral
>6	1	1-tibia	1-femur, tibia 1-femur condyle 1-medial femoral condyle 1-posterior condyle femur, lateral condyle tibia
Total	18		6 6

Table 8: Period of symptoms Vs Anterior Cruciate Ligament

Duration (Months)	Anterior Cruciate Ligament			
	Normal	Strain	Mucoid degeneration	Tear
0-3	11	-	1	1(partial)
3-6	7	1	1	1(partial)
>6	-	1	5	1(complete)
Total	18	2	7	3

Table 9: Period of symptoms Vs Posterior Cruciate Ligament

Duration (Months)	Posterior Cruciate Ligament			
	normal	Strain	Mucoid degeneration	Tear
0-3	1	-	-	-
3-6	-	-	-	-
>6	-	-	-	-
Total	1	-	--	-

Table 10: Period of symptoms Vs Medial Meniscus

Duration (Months)	Medial Meniscus				
	normal	strain	Mucoid degeneration	Tear	Extrusion
0-3	5	2	1	1	1
3-6	1	2	2	5	1
>6	5	-	2	2	-
Total	11	4	5	8	2

Table 11: Period of symptoms Vs Lateral Meniscus

Duration (Months)	Lateral Meniscus				
	normal	strain	Mucoid degeneration	Tear	Extrusion
0-3	10	1	-	1(partial)	-
3-6	7	1	1	3	-
>6	5	-	1	-	-
Total	22	2	2	4	-

Table 12: Period of symptoms Vs MCL/LCL

	MCL			LCL
Duration (months)	Normal	Strain	Normal	Strain
0-3	7	2	11	-
3-6	9	1	10	2
>6	9	2	6	1
Total	25	5	27	3

Table 13: Period of symptoms Vs Bone marrow edema lesions (BML)

Duration (Months)	Bone Marrow Edema	
	Normal	Present
0-3	8	-
3-6	11	1-distalfemur and proximal tibia 1-medial condyle femur
>6	6	1- distalfemur and proximal tibia 1- medial condyle femur 1- patello-femoral
Total	25	5

Table 14: Period of symptoms Vs Joint effusion

Duration (Months)	Joint Effusion		
	Minimal	Moderate	Severe
0-3	10	1	-
3-6	8	1	1
>6	4	4	1
TOTAL	22	6	2

3. Discussion

Our results confirms that there are increasingly more frequent, as well as more severe, abnormalities at MR imaging in multiple tissues as the Kellgren-Lawrence grade of osteoarthritis of the knee at radiography and duration of symptoms increases. The group with radiographically determined osteoarthritis of the knee and pain had more frequent and more severe abnormalities at MR imaging. Frequent defects in cartilage, bone marrow lesion and other soft tissue abnormalities and the frequent patella-femoral findings contributed substantially to the burden of abnormalities in our subjects and may be critical in consideration of clinical expression of early osteoarthritis of the knee. Five cases of cartilage defects and bone marrow lesions were seen in patella-femoral compartment in our study population. This disparity in sensitivity between MR imaging and standard radiography for detection of abnormalities, especially in patella-femoral compartment, may partly explain the observation that clinically symptomatic osteoarthritis of the knee can long precede radiographic evidence of osteoarthritis of the knee. Since skyline views of the knee were not used in the categorization of the radiographic severity of osteoarthritis in our subjects, radiographic patella-femoral involvement was undiagnosed.

Increasing Kellgren-Lawrence severity grading and longer the duration of symptoms is associated with more severe defects of cartilage, meniscal tears, subchondral cysts, bone marrow edema and joint effusion. These findings reinforce that osteoarthritis of the knee is a whole-organ disease and the MR imaging is capable of showing the bone and soft tissue evidence of osteoarthritis of the knee.

The study design enables comparison of MR imaging defined abnormalities among women with and without radiographically determined osteoarthritis of the knee and pain. The group with radiographically determined osteoarthritis of the knee and pain consistently had more frequent and more severe MR imaging defined abnormalities.

Our study report is consistent with other similar study by Fernandez-Madrid et al. [9], which published a study of 97 knee in 52 subjects with osteoarthritis of the knee. They compared radiographic evidence of osteoarthritis and MR imaging findings. They found a significant correlation between MR imaging parameters like cartilage loss, meniscal abnormalities, joint effusion and subchondral lesions with radiographically increasing Kellgren-Lawrence severity of osteoarthritis.

Joint effusion has showed a strong correlation with both radiographic severity of osteoarthritis and pain symptoms. This is consistent with the findings of Felson et al. [10]. Our study was limited to women. Hence some of our findings like more patella-femoral abnormalities may be sex specific and so our results could not be extrapolated to men, who are likely to have different body size and occupational demands.

In our study we focused mainly on younger population in the hope of authenticating MR imaging parameters for detecting early osteoarthritis of the knee. This is because as opposed to older patients with osteoarthritis of the knee, younger persons with early osteoarthritis of the knee may benefit most from the development of structure – modifying therapies.

4. Conclusion

This study among thirty middle aged women showed that the MR imaging parameters of cartilage defects, bone marrow lesions, osteophytes, meniscal abnormalities, subchondral lesion and joint effusion have got strong correlation with radiographic severity measurements of osteoarthritis of the knee and duration of knee pain. Our data establishes the relevance of these MR imaging parameters in a population of relatively young women with generally mild osteoarthritis of the knee.

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