Original Research Article

High resolution sonographic evaluation of symptomatic knee joint

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Abstract

Background: Symptomatic knee osteoarthritis, which was a serious disorder in ancient days also impairing the quality life of general population in modern age and also seeks the global attention to find out effective modes of prevention and intervention. High resolution ultrasound is advocated as a useful tool in assessing the superficial supporting structures about the symptomatic knee because it's a simple, rapid, inexpensive and accurate method. **Methods:** Fifty patients of symptomatic knee joint osteoarthritis (OA) and fifty controls were selected for the study. All the patients underwent high resolution ultrasonography and conventional radiography. CR included weight bearing anterio-posterior and lateral knee radiographs. Kellgren and Lawrence (K-L) grades were evaluated and tibio-femoral joint space width was measured. Data were analysed using SPSS version 20. **Results:** Eighty nine (89) knees had symptomatic knee joint osteoarthritis. US findings were femoral osteophytes (61.8%), tibial osteophyts (58.4%), effusion (59.55%), synovitis (49.43%), medial meniscal protrusion (37.07%), Baker's cyst (38.8%) and lateral meniscal protrusion (33.7%). Student's t- test showed a significant difference ($p < 0.001$) between femoral condylar thickness in OA patients and controls. **Conclusion:** High resolution sonographic evaluation appears to be an accurate, reliable, easy available and cost effective method for the evaluation of knee joint menisci, ligaments, tendons and muscles and also complement conventional radiography (CR) in evaluating symptomatic knee osteoarthritis (OA).

Key Words: High resolution ultrasonography, symptomatic knee joint, Osteoarthritis.

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INTRODUCTION

Osteoarthritis (OA) is one of the most common disorders of the muskoloskeletal system. The knee is one of the most frequent joint involved in patients of osteoarthritis which is probably due to alteration in chondrocyte responsiveness to different cytokines[1]. OA of the knee is a major cause of mobility impairment, particularly among females[2,3]. OA was estimated to be the 10th leading cause of nonfatal burden[2,4]. In fact, symptomatic knee joint has been reported in 6-10% of the adult population[5,6]. Many epidemiological studies have investigated the risk factors behind symptomatic knee OA, finding a consistent association between the incidence or progression of symptomatic knee OA and age, sex, obesity, weight change, history of knee injury, occupational physical demand,, lifestyle, physical activity and geographic region as well[7]. The common symptoms of symptomatic knee joint OA are pain particularly after prolonged activity and weigh bearing; while stiffness is experienced after inactivity[1]. The diagnosis of symptomatic knee OA is generally established late when the disease has already progressed and very little help can be achieved from the use of disease modifying drugs[8]. This late presentation of symptoms are partially due to the pathophysiology of OA which is to some extent is complex and majority of them are driven by articular cartilages[8-10]. There is an

insufficiency in its own vascular supply and inadequate innervations. Therefore, degenerative changes in articular cartilage do not produce any symptoms[8]. However, some studies have reported the involvement of synovitis in the pathophysiology of both the early and the late OA, establishing a fruitful targer for the management of both symptoms and potential structure modification[8,11-13]. The characterising facts of OA are cartilage loss, subchondral bone changes, synovial inflammation and meniscal degeneration[11,14,15]. Different studies have established a link between synovial inflammation and progression to structural damage[13-18]. The diagnosis of knee OA is established by clinical evaluation usually supplemented by conventional radiography (CR). Conventional radiography is the primary imaging modality used to assess OA. Traditionally, it has been considered the gold standard for examining the osteoatrthritic knee joint[19-21]. In addition, it is the most common, easiest, relatively cheapest and widely available radiological modality for the diagnosis and follow-up of knee joint OA[9,11,20,21]. Conventional radiography demonstrates osteoarthritic bony abnormalities and shows indirect signs of articular cartilage lesion. The assessment of joint width space on CR is considered as the gold standard and has been recommended as the best modality for the assessment of progression of joint damage due to OA[9,12,20]. However, this technique is limited by its inability to visualize early cartilage changes with indisputably occur before the reduction in joint space, synovial recesses, menisci and other soft tissue involved in the pathophysiology of OA[12,20-22]. 10% of cartilage is already lost by the time the first knee joint changes are visualized on CR[11]. Clinically significant changes are frequently not apparent on CR for at least one or even two years[19]. Mainly it reflects the pathologies of bone at an advance stage, detecting the secondary changes like osteophyte formation, cartilage loss and meniscal extrusion[21]. These are what visualised as joint space narrowing on conventional radiography[19]. So, its efficacy in the early detection of knee joint OA is therefore inadequate[22,23]. Newer imaging modalities like magnetic resonance imaging (MRI) and high resolution ultrasonography offer a more detailed overall assessment of the osteoarthritic knee joint[9]. MRI is accurate and reproducible in detecting pre-radiographic OA in the early stages of the disease as it has the advantage of evaluating the bone, articular cartilage and soft tissue structures of the joint[12]. Advantages of MRI include its non-invasiveness, multiplanar capability. It also offers excellent soft tissue contrast to aquire morphological and biochemical data[19]. However, MRI is expensive, time consuming and not widely available for routine use in most of the countries. High resolution ultrasonographic evaluation effectively depicts superficial periarticular and intraarticular structures involved in rheumatic diseases[25,26]. This technique plays a minor role in routine clinical and scientific settings but is invaluable in the evaluation of inflammatory conditions in acute OA of the knee and effusions[2]. This technique has demonstrated accuracy and reliability in the identification of Baker's cyst as well as higher sensitivity than physical examination for the detection of these pathological findings[27,28]. Moreover, periarticular tendons, ligaments, bursae and the peripheral aspect of the menisci can be evaluated by high resolution utrasonography[25,26]. It has considerable advantages including non-invasiveness, quick to perform, relatively low cost, ability to scan multiple joints, repeatability and high patient acceptability over other imaging modalities such as MRI specially in resource poor environments[20]. In addition, several studies reported that MRI may sometimes overestimate cartilage thickness unlike high resolution ultrasonography which has a good histological correlation[14,20,28]. This modality is usually sensitive in assessing inflammatory joint conditions such as synovitis and periarticular inflammatory disease[9,14,29]. Contrast enhanced ultrasonographic evaluation is also more sensitive than contrast enhanced MRI in detecting synovitis[11]. However, it has the disadvantages of being operatoe dependent and is only able to assess superficial structures sufficiently[11,19]. In addition, high resolution ultrasonography can be used routinely to perform dynamic examination. The present study aimed to find out the pattern of high resolution ultrasonographic findings of osteo-arthritic knee joint and to compare these findings with conventional radiography.

METHODS

It was a case-controlled, cross sectional study. This study was carrien out in the Department of Rdiology, M.G.M. Medical College and L.S.K Hospital, Kishanganj, Bihar between January 2019 and December 2019. Fifty (50) consecutive cases of unilateral or bilateral primay symptomatic knee joint OA were selected according to American College of Rheumatology[30].controls were the patients who have no issues related to knee joint and matched in terms of age, sex and weight with case group. Written informed consent form was obtained from all the patients.

Inclusion Criteria:

Case Group:

- All patients who were referred for CR and presented with knee pain
- Patients with a clinical diagnosis of symptomatic knee joint OA.

Control Group:

- Patients presented with other radiological investigations and not related to knee joint.

Exclusion Criteria:

- Patients with a clinical history of mechanical knee derangements.
- Inflammatory arthritis.
- Microcrystalline arthropathty, knee trauma or surgery.
- Patients who received any arthrocentesis or any intra-articular steroid injection within last 6 months.

Statistical Analysis: Statistical analysis was performed using the Statistical Package for the Social Science for Windows (SPSS), version 20. Parametric and non-parametric quantitative variables were expressed as mean ± standard variation (SD) of the mean, interval and median percentiles interval respectively. The chi-square test was applied for comparing qualitative variables. The independent Student's t test was used to compare means between parametric variables. Any p value under 0.05 was considered statistically significant.

RESULTS

Total 100 study participants comprising 50 symptomatic knee OA patients and 50 controls were included for the present study. The mean age for OA group and control group was 61.82 and 61.34 years respectively. There was a female predominance in both groups. In OA group 82% patients were female and 18% were male while in control group 78% were female and 22% were male. In both groups the body weights of the patients were comparable. In the OA group 22% patients and in control group 24% patients had normal BMI level. Details of demographic data for both groups are shown in **Table 1**.

Table 1: Socio-demographic characteristics of case (OA patients) and control group

Variables	OA patients (n=50)	Control (n=50)	Chi square value	p value
		Gender, n (%)		
Male	9 (18)	11 (22)	0.25	0.617
Female	41 (82)	39 (78)		
		Age range in years, n (%)		
40-49	6 (12)	5 (10)	0.199	0.97
50-59	13 (26)	14 (28)		
60-69	20 (40)	21 (42)		
≥70	11 (22)	10 (20)		
Mean Age	61.82	61.34		
		BMI, n (%)		
Normal	11 (22)	12 (24)	0.184	0.91
Overweight	21 (42)	22 (44)		
Obese	18 (36)	16 (32)		
Mean BMI	28.07	27.70		

US findings of OA knees showed effusion in 53 knees (59.55%) (pvalue=0.02), synovitis in 44 knees (49.43%), medial meniscal protrusion in 33 knees (37.07%) and lateral meniscal protrusion in 30 knees (33.7%). Femoral and tibial osteophytes were seen in 55 knees (61. 8 %) and 52 knees (58.4%) respectively (p value= <0.01). Baker's cyst were demonstrated in 31 knees (38.8%) (p value =0.01).The mean thickness for medial femoral condylar cartilage was 1.736±0.65 mm while the lateral femoral condylar cartilage thickness measured was 1.955±0.715 mm. Details of US findings of OA knees are shown in **Table 2**.

Table 2: High resolution ultrasonographic findings of case group (OA patients)

Variables	Knee Status, n (%)		Chi square value	p value
	Affected (n=89)	Unaffected (n=11)		
		Side of affection, n(%)		
Right	47 (52.8)	3 (27.3)	2.55	0.11
Left	42 (47.2)	8 (72.7)		
		Ultrasonographic Findings, mean ±SD(mm)		
Synovitis		NA		
Grade 0	45 (50.6)	11 (100)	9.711	0.02
Grade 1	32 (35.9)	0 (0.0)		
Grade 2	6 (6.7)	0 (0.0)		
Grade 3	6 (6.7)	0 (0.0)		
Effusion		NA		
Grade 0	36 (40.4)	11 (100)	13.93	<0.01

Grade 1	27 (30.3)	0 (0.0)		
Grade 2	16 (18.0)	0 (0.0)		
Grade 3	10 (11.2)	0 (0.0)		
		Medial Meniscal Protrusion (MMP)		
Grade 0	56 (62.9)	11 (100)	6.087	0.10
Grade 1	11 (12.4)	0 (0.0)		
Grade 2	15 (16.6)	0 (0.0)		
Grade 3	7 (7.9)	0 (0.0)		
		Lateral Meniscal Protrusion (MMP)		
Grade 0	59 (66.3)	11 (100)	5.296	0.15
Grade 1	8 (9.0)	0 (0.0)		
Grade 2	16 (18.0)	0 (0.0)		
Grade 3	6 (6.7)	0 (0.0)		
Medial Femoral Thickness (mm), mean ±SD	1.736±0.65	NA	-	-
Lateral Femoral Thickness, mean ±SD(mm)	1.955±0.715	NA	-	-
		Osteophyte (femur)		
Present	55 (61.8)	0 (0.0)	15.10	<0.01
Absent	34 (38.2)	11 (100)		
		Osteophyte (tibia)		
Present	52 (58.4)	0 (0.0)	13.38	<0.01
Absent	37 (41.6)	11 (100)		
		Baker's Cyst		
Present	31 (38.8)	0 (0.0)	5.55	0.01
Absent	58 (65.1)	11 (100)		

Radiographic findings showed tibio-femoral degenerative changes in all OA knees. K-L grade I was seen in 9 knees (10.1%), Grade II in 24 knees (27%) while Grade III and IV were seen in 31 knees (34.8%) and 25 knees (28.1%) respectively. Details of radiographic findings are shown in **Table 3**.

Table 3: Radiographic findings of case group (OA patients)

Variables	Knee Status, n (%)		Chi square value	p value
	Affected (n=89)	Un affected (n=11)		
		Femoro-tibial space width (mm), mean ±SD		
Medial	2.156±0.96	NA	NA	NA
Lateral	3.548±1.23	NA	NA	NA
		Kellgren Lawrence Grade		
Grade I	9 (10.1)	NA	-	
Grade II	24 (27.0)		-	
Grade III	31 (34.8)			
Grade IV	25 (28.1)			
		Osteophyte (femur)		
Present	56 (62.9)	10 (90.9)	3.41	0.06
Absent	33 (37.1)	1 (9.1)		
		Osteophyte (tibia)		
Present	51 (57.3)	9 (81.8)	2.45	0.11
Absent	38 (42.7)	2 (18.2)		

Mean measurements of both medial and lateral femoral condylar cartilage thickness in OA and control groups was found to be statistically significant while compared using student's t- test (p value = <0.001). In case of right knee the mean measurement of the femoral cartilage thickness of medial condyle for OA and control group was 1.69±0.66 mm and 2.5±0.24 mm respectively (p value = <0.001). For the lateral condyle, it was 1.89±0.73 mm in OA patients and 2.27±0.13 mm in controls (p value = <0.001). On the left knee, the mean measurement of the femoral cartilage thickness of the medial condyle was 1.78±0.65 mm in OA patients and 2.66±0.31 mm in controls with healthy knees (p value = <0.001), while the mean femoral cartilage thickness of the lateral condyle for OA patients and controls measured was 2.02±0.69 mm and 2.28±0.09 mm respectively (p value = <0.001). Details are shown in **Table 4**.

Table 4: Comparison of medial and lateral femoral cartilage thicknesses in osteoarthritis and controls

Variables	OA patients	Control	t	p value
All Knee	n = 89	n = 100	-	-
Medial femoral cartilage thickness (mm)	1.736±0.65	2.601±0.29	-11.894	<0.001
Lateral femoral cartilage thickness (mm)	1.955±0.715	2.276±0.116	-4.427	<0.001
Right Knee	n = 47	n = 50	-	-
Medial femoral cartilage thickness (mm)	1.695±0.66	2.538±0.24	-8.304	<0.001
Lateral femoral cartilage thickness (mm)	1.895±0.73	2.271±0.133	-3.536	<0.001
Left Knee	n = 42	n = 50	-	-
Medial femoral cartilage thickness (mm)	1.781±0.65	2.665±0.31	-8.468	<0.001
Lateral femoral cartilage thickness (mm)	2.021±0.69	2.281±0.09	-2.631	<0.001

DISCUSSION

Pain is the predominant symptom of knee osteoarthritis (OA). However, the reason behind the pain in knee is poorly understood. Although the articular cartilage is observed as the major structure involved in knee OA, hyaline cartilage has no nervous fibres. So, pain may arise from other perirticular and/ or intraarticular structures such as the joint capsule, synovium, periosteum, bone, tendons, bursae, ligaments or menisci[31-33]. The need of high resolution ultrasonographic findings in rheumatic disease is becoming popular nowadays and the availability of high-frequency transducers even in countries with poor resource is increasing. This modality allows for better visualization and therefore high resolution US is in increasing demand because of its non-invasiveness, safety and it is cheap and readily available, can be easily repeated and does not require the use of ionizing radiation[11,14,23]. US findings of our study showed osteophytes was the most common finding. Femoral and tibial osteophytes were observed in 55 knees (61.8%) and 52 knees (54.8%) respectively. The reason behind this is possibly most OA patients selected for the study had K-L radiographic grades II-IV. In our environment late occurrence is more common, when articular cartilaginous changes the sign of early OA detected by US are no longer detectable. These changes cannot be determined by plain radiographs[12,14,20,21,23]. Similar findings were observed by Gaafar *et al.*. and Wu *et al.*[34,35]. They both found that the most common US finding in patients with symptomatic OA was osteophytes. The prevalence of osteophytes in their studies was 100% and 88%, respectively. The higher prevalence rate recorded in Gaafar *et al.*.'s study[34] may be due to their smaller sample size, as only 15 patients with knee OA were examined, while in the study by Wu *et al.*.,[35] OA patients with equal radiographic scales were used and 92% of the population group were in K–L Stages III and IV. In keeping with our study, effusion, synovitis, MMP, LMP and Baker's cyst were the principal findings in US studies of knee OA[36-40] The effect of joint effusion in the pathophysiology of OA is controversial. Mild synovitis with secondary effusion has been described in knee OA[41]. Hill *et al.* reported a strong association between effusion and pain in knee OA[36]. Radiographic scoring of joint damage relies mainly on joint space narrowing and osteophytes, both of which take some time to manifest. Joint space narrowing is a primary radiographic feature of OA. A moderate correlation between radiographic joint space narrowing and loss of hyaline articular cartilage was observed in arthroscopic studies[9,37,38,42]. This was also observed in our study. Mazzuca *et al.*[43] demonstrated that increase in knee pain and inflammation may restrict the ability to fully extend the knee, thus reducing the apparen radiographic thickness of the articular cartilage. Other studies have shown that menisci can contribute to joint space width and menisci protrusion or displacement away from their normal anatomic location may cause radiographic tibiofemoral joint space width independent of cartilage thinning in knee OA[37-39]. The femoral condylar cartilage thickness in both knees in the OA group was found to be significantly less (p value =<0.001) while comparing to control group which was matched for age, sex and BMI. This result is showing that US measurement of knee femoral cartilage is useful in separating OA grom asymptomatic knees. This findings is comparable with a study carried out on patients with rheumatoid arthritis and OA[44]. They concluded that the thickness of knee cartilage in patients with rheumatoid arthritis was significantly less than that of their control group. The present study has a limitation of sample size. We recommend that the study should be done on large number of patients as well as at multiple centres

CONCLUSION

Based on our result it can be concluded that high resolution sonographic evaluation is a cheap, prompt, sensitive and is an effective imaging modality that has a positive effect in assessing articular cartilage which plays an important role in the pathophysiology of OA**.** The commonly seen and diagnosed signs of symptomatic knee OA on high resolution US are synovitis, effusion and Baker's cyst. Early diagmosis and prompt management can therefore improve the quality of life.it is relevant in late presentation as it also has potential in monitoring the progression of OA.

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