Umm Al-Qura Univ. Medical J. Vol. 4, No.1, pp. 1-9 (2013)
01-06 © The University Press

UQU Medical Journal

Original Article

Ultrasound of knee osteoarthritis

Ayman A. Eskandar *, Tareq H. Ahmed**
Umm Al Qura University- Medicine, Department of Radiology.

Correspondence :
Dr. Ayman A. Eskander
Assistant Professor of Radiology
Umm Al Qura University – Medicine
P.O.Box 61,21955, Makkah
Saudi Arabia
Email: aymaneskandar@hotmail.com
Mobile: 00966-555909473

إستخدام الموجات الصوتية في تشخيص خشونة مفصل الركبة الروميتزمي

د.أيمن إسكندر و د. أحمد حلمي
قسم الأشعة, كلية الطب, جامعة أم القرى- مكة المكرمة- المملكة العربية السعودية. ص.ب:61-21955

الملخص

خلفية البحث وأهدافه : الصور الأشعاعية هي تقنية التصوير الرئيسية في الممارسة السريرية اليومية لتقييم مرضى خشونة مفصل الركبة الروميتزمي وذلك نظرا لسهولة عملها وقلة تكالفيها باضافة إلي إمكانية مقارنة نتائجها. وللموجات فوق الصوتية ميزتها الفريدة كونها لا تعرض المريض إلي الإشعاع مع سهولة إستخدامها وإمكانية معاينة وفحص الغضاريف والانسجة اللينة والعضلات.و بالرغم من ذلك,فان استخدام الموجات فوق الصوتية في المملكة العربية السعودية لمثل هذة الحالات محدود.تهدف هذه الدراسة إلي استخدام الموجات فوق الصوتية لمعاينة الملامح المختلفة لخشونة مفصل الركبة الروميتزمي ومقارنتها بالصور الاشعاعية.

الطريقة: تم دراسة ستين مريضا يعانون من خشونة مفصل الركبة الروميتزمي ووجد أن 47 مريضا من ستين يعانون من ضيق في مفصل الركبة حسب نتائج الصور الإشعاعية، بينما تم إكتشاف جميع المرضى بالموجات فوق الصوتية حيث وجد تهالك في الغضروف المفصلي في جميع المرضى. تم اكتشاف وجود سائل مفصلي في 17 مريض بينما تم اكتشاف خمس حالات فقط بالصور فوق الأشعاعية.كما تم اكتشاف تورم الغشاء المفصلي السميك بالموجات فوق الصوتية في 7 حالات بينما لم يتم إكتشاف اي من هذة الحالات بالصور الاشعاعية.

اكتشفت الصور الاشعاعية 54 حالة من الزوائد العظمية المصاحبة لمرض خشونة مفصل الركبة الروميتزمي بينما تم اكتشاف 52 حالة. وجدت الموجات فوق الصوتية تحسنا في تجمع السائل المفصلي في 8 حالات من عشرة تم علاجها بواسطة العقاقير المضادة للالتهاب غير الستيرويدية بينما اختفى السائل المفصلي تماما في حالة واحدة ولوحظ عدم تحسن في حالة واحدة فقط.

الخلاصة:

الموجات فوق الصوتية مفيدة جدا في الفحص المبكر لمرضي خشونة مفصل الركبة الروميتزمي حيث أنها تستطيع المساعدة في الاكتشاف المبكر للمرض وذلك بمعانية الغضروف المتمفصل وزيادة سائل مفصل الركبة وكذلك معاينة التورم الناتج عن المرض في الغشاء المفصلي السميك و إمكانية معاينة الزوائد العظمية. كل ذلك بالاضافه الى سهولة عملها وعدم وجود الاشعاع الذي قد يضر بالمرضى, مما يؤهل هذا الفحص ليكون من الفحوص الاولية التى تجرى لمرضى خشونة مفصل الركبة الروميتزمي.

ABSTRACT

Background: Radiography is the main imaging technique in daily clinical practice for the evaluation of patients with osteoarthritis (OA), owing to its accessibility, low cost and reproducibility. Ultrasound (US) imaging has unique advantages in that it involves no ionizing radiation, is easy to use and visualizes soft tissue structures. However, musculoskeletal US is relatively underused in Saudi Arabia. The aim of this study was to use US imaging in the detection of different features of knee OA.

Methods: In sixty patients with OA, clinical assessment of both knees was performed by the rheumatologist. Weight-bearing anteroposterior and lateral knee radiographs were done. US examination of the knees was done for all patients under study. Comparison between the US and plain radiographs was performed. US follow-up after three months on patients with acute flare of their OA after management with NSAIDs was also performed and compared with their prior US.

Results: Sixty patients with degenerative OA were studied; **47/60** showed narrowing of femero-tibial (FT) articulations seen by X-ray, while all were detected by US as articular cartilage destruction. **Seventeen** cases had synovial effusion elicited by US, while only five were seen by plain radiography. Seven cases showed synovial thickening, while none was identified on plain radiography. However, as regards osteophytes, radiographs detected **54** cases while US elicited **52** cases. Ten patients were treated with NSAIDs for three months, eight of whom showed significant improvement to minimal effusion, **one case** fully resolved, while one case showed no improvement.

Conclusion: Ultrasound is a useful tool that has been demonstrated to be more sensitive than clinical examination and radiography. Ultrasound also allows broad assessment of structural damage and lesions. It is able to detect the presence of inflammation within the joints and at the peri-articular soft-tissue level. Substantial agreement was observed between ultrasound and radiographs for presence of osteophytes.

INTRODUCTION

Osteoarthritis (OA) is a degenerative and progressive joint disease that causes physical inactivity and impaired quality of life and whose frequency is increasing. OA most commonly affects the elderly population, where 70% of those affected are over 65 years of age. OA is considered a multifactorial disease in which numerous risk factors are involved, including advanced age, female gender and mechanical factors (trauma, overuse, articular malposition or malformation, joint instability, occupational and sport activities). Genetic predisposition, inflammation, obesity and endocrine disorders (diabetes, hyperuricemia) are also included. In particular, the increased prevalence of obesity is associated with the rise of OA, especially knee OA in women. The typically affected joints are the knees, hips, lumbosacral spine, neck, feet and hands. Clinically, OA is characterized by pain, morning stiffness (lasting less than 30 minutes), functional limitation and crackles. The joint structures involved are articular

cartilages, bone and the synovium. Most commonly, abnormalities are represented by articular cartilage breakdown, osteophytes at the joint margins, subchondral sclerosis and subchondral cysts, ligamentous contractures and relaxation, muscle atrophy and spasm, in addition to morphological alterations of the synovium[1].

However, OA remains a poorly understood disease. Over the last few years, imaging techniques have become more sophisticated, especially with advances in magnetic resonance imaging (MRI) and ultrasound technologies. Although the use of MRI and other imaging techniques allows the detection of early cartilage fibrillation and defects not seen on conventional radiography (X-ray), several studies have demonstrated that X-ray remains the mainstay of imaging in OA owing to its accessibility, low cost and reproducibility [6,9].

Ultrasound examination may be considered useful in OA assessment owing to its low cost, short duration of examination, and the possibility of performing a multiregional joint evaluation in the same scanning session. This technique allows various anatomical structures to be depicted in fine detail, thus it is considered a promising imaging technique for OA evaluation. Ultrasound has the advantage over MRI in that it is cheaper, convenient, easier to use, dynamic and has no contra-indications to its use [2]. Ultrasound involves no radiation and can obtain views in multiple planes. It can also visualize soft tissue structures like the menisci and cartilages, which are known to be involved in the pathophysiology and progression of OA [3].

OBJECTIVE

The aim of this work is to demonstrate the role of ultrasound in the detection of different features of knee OA.

MATERIAL AND METHODS

This current study was carried out at the departments of radiology and orthopedic surgery Umm Al-Qura University (UQU). This study included 60 patients. All patients attended the outpatient rheumatology clinic of UQU . There were 35 women and 25 men, all with a history of OA. with a mean age of 52 year. A written informed consent was obtained from each patient before participation. Clinical assessment of both knees was performed by the rheumatologist. Weight-bearing anteroposterior (AP) and lateral knee radiographs were done. US examination prior to treatment with NSAIDs was compared to the knee radiographs for each patient involved in the study. Ten patients, who were in severe acute flare and were treated with NSAIDs for three month, underwent US examination of their affected knees at the end of treatment.

All patients were subjected to the following:

Clinical assessment

A- History taking including patient age, occupation (staff, students, or employee), and complaints such as pain, swelling, locking….etc.

B- Local examination for the diseased knee by referring physicians.

Radiographic assessment

Weight-bearing anteroposterior (AP) and lateral knee radiographs were done for all patients.

US assessment

All patients underwent US examination of the knees within 5 days of clinical evaluation usinga commercially available ultrasound real-time scanner (AU5; ESAOTE, Genoa, Italy) with a multi-frequency linear transducer (7–10MHz). The patient lay in supine position on the examining table exposing both knees for comparison.

Anterior approach: The examination of the knee started on the suprapatellar area, with the knee flexed 30°. Longitudinal and transverse scans of the quadriceps tendon, suprapatellar bursa and prepatellar bursa were performed. In the infrapatellar anterior knee, the patellar tendon and infrapatellar superficial and deep bursae were scanned longitudinally and transversely, with the patient supine and the knee flexed 45°.

Medial approach: The patient was in the supine position, with external rotation of the leg and the knee flexed 10° with mild valgus stress. Longitudinal and transverse scans of the medial collateral ligament (MCL) and the anterior horn of the medial meniscus were performed

Lateral approach: Longitudinal and transverse scans of the lateral collateral ligament, anterior horn of the lateral meniscus, iliotibial band and biceps femoris tendon were performed in the lateral aspect of the knee. Thehe patient lay supine, with internal rotation of the leg, and the knee flexed 10° with mild varus stress.

Posterior Approach: The examination of the posterior aspect of the knee was performed with the patient prone and the knee in full extension. Examination included longitudinal and transverse scans of the gastrocnemiussemimembranosus bursa, posterior meniscal horns and posterior cruciate ligament.

The presence or absence of osteophytes was assessed in the tibial and femoral sites of both knees, with 30 degrees of knee flexion. Osteophytes were defined as cortical protrusions at the joint margin seen in two planes [4]. Femoral and tibial osteophytes were assessed in the medial and lateral compartments using medial and lateral longitudinal scan positions, respectively. Flexion of the knees at 30^{o} was standardized by using the same wedge for all ultrasound assessments.

Synovial effusion was defined as an abnormal anechoic or hypoechoic area in the joint that was displaceable,compressible, and lacks Doppler signal [5]. The size of effusions was measured in the longitudinal supra-patellar position, with the knee in 30 degrees flexion. The maximum diameter of the effusion in the longitudinal view was used to quantify it. Joint effusion was defined by using a cut off of ≥4 mm effusion depth, as seen in a previous multicentre European study [6]. Normal MCL was seen hyperechoic covering the medial femoral condyle, the outer margin of the medial meniscus and the medial tibial plateau [7, 8]. Distances were measured using electronic calipers.

Protrusion of the menisci was defined as the distance between the peripheral border of the meniscus and the outline of the tibial plateau greater than 2 mm. The measurement of meniscal protrusion was also recorded in this study.

RESULTS

Among the sixty patients studied, there were 35 women and 25 men, with a mean age of 52 years. Degenerative OA was diagnosed by clinical and conventional knee radiographs taken in the standing position. **Forty-seven** of the sixty patients revealed narrowing of the medial compartments of the femero-tibial (FT) articulations by plain radiography subsequent to articular cartilage destruction.

On sonography, there was thinning out of the articular cartilage of all **60** cases over the medial femoral condyle, associated with clouding and loss of the sharp anterior and posterior edges. Irregularity of the bony surfaces and calcification of the menisci were also noted in some cases (Fig. 1A, B, C & D).

Fig.1A: Normal articular cartilage with sharp edges and homogenous hypoechogenicity.

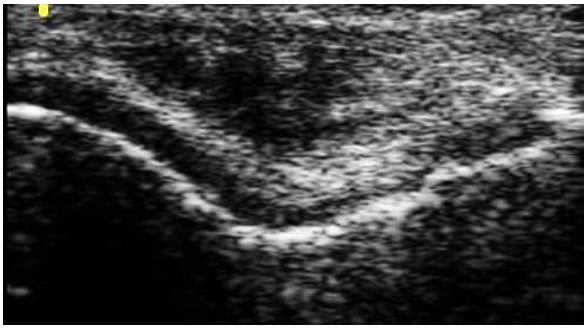

Fig.1B: Irregular thinned out articular cartilage in a patient with knee OA.

Fig.1C : Irregularities of the bony surface with destroyed articular cartilage.

Fig.1D : Calcified extruded fragments of the meniscus

Conventional knee radiographs showed **54** patients with *osteophytes*. In 52 patients, *osteophytic lipping* was seen by US as dense echoic projections from the bone margins, and was associated with extrusion of the medial menisci in **16** cases. This was also associated with the medial collateral ligament (MCL) bowed or stretched over the extruded menisci. **Three** meniscal cysts were also seen (Fig. 2).

Fig.2: Posterior lateral meniscus with a tear and a meniscal cyst near the outer surface (ice cream cone).

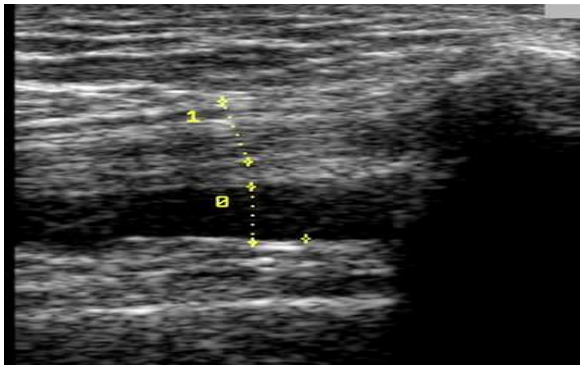

Fig.3 : Moderate suprapatellar effusion deep to the quadriceps tendon.

Fluid collections appeared anechoic on US (Fig. 3), seen as suprapatellar recess *effusion* in **17**cases, Baker's cysts in **4** cases, as well as a prepatellar bursa and a small pes anserine bursa in one case for each. Only **5/17** of these suprapatellar effusions were seen radiographically. None of the Baker's cysts or the fluid collections seen in the prepatellar bursa or the pes anserine bursa was seen radiographically.

Synovial thickening was seen in **7** cases within the suprapatellar recesses (Fig.4). One of them showed mild increase of vascularity by power Doppler sonography (PDS).

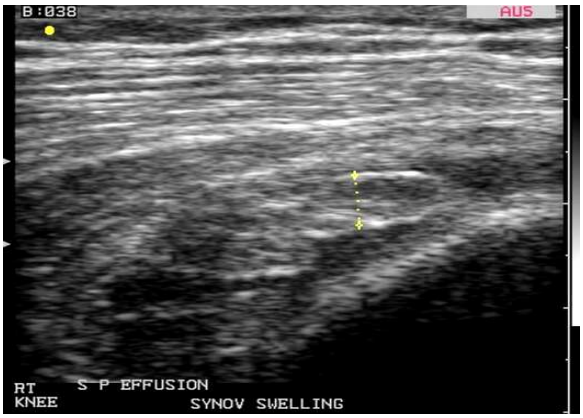

Fig.4: Synovial swelling in the lateral recess of the right knee

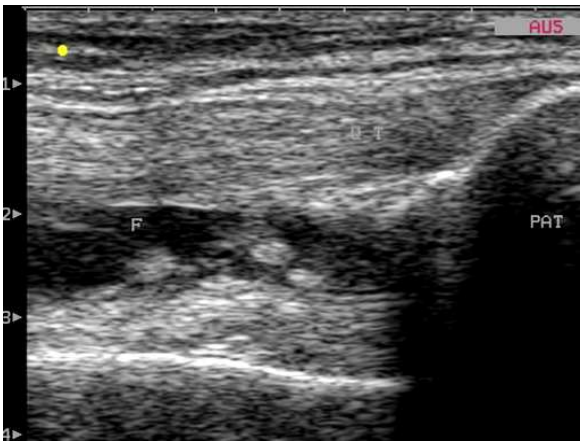

Fig.5A:Suprapatellar effusion with osteochondral fragments

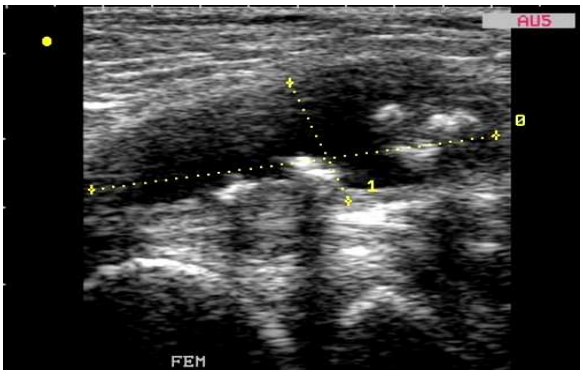

Fig.5B : Baker's cyst with osteochondral fragments

*Loose bodies (*osteochondral fragments) were seen. One was seen within a Baker's cyst (Fig 5A), and two were identified in the suprapatellar effusion (Fig.5B). They appeared as hyperechoic foci with acoustic back shadows within the anechoic fluids.

In **10** patients with acute flare of their symptoms and who were treated with non-steroidal anti-inflammatory drugs (NSAIDs) and followed up subsequently after 3 months, **8** effusions diminished, 1 did not improve, and **1** showed absence of effusion.

One case of pre-patellar bursitis and one case of pes anserine bursitis were identified on US but were not seen radiographically.

Table 1: **Sonographic findings**

Sonographic findings	***No***	Knee radiographs	***No***
Articular cartilage destruction	47	*Narrowing of(FT) articulations*	47
Osteophytes	52	***Osteophytic lipping***	54
Suprapatellar effusion	17	*Suprapatellar effusion*	5
Synovial thickening	7	*Synovial thickening*	0
Bursae *Baker cyst* *Pre-patellar bursitis* *Pes Anserine bursitis*	 4 1 1	*Bursae* *Baker cyst* *Pre-patellar bursitis* *Pes Anserine bursitis*	 0 0 0
Loose bodies	3	*Loose bodies*	7

DISCUSSION

Ultrasound assessment of osteoarthritis is based on measurements of cartilage thickness and detection of osteophytes [9]. The sonographic feature of an osteoarthritic cartilage is loss of the normal sharpness of the synovial space-cartilage interface, where it appears blurred with poor visualization of

the outer cartilaginous margin. Loss of cartilage transparency is an early sonographic feature of osteoarthritis. The increased echogenicity may reflect structural alteration such as fibrillation of cartilage and cleft formation [10].

Major changes of echogenicity of the cartilage are clearly evident in patients with advanced osteoarthritis. Narrowing of the articular cartilage and even its complete absence can be observed in patients with osteoarthritis. Loss of articular cartilage resulting in asymmetric narrowing of the inter-bone distance, with increased intensity of the posterior bone cartilage interface and loss of continuity of the bone profile can be also detected [11]. Osteochondral fragments may be detected within the joint fluid located in the suprapatellar pouch deep to the quadriceps tendon, or posteriorly within a baker's cyst [12]. Joint space narrowing is a primary radiographic feature of OA.

Studies have shown that menisci can contribute to joint space width.Meniscal protrusion, or displacement away from their normal anatomic location, may cause radiographic FT space narrowing independent of cartilage thinning in knee OA. In this study, the sonographic findings in 47/60 patients with degenerative arthritis showed comparable results.

Sonographic assessment of the extent of cartilage damage in patients with OA is important in the early diagnosis and monitoring of therapy in osteo-arthritis [11]. The hyaline articular cartilage in the intercondylar notch can be used as a marker of activity of inflammatory arthropathy [13].

Although cartilage evaluation by US seems reliable, the clinical value is limited in active inflammation because the weight bearing areas are inaccessible [14)]. In patients affected by OA, the typical bone changes are osteophytes, which appear as hyperechoic signals at the joint margins. There is optimal correlation between ultrasound and plain radiography in detecting the presence of osteophytosis.Recently, ultrasound has been demonstrated to be more sensitive than X-ray in the detection of osteophytes in patients with hand OA [6]. Ultrasound is able to detect, with higher sensitivity than clinical examination, the presence of joint effusion, correlating well with MRI, arthroscopic findings and pain in knee OA [16, 17]. Usually, the fluid is anechoic, but in OA it may appear inhomogeneous with particulate matter, possibly due to proteinaceous material, debris or calcified fragments. Moreover, by using color Doppler and power Doppler, it is possible to show hyperaemia due to raised synovial vascularity, correlating with histological findings in patients with OA [18, 19]. Moreover, by using ultrasound, it is possible to evaluate the pathology of the adjacent soft tissues, such as Baker's cysts, which are frequently involved in OA.

Ultrasound is also useful and safe as a guide for joint injections[15]. Therefore, by using ultrasound, it is possible to image the structural damage and the inflammatory state of the OA. Since ultrasound can detect minimal synovitis, this technique can identify patients with a higher risk of progression and can be used to monitor the progression of the disease [19]. In this work, marked synovial thickening with increased vascularity are seen as signs of inflamed synovium and detected in some patients with acute flare of OA.

In this study, sonographic examination in patients with bursitis showed hypoechoic fluid collection with coarse internal echoes in the superficial and deep infra-patellar bursae. This is in agreement with Acebes et al[20], who reported that bursae adjacent to joints with irregular bony contours and hypertrophic tendon insertions were predisposed to the development of frictional bursitis. Bursae of the knee most commonly involved are the pre-patellar as well as infra-patellar bursae. In chronic bursitis due to impingement or overuse, the bursa is

distended with anechoic fluid. More frequently, there is just bursal thickening evidenced by bands of moderate echogenicity with echogenic debris.

CONCLUSIONS

This study has shown several advantages of ultrasonography, including absence of hazardous ionizing radiation, accessibility, low price, noninvasiveness, quick and precise evaluation of the entire knee soft tissue structures which are all frequently involved in knee OA, as well as the possibility of frequent repetitions.

The US technique is done within 15 minutes for bilateral knee joints, which is a short time compared to another advanced imaging modality, i.e. MRI, which would take 30 minutes for one knee examination, not taking in consideration the reading time required afterwards.

Ultrasound can be used efficiently to follow up diagnosed osteoarthritic patients.

The quality of ultrasound examination depends on technical equipment and the doctor's experience.

This study recommends the use of ultrasonography as a routine and fundamental method in contemporary rheumatological practice, and as a complement to clinical examination.

ACKNOWLEGMENT

It is a pleasure to acknowledge my indebtedness to all the surgical staff and all health professionals at King Faisal Hospital, Makkah, for their help and cooperation in carrying out this work.

REFERENCES

1. Iagnocco A, Modesti M, Vavala,C, Rutigliano I, Valesini G. Imaging Modalities in Osteoarthritis, European Musculoskeletal Review, 2011; 6(2):74-78.

2. Abraham et al. BMC Musculoskeletal Disorders, 2011; 12:70.

3. Berthiaume MJ, Raynauld JP, Martel-Pelletier J, Labonte F, Beaudoin G, Bloch DA, et al. Meniscal tear and extrusion are strongly associated with progression of symptomatic knee osteoarthritis as assessed by quantitative magnetic resonance imaging, Ann Rheum Dis 2005; 64:556-563.

4. Keen HI, Conaghan PG. Ultrasonography in osteoarthritis, Radiol Clin North Am 2009; 47:581-594

5. Wakefield RJ, Balint PV, Szkudlarek M, Filippucci E, Backhaus M, D'Agostino MA, et al. Musculoskeletal ultrasound including definitions for ultrasonographic pathology. J Rheumatol.2005; 32:2485-2487.

6. D'Agostino MA, Conaghan P, Le Bars M, Baron G, Grassi W, Martin-Mola E, et al. EULAR report on the use of ultrasonography in painful knee osteoarthritis, Part 1: prevalence of inflammation in osteoarthritis. Ann Rheum Dis.2005;64:1703-1709.

7. McCune WJ, Dedrock DK, Aisen AM, MacGuire A. Sonographic evaluation of osteoarthritic femoral condylar cartilage, correlation with operative findings. Clin Orthop Relat Res 1990; 254:230-235.

8. Ko CH, Chan KK, Peng HL. Sonographic imaging of meniscal subluxation in patients with radiographic knee osteoarthritis. J Formos Med Assoc.

2007; 106:700-707.

9. Preidler KW, Resnick D. Imaging of osteoarthritis, Radiol Clin North Am, 1996;34:259-270.

10. Myers SL, Dines K., Brandt DA, Brandt KD, Albrecht ME. Experimental assessment by high frequency ultrasound of articular cartilage thickness and osteoarthritic changes, J Rheumatol, 1995; 22:109-116,.

11. Grassi W, Lamanna G, Farina A, Cervini C.Sonographic imaging of normal and osteoarthritic cartilage. Semin Arthritis Rheum1999; 28:398-400,.

12. Ptasznik R. Ultrasound in acute and chronic knee injury, Radiol Clin North Am, 1999; 37:797-830.

13. Martinoli C, Bianchi S, Derchi L. Tendon and nerve sonography, Radiol Clin North Am 1999; 37: 691-711.

14. Ostergaard M, Court-Payen M, Gideon P, Wieslander S, Cortsen M, Lorenzen I et al. Ultrasonography in arthritis of the knee, a comparison with MR imaging. Acta Radiol, 1995; 36:19-26, 1995.

15. Bouffard JA, Dhanju J. Ultrasonography of the knee. Semin Musculoskelet Radiol , 1998; 2:245-267,.

16. de Miguel Mendieta E, Cobo Ibáñez T, Usón Jaeger J, Bonilla Hernán G, Martín Mola E., Cobo Ibáñez T, Usón Jaeger J, Bonilla Hernán G, Martín Mola E. . Clinical and ultrasonographic findings related to knee pain in osteoarthritis, Osteoarthritis Cartilage. 2006;14:540–4.

17. Walther M, Harms H, Krenn V, Radke S, Kirschner S, Gohlke F. Synovial tissue of the hip at power Doppler US: correlation between vascularity and power Doppler US signal. Radiology, 2002;225:225–31.

18. Walther M, Harms H, Krenn V, Radke S, Faehndrich TP, Gohlke F. Correlation of the power Doppler sonography with the synovial tissue of the knee joint in patients with osteoarthritis and rheumatoid arthritis. Arthritis Rheum, 2001;44:331–8.

19. Acebes JC, Sanchez-Pernaute O, Diazoca A, Herrero- Beaumont G. Ultrasonographic assessment of Baker's cysts after intra-articular corticosteroid injection in knee osteoarthritis, J Clin Ultrasound, 2006; 34:113–17.