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Original Article

Radiology Section

Evaluation of Medial Meniscal Thickness, Tear and Extrusion in Patients with and without Osteoarthritis of Knee: A Cross-sectional Study

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ABSTRACT

Introduction: Loss of articular cartilage is the primary change occurring in osteoarthritis. However, due to combination of several cellular changes and biomechanics stresses, several secondary changes like formation of osteophytes, development of bone osteophytes, synovial and capsular changes, meniscal tears and extrusion also occur. A meniscal lesion in a healthy knee joint may eventually lead to the development of knee osteoarthritis, but an osteoarthritic knee may also lead to meniscal damage which in turn can further accelerate the disease process. It is often concluded to be a two-way relationship.

Aim: To assess medial meniscal thickness and incidence of medial meniscal tear, extrusion in patients with knee osteoarthritis and also to assess cartilage damage in knee osteoarthritis patients in comparison to normal patients.

Materials and Methods: A cross-sectional study was in the Department of Radiodiagnosis, SRM Medical College, Hospital and Research Centre, Tamil Nadu, India, in 180 subjects, out of which 90 had osteoarthritis and 90 were controls. Patients were evaluated radiographically using anteroposterior and lateral projections in plain X-ray following which patient's knees were imaged using routine Magnetic Resonance Imaging (MRI) protocols. The thickness of anterior horn, posterior horn and body of medial meniscus was assessed manually in sagittal Proton Density Fat Saturation (PDFS) sequence images. The signal intensity changes within the menisci was assessed and graded accordingly. Meniscal tear associated with meniscal extrusion was also assessed. The articular cartilage thickness was measured in coronal PDFS images. Data was analysed using Chi-square test for qualitative analysis and unpaired t-test for quantitative analysis.

Results: The mean medial meniscal thickness of anterior horn, body and posterior horn was 3.95 mm, 3.57 mm, 3.53 mm in patients with osteoarthritis; while those for patients without osteoarthritis was 5.65 mm, 6.05 mm, 6.56 mm (p-value of 0.021, 0.032, 0.029, respectively). The medial meniscal tear was seen in 46 patients with osteoarthritis and 40 without osteoarthritis (p-value=0.018). The meniscal extrusion was nil, less than 50% and more than 50% in 39, 34 and 17 patients with osteoarthritis; while those for the other group was 72, 14 and four (p-value <0.001, 0.001 and 0.003, respectively). The mean medial tibial articular cartilage thickness was 1.86 mm in patients with osteoarthritis and 2.04 mm in patients without osteoarthritis (p-value=0.009), and the mean femoral articular cartilage thickness was 1.84 mm in patients with osteoarthritis and 2.02 mm in patients without osteoarthritis (p-value=0.010).

Conclusion: The study concludes that the incidence of meniscal tear, extrusion, and cartilage damage is more common in patients with knee osteoarthritis. Further research is needed to provide proficient knowledge and to improve the quality of life in patients suffering from knee osteoarthritis.

Keywords: Knee pain, Magnetic resonance imaging, Radiograph

INTRODUCTION

Osteoarthritis (OA) is characterised by gradual loss of articular cartilage and is a slowly progressive degenerative disease. It is a serious joint disease that leads to a reduced quality of life [1,2]. Osteoarthritis is usually graded following the Kellgren-Lawrence score and radiography remains as the standard for assessment of progression of osteoarthritis [3]. According to World Health Organisation (WHO) since knee joint is most frequently affected as compared to other joints, osteoarthritis is considered to be among top ten conditions representing global disease burden [2]. Although loss of joint cartilage as mentioned above is considered as the hallmark of osteoarthritis of knee joint, many studies proved osteoarthritis to be a complete joint disease with involvement of all structures of the knee joint. Menisci have main role in many aspects of knee function, including load sharing, shock absorption, reduction in joint contact stresses, passive stabilisation, increasing congruity and contact area, limitation of extremes of flexion and extension, lubrication, joint stability and proprioception [4,5].

Few studies demonstrate that normally configured menisci are rarely found in osteoarthritic knees instead they are often macerated, torn or sometimes totally destructed. These findings suggest a strong relationship between osteoarthritis and meniscal pathologies [1,6]. It is often concluded to be a two-way relationship. A meniscal lesion in a healthy knee joint may eventually lead to the development of knee OA.

There is association between medial meniscal tear, degeneration and reduced articular cartilage thickness in patients with osteoarthritis [1,2]. Patients with osteoarthritis most commonly have meniscal tear and there is reduced articular cartilage thickness in patients with osteoarthritis. The purpose of the present study was to assess the thickness of medial meniscus and pathologies of medial meniscus like extrusion and tear with quantitative assessment of thickness of articular cartilage in tibio-femoral and patello-femoral compartments in patients with knee OA in comparison with patients without knee OA.

MATERIALS AND METHODS

This was a cross-sectional study, and was done in the Department of Radiodiagnosis, SRM Medical College Hospital and Research Centre, Tamil Nadu, India from January 2019 to July 2020, after getting Institutional Ethical Committee clearance (1491/IEC/2018).

Total 180 patients were included where, 90 patients had osteoarthritis and 90 were normal controls. Controls were patients referred to

Radiology Department for knee pain but with normal radiograph without osteoarthritic changes.

Inclusion criteria: Men and women of ages between 40 to 70 years with symptoms of knee OA and radiographic abnormality and similar age matched normal control groups without osteoarthritis were included in the study.

Exclusion criteria: Patients with trauma, operated knee joint, other types of arthritis i.e., secondary osteoarthritis, patients below 40 years and those above 80 years and patients with conditions contraindicating MRI study.

Radiographic assessment was done using anteroposterior and lateral radiographs of knee, obtained in a weight bearing extended position by using a standard radiographic technique. Scores to all radiographs were assigned by using Kellgren-Lawrence (KL) scoring system [3]. All MRI examinations were done by 1.5T Siemens MRI system and a dedicated knee coil system. MRI examination were done in a coronal T1 weighted; sagittal PDFS sequence; coronal PDFS, axial PDFS, sagittal T2 sequence of knee (TR/TE=2500-3000/35-45; FLIP angle=90; matrix=512; number of signals acquired=2; FOV=16 cos; section thickness=3 mm; gap=4 mm).

The thickness of anterior horn and posterior horn of medial meniscus was assessed in mid sagittal section of PDFS sequence with measurement done inner to inner border of meniscus. The thickness of body was assessed in coronal section of PDFS sequence. The meniscal tear was accounted as high signal intensity within the mesnisci reaching the articular surface. The meniscal extrusion was assessed in PDFS coronal section with less than 50% extrusion labelled as grade 1 and more than 50% extrusion as grade 2 [7]. Cartilage assessment was done in coronal and axial PDFS sequence.

STATISTICAL ANALYSIS

All statistical analysis was performed using statistical package for the social sciences (SPSS, version 17.0) for Microsoft windows. Data was entered in Microsoft Excel Office application and appropriate analysis was done (using Chi-square test for nominal qualitative analysis and unpaired t-test for quantitative analysis). Descriptive statistics were presented as numbers and percentages. The data were expressed as mean and standard deviation. A two sided p-value <0.05 was considered statistically significant.

RESULTS

The mean age of patients presenting with knee osteoarthritis was 50.36±7.43 years, and that of the control group was 24±4 years, and most of them were males [Table/Fig-1,2]. Most of the cases had grade 2 and 3 osteoarthritis according to KL grade [Table/Fig-3].

Age group (years)	Cases (n=90)	Controls (n=90)
Up to 40	7 (7.8%)	14 (15.6%)
41 to 45	23 (25.6%)	40 (44.4%)
46 to 50	24 (26.7%)	28 (31.1%)
51 to 55	13 (14.4%)	5 (5.6%)
56 to 60	14 (15.5%)	3 (3.3%)
>60	9 (10%)	0
Total	90 (100%)	90 (100%)

[Table/Fig-1]: Comparison of age group between two groups (N=180).

Gender	Cases (n=90)	Controls (n=90)
Male	47 (52.2%)	74 (82.2%)
Female	43 (47.8%)	16 (17.8%)
Total	90 (100%)	90 (100%)

[Table/Fig-2]: Comparison of gender between two groups (N=180).

OA grade	Cases (n=90)	Controls (n=90)
0	0	90 (100%)
1	14 (15.6%)	0
2	30 (33.3%)	0
3	27 (30%)	0
4	19 (21.1%)	0
Total	90 (100%)	90 (100%)

[Table/Fig-3]: Comparison of OA grades using Kellgren-Lawrence (KL) scoring system between two groups (N=180).
OA: Osteoarthritis

The medial meniscus anterior horn thickness, mid portion of meniscal body thickness and posterior horn thickness was found to be 3.95±1.13 mm, 3.57±1.49 mm and 3.53±1.58 mm, respectively in osteoarthritis study group and 5.65±1.17 mm, 6.05±0.88 mm and 6.56±1.43 mm in control group. There was statistically significant association between the reduced medial meniscal thickness and study group [Table/Fig-4].

Thickness (mm)	Cases (n=90)	Controls (n=90)	p-value (Chi-Square test)
MM anterior horn thickness	3.95±1.13	5.65±1.17	0.021*
MM body thickness	3.57±1.49	6.05±0.88	0.032*
MM post horn thickness	3.53±1.58	6.56±1.43	0.029*

[Table/Fig-4]: Comparison of mean MM thickness between two groups (N=180).
MM: Medial meniscus; *p-value <0.05 was considered statistically significant

The meniscal tear was observed in 51.1% of the patients in study group and 44.4% of patients in control group. There was statistically significant association between presence of meniscal tear and the study groups [Table/Fig-5].

MM tear	Cases (n=90)	Controls (n=90)	Chi-square, p-value
No tear	44 (48.9%)	50 (55.6%)	5.71, 0.018*
Tear	46 (51.1%)	40 (44.4%)	5.71, 0.018*

[Table/Fig-5]: Comparison of MM tear between two groups (N=180).
MM: Medial meniscus; *p-value <0.05 was considered statistically significant

Less than 50% of meniscal extrusion was observed in 37.8% of patients in study group, and 15.6% in control group, followed by more than 50% of meniscal extrusion was observed in 18.9% in study group and 4.4% in control group which was statistically significant [Table/Fig-6].

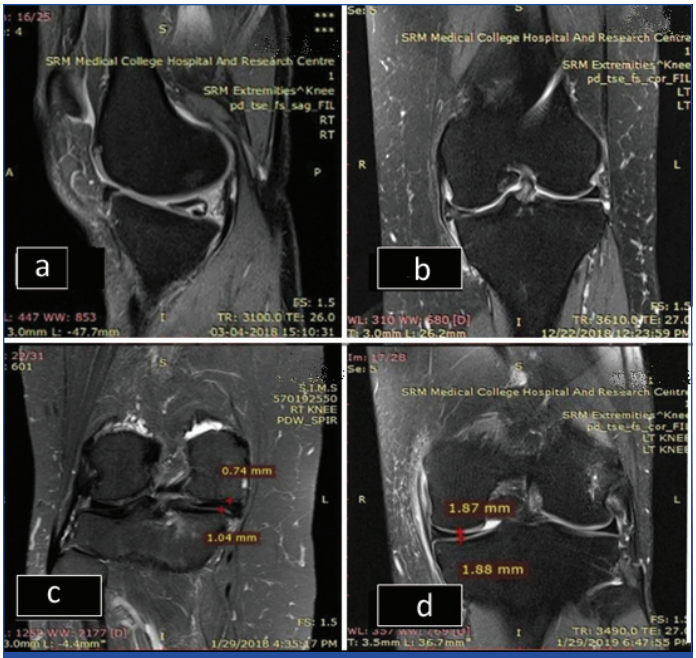
MM extrusion	Cases (n=90)	Controls (n=90)	Chi-square	p-value (Chi-square test)
No extrusion	39 (43.3%)	72 (80%)	25.59	<0.001*
Less than 50%	34 (37.8%)	14 (15.6%)	11.36	0.001*
More than 50%	17 (18.9%)	4 (4.4%)	9.11	0.003*

[Table/Fig-6]: Comparison of MM extrusion between two groups (N=180).
*p-value<0.05 was considered statistically significant

The medial femoral and tibial articular cartilage thickness in patients with osteoarthritis was found to be less than the control groups [Table/Fig-7]. Overall in patients with osteoarthritis, the meniscal thickness is reduced, meniscal tears and meniscal extrusion are common than normal control groups. The cartilage thickness also reduced in patients with osteoarthritis when compared with control groups [Table/Fig-8].

Thickness (mm)	Cases (n=90)	Controls (n=90)	p-value (Chi-square test)
Medial femoral cartilage	1.84±0.50	2.02±0.45	0.010*
Medial tibial cartilage	1.86±0.49	2.04±0.46	0.009*

[Table/Fig-7]: Comparison of mean medial joint space cartilage (mm) between two groups (N=180).
*p-value <0.05 was considered statistically significant



[Table/Fig-8]: (a) Shows medial meniscal tear in patient with knee osteoarthritis; (b) shows medial meniscal extrusion; (c) Shows articular cartilage thickness in normal patient; (d) Shows articular cartilage thickness in patient with osteoarthritis.

DISCUSSION

Osteoarthritis is highly prevalent condition across the globe becoming a leading cause of disability and can negatively impact people's physical and mental well-being. The healthcare resources and costs required to curb and manage the disease can be quite substantial. However, physiologically applied load to pathologically impaired joint may also cause development of osteoarthritis associated with joint subluxation, malalignment and crystal deposition. Certain genetic factors have also been known to show association with development of OA, however, the extent of association between genetic factors or family environment and osteoarthritis is still uncertain [6]. Loss of articular cartilage is the primary change occurring in osteoarthritis. However, due to combination of several cellular changes and biomechanical stresses, several secondary changes like formation of osteophytes, development of bone osteophytes, synovial and capsular changes, meniscal tears and extrusion also occur [6]. It is often concluded to be a two way relationship. A meniscal lesion in a healthy knee joint may eventually lead to the development of knee osteoarthritis, but an osteoarthritic knee may also cause meniscal damage which in turn can further hasten the disease process.

In the present study, the medial meniscus anterior horn thickness, mid portion of meniscal body thickness and posterior horn thickness was found to be significantly lower when compared to patients without osteoarthritis. This observation is in consonance with study conducted by Wenger A et al., which showed significantly less meniscal coverage, likely due to radial displacement in osteoarthritis with a more convey shape of menisci, particularly in the weight bearing compartment of the knee joint along with mildly reduced medial meniscal thickness in osteoarthritis [6]. In another study, conducted by Arno S et al., it was stated that due to volume loss in the articular cartilage, there is medial subluxation that causes loss of contact and height of medial meniscus in osteoarthritis thereby rendering it to more vulnerable to damage and extrusion [8]. The same was noted in a study by Kawahara T et al., which showed mild reduction in meniscal size particularly anterior horn and body of medial meniscus in patients with osteoarthritis [9].

In the present study, greater incidence of meniscal tear was found in osteoarthritic population. Similar findings were noted in study conducted by Resorlu M et al., which showed significant correlation between tears of medial meniscus and medial periarticular bursitis in patients with knee osteoarthritis [10]. The study conducted by Jarraya M et al., showed increased incidence of meniscal tears, particularly radial tears of posterior horn of medial meniscus in patients with osteoarthritis and showed significant association with incidence of cartilage loss and meniscal extrusion [11]. Hare KB et al., concluded that patients with evidence of degenerative tears of medial meniscus reported symptoms concurrent with osteaoarthritis [12]. Ozdemir M and Turan A also remarked the same that incidences of meniscal tear were higher in patients with knee osteoarthritits [13].

In the present study, more than 50% of meniscal extrusion was observed in 18.9% of the patients, followed by less than 50% of meniscal extrusion were observed in 37.8%. In a study conducted by Berthiaume MJ et al., it was shown that in symptomatic osteoarthritis there was rapid disease progression in medial compartment of knee, therefore meniscal damage including tear and extrusion are important factors while selecting patients who would eventually require structure modifying osteoarthritic drugs [14]. Teichtahl AJ et al., showed presence of baseline medial meniscal extrusions are associated with accelerated cartilage loss thereby suggesting strong correlation with progression of osteoarthritis [15]. In another study by Van der Voet JA et al., showed significantly higher incidence of knee osteoarthritis in women with meniscal extrusion, thereby proving extrusion to be an important factor for detection in early stages for individuals at risk for developing osteoarthritis [16].

In the present study, cartilage thickness was assessed in medial tibial and femoral compartments in patients with osteoarthritis and compared with the thickness measured in controls. In studies conducted by Pelletier JP et al., and Maschek S et al., showed greatest percentage loss of cartilage was noted in central weight bearing portion of medial condyles and plateau followed by central portion of lateral condyles and trochlea [17,18]. This is in agreement with the present study that showed maximum reduction in cartilage thickness in medial tibia-femoral cartilage which also shows a linear relationship with grades of osteoarthritis. Similar findings were also noted by Saunders J et al., concluded that subjects with knee osteoarthritis lose cartilage faster than normal patients thereby proving to be an independent risk factor in predicting cartilage loss, particularly in medial compartment [19]. Comparison of the present study with previously published studies have been summarised in [Table/Fig-9] [6,10,13,14].

Author	Medial meniscal thickness	Medial meniscal tear	Medial meniscal extrusion	Loss of articular cartilage
Wenger A et al., (2012) [6]	Reduced	Present	Present	Present
Resorlu M et al., (2017) [10]	Reduced	Present	Present	Present
Ozdemir M and Turan A (2019) [13]	Reduced	Present	Present	Present
Berthiaume MJ et al., (2005) [14]	Reduced	Present	Present	Present
Present study	Reduced	Present	Present	Present

[Table/Fig-9]: Comparison of the present study with previously published studies correlating medial meniscus thickness, tear and extrusion with incidence of knee osteoarthritis [6,10,13,14].

Limitation(s)

Limitation of the present study was the small number of patients. Large scale studies are needed for generalisation of results. The degree of chronicity of meniscal changes could not be established as the timing of the meniscal damage was not known. Secondary methods of assessment like arthroscopy, were not performed in the present study in order to evaluate tears involving menisci and damage to cartilage.

CONCLUSION(S)

The study shows significant association between reduced medial meniscal thickness, articular cartilage thickness particularly in medial tibio-femoral compartment and increased incidence of medial meniscal tear and extrusion in patients with knee osteoarthritis. Hence, it can be concluded that the patients with knee osteoarthritis are at a greater risk to develop meniscal tears and extrusion.

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