Role of Ultrasonography in Evaluation of Knee Joint Synovial Lesions

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Abstract

Background: Synovial lesions involving knee joint are considered common causes of intraarticular masses and can be classified as noninfectious synovial proliferative processes (synovial osteochondromatosis, Pigmented Villonodular Synovitis [PVNS], hemophilic hemoarthrosis, rheumatoid arthritis), infectious diseases (septic arthritis) and malignancies (synovial sarcoma, synovial metastases). The use of Ultrasonography (US) in patients with suspected synovial proliferation in inflammatory arthritides has increased dramatically over the last decade and most rheumatologists have adopted this technique as an integral part of routine diagnosis and management of musculoskeletal diseases. An increasing number of publications support the use of US in early detection, quantification and follow-up of several synovial pathologic changes affecting knee joint.

Aim of the Work: The purpose of this study is to emphasize the role of ultrasonography in the assessment of synovial lesions involving knee joint.

Patients and Methods: Thirty nine cases; 25 females and 14 males with 69 symptomatic knee joints were included in this study at the period from November 2011, till January 2014, age range 22 to 62 years old (average 42 years). Patients were referred to the Radiology Department at Kasr Al-Aini Hospital after full clinical examination and laboratory investigations to evaluate their knee joints synovial affection using US and MRI.

Results: The high correlation rate between the results of US and MRI have shown that in patients with knee joint synovial lesions involvement, US is an effective alternative/complimentary method of examination in detection of knee joint early signs of synovitis, effusion and mass lesions.

Key Words: Ultrasonography – Knee joint – Synovial lesions.

Introduction

SYNOVIAL. lesions involving knee joint are considered common causes of Intra articular masses and can be classified as noninfectious synovial proliferative processes (synovial osteochondromatosis, Pigmented Villonodular Synovitis [PVNS], hemophilic hemoarthrosis, rheumatoid arthritis), infectious diseases (tuberculous and septic arthritis) and malignancies (synovial sarcoma, synovial metastases). The use of Ultrasonography (US) in patients with suspected synovial proliferation in inflammatory arthritides has increased dramatically over the last decade and most rheumatologists have adopted this technique as an integral part of routine diagnosis and management of musculoskeletal diseases. An increasing number of publications support the use of US in early detection, quantification and follow-up of several synovial pathologic changes affecting knee joint [1].

Synovial osteochondromatosis is a cartilaginous metaplasia of the synovial membrane of undetermined origin. The diagnosis is usually established by conventional radiography. Sometimes synovial masses may not be calcified and therefore are not seen on plain films. In these cases, US is the key modality for thickened synovium containing hyperechoic chondral nodules that can or cannot undergo calcification. When mineralized, these nodules appear as bright hyperechoic fragments with posterior acoustic shadowing and are better delineated with US [2].

Pigmented villonodular synovitis is an uncommon benign proliferative disorder of the synovium which affects joints, bursae or tendons sheaths. US can detect nodular pigmented villonodular synovitis as a well-delineated hyperechoic mass usually located inside the Hoffa’s fat pad; the diffuse type is most often detected with US at the level of the posterior aspect of the joint, between the posterior tendons and the femoral bone. Color Doppler imaging reveals internal flow signals [2].

Rheumatoid Arthritis (RA) is a chronic systemic autoimmune disorder of unknown etiology charac-
terized by symmetrical joint synovitis and pain. The knee is commonly affected in RA, ultrasound findings in rheumatoid arthritis affection of the knee joint include synovial hypertrophy; joint effusion and marginal erosions and are crucial findings in rheumatoid arthritis [3].

Septic arthritis is a particularly serious condition given the propensity for long term morbidity if not recognized and treated early. Septic arthritis most commonly affects the hip, knee and shoulder, joints, Staphylococcus aureus is the most common causative organism. The hallmark of septic arthritis on ultrasound is the presence of a joint effusion in a patient with clinical signs of joint infection. Ultrasound enables recognition and guided-aspiration of joint fluid at an early stage thereby allowing early diagnosis and treatment of septic arthritis. Joint fluid in septic arthritis may be hypoechoic or hyperechoic with increased synovial vascularity in about 50% of septic arthritis cases by power Doppler imaging [4].

Hemophilia is a hereditary blood disease characterized by impaired coagulability of the blood. Hemophilia A is the most common of the severe, inherited bleeding disorders. This type, also called classic hemophilia, is due to a deficiency of clotting factor VIII. US shows joint effusion with complex areas of hypo and isoechogenecity on grey scale and minimal to no power Doppler signal. Synovial hypertrophy may be noted in the affected knee [5].

Synovial sarcoma accounts for 8-10% of all of the soft tissue sarcomas; it’s characterized by high risk of local relapse, even after surgical complete excision, deceiving onset and slowly growth. Because of the aggressive potential behavior of synovial sarcoma, pathologic and radiologic assessment is important for staging and evaluating lesion extent to direct appropriate therapy. Imaging findings, although not pathognomonic, frequently suggest the diagnosis. Radiographic findings of a soft-tissue mass near but not in a joint in patient, particularly if calcification is present, are very suggestive of synovial sarcoma [6].

Synovitis is defined as non compressible intra articular tissue, within synovial recesses. It may occur in the joint capsules, bursae, and tendons sheaths. The thickened synovium tend to appears as hypochoic vegetations protruding inside the synovial fluid or completely filling the articular space [3].

Effusion is defined as hypoechoic or anechoic compressible intra articular material within synovial recesses, simple effusion should be completely transonic with no increase in Doppler signal [7].

**Aim of the work:**

The purpose of this study is to emphasis the role of ultrasonography in the assessment of synovial lesions involving knee joints.

**Patients and Methods**

Thirty nine cases; 25 females and 14 males with 69 symptomatic knee joints (30 cases with bilateral knee joints examination) were included in this study at the period from November 2011, till January 2014, age range 22 to 62 years old (average 42 years). Patients were referred to the Radiology Department at Kasr Al-Aini Hospital after full clinical examination and laboratory investigations to evaluate their knee joints affection by using US and MRI.

Ultrasoundography of knee joints were performed using GE LOGIQ P6 Pro ultrasound machines using a near focused linear array transducer with a centre frequency of 7.5-12MHz.

MRI was performed using Philips scanres achieva or intera (1.5T) by knee coil in all cases.

Thirty three patients were known to be cases of seropositive autoimmune inflammatory arthritis by laboratory investigations.

Two patients were already known to be cases of hemophilia by laboratory investigations.

Two patients were pathologically proven to be cases of pigmented villinodular synovitis.

One patient was pathologically proven to be synovial sarcoma.

One patient was proven to be septic arthritis.

**Inclusion criteria:**

Patients with clinical and laboratory data suggestive of knee joint affection by synovial lesions.

**Data assessment and interpretation:**

The joint effusion, synovial proliferation and mass lesions were assessed by US and Magnetic Resonance Imaging (MRI). The results of both examinations were interpreted blindly and compared by two experienced radiologists, MRI was considered as gold standard tool.
Results

This study involved 39 cases with 69 symptomatic knee joints by different synovial lesions (30 cases with bilateral knee joints examination), 25 females and 14 males, age ranged from 22 to 62 years old (average 42 years).

Both MRI and ultrasound detected and agreed in detection of joint effusion and synovial proliferation of 49 joints out of the 69 knee joints.

Regarding mass lesions, both MRI and ultrasound detected and agreed in diagnosis of 2 joints with mass lesions out of the 69 knee joints.

Thirty three patients were known to be cases of seropositive autoimmune inflammatory arthritis by laboratory investigations.

Two patients were already known to be cases of hemophilia by laboratory investigations.

Two patients were pathologically proven to be cases of pigmented villonodular synovitis.

One patient was pathologically proven to be synovial sarcoma.

One patient was proven to be septic arthritis.

The distribution of pathological entities, which were diagnosed by in 69 knee joints (Table 1).

In the comparison of both examination modalities (US and MRI), the results were concordant (Tables 2,3). This makes the sensitivity, specificity, positive/negative predictive values and overall accuracy values of US regarding joint effusion, synovial proliferation and mass lesions all equal 100%.

Table (1): Distribution of pathological entities, which were diagnosed by in 69 knee joints.

<table>
<thead>
<tr>
<th>Pathological entities</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seropositive inflammatory arthritis</td>
<td>33</td>
<td>84.6</td>
</tr>
<tr>
<td>Septic arthritis</td>
<td>2</td>
<td>5.2</td>
</tr>
<tr>
<td>Hemophilia</td>
<td>2</td>
<td>5.2</td>
</tr>
<tr>
<td>Pigmented villonodular synovitis</td>
<td>2</td>
<td>5.2</td>
</tr>
<tr>
<td>Synovial sarcoma</td>
<td>1</td>
<td>2.5</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>100</td>
</tr>
</tbody>
</table>

Table (2): Concordance and discordance rates between magnetic resonance imaging and ultrasound in detection of joint effusion and synovial hypertrophy.

<table>
<thead>
<tr>
<th>Joint effusion and Synovial hypertrophy by ultrasound</th>
<th>Absent</th>
<th>Present</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>20</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Present</td>
<td>0</td>
<td>49</td>
<td>49</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>49</td>
<td>69</td>
</tr>
</tbody>
</table>

Table (3): Concordance and discordance rates between magnetic resonance imaging and ultrasound in detection of mass lesions.

<table>
<thead>
<tr>
<th>Mass lesions by ultrasound</th>
<th>Absent</th>
<th>Present</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>67</td>
<td>0</td>
<td>67</td>
</tr>
<tr>
<td>Present</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>67</td>
<td>2</td>
<td>69</td>
</tr>
</tbody>
</table>

Case (1): Female patient 30 years old with chronic knee pain and swelling and was pathologically proven Pigmented Villonodular Synovitis (PVN). (A) Grey scale and power Doppler longitudinal US images on the infra patellar region shows hyperechoic, heterogenous, irregularly-shaped mass like lesion with markedly increased vascularity by Doppler study. (B) Sagittal MRI T2 WIs shows low-signal-intensity mass like lesions.
Case (2): Female patient 31 years with rheumatoid arthritis. (A) Longitudinal US images over the supra patellar region showing mild joint effusion, mild hypo echoic synovial thickening with increased vascularity on by Doppler study indicating activity. (B) Sagittal T1 post contrast images on supra patellar region showing mild joint effusion and synovial thickening as well as bone infarcts (not detected by US).

Case (3): Female patient 23 years with rheumatoid arthritis. (A) Longitudinal US images over the supra patellar region showing hypo echoic synovial thickening with increased vascularity on by Doppler study indicating activity. (B) Sagittal T2 images on supra patellar region showing mild synovial thickening.

Case (4): 42 years old female patient with rapidly growing focal right knee swelling and was pathologically proven synovial sarcoma. (A) Grey scale and power Doppler longitudinal US images on the infra patellar region shows hypoechoic, heterogenous, irregularly-shaped mass lesion with markedly increased vascularity by Doppler study centered upon and infiltrating the patellar tendon. (B) Post contrast Sagittal T1WIs showing heterogeneously enhancing mass lesion centered upon and infiltrating the patellar tendon.
Case (5): 58 years old male patient with septic arthritis severe knee pain swelling and fever. (A) Transverse gray scale and power Doppler US images of the baker cyst showing marked synovial thickening with marked increased vascularity in power Doppler. (B) Sagittal STIR WIs shows joint effusion with marked synovial thickening at the Baker cyst and supra patellar recess.

Case (6): 41 years old female patient with anterior knee pain and swelling (pre patellar bursitis). (A) Longitudinal gray scale and power Doppler US images shows separated fluid collection at the pre patellar subcutaneous fat with mild increased vascularity at its wall by Doppler study. (B) Sagittal T2W images showing a distended pre patellar bursa by fluid signal with thin septae seen within.

Discussion

Synovial lesions involving knee joint are considered common causes of intra articular masses and can be classified as noninfectious synovial proliferative processes (synovial osteochondromatosis, Pigmented Villonodular Synovitis [PVNS], hemophilic hemoarthrosis, rheumatoid arthritis), infectious diseases (tuberculous and septic arthritis) and malignancies (synovial sarcoma, synovial metastases). The use of Ultrasonography (US) in patients with suspected synovial proliferation in inflammatory arthritides has been increased that most rheumatologists have adopted this technique as an integral part of routine diagnosis and management of musculoskeletal diseases [1].

This study was performed to assess the value of high resolution ultrasonography as a diagnostic tool in the evaluation of patients with synovial lesions involving the knee joint.

It included thirty nine patients; 25 females and 15 males with 69 symptomatic knee joints were included in this study with their ages ranged between 22 to 62 years old.

Regarding joint effusion and synovial thickening detection, D’Agostino and his collagues [6]
studied 600 patients with painful knee and found that inflammation evident by synovitis and joint effusion seen by US correlated statistically with advanced radiographic disease.

Abraham and his colleagues [1], studied reliability and validity of ultrasound imaging of features of knee osteoarthritis in the community and found substantial to excellent agreement between ultrasound observers for the presence of joint effusion size.

Scheel et al. [8] demonstrated excellent agreement of ultrasound with MRI. There was 100% agreement for effusion and 79% for synovial hypertrophy, when comparing US to MR imaging of the knees with inflammatory arthritis.

Karim et al. [7] stated that with the use of arthroscopy as the gold standard, US had 98% sensitivity, 88% specificity, 97% accuracy as a tool of detecting synovitis in the knee joint.

This matches with our results, we found US 100% sensitive, specific and accurate in detection of the joint effusion and synovial thickening in comparison with MRI.

Regarding septic arthritis, the study of Mnif et al. [9], showed that ultrasound scanning in the diagnosis of joint effusion had a sensitivity of 93.4 per cent and a specificity of 100 percent. Matter floating within the joint effusion was noted in 50 per cent of septic arthritis. These changes were not found in other arthritis. They concluded that US enables detection and grading of joint destructive changes.

This matches with our results, we found US is accurate in detection of the joint effusion, synovial thickening and effusion turbidity in comparison with MRI only in one case.

Another study conducted by Tien et al. [20], found ultrasonography has the following advantages for the diagnosis of septic arthritis: 1) ultrasonography is very sensitive in detecting the joint effusion of septic arthritis; 2) ultrasonography can clearly define the pathological extent of septic arthritis and help clinicians to treat the concurrent osteomyelitis by appropriate surgical debridement; and 3) ultrasonography can differentiate soft tissue abscess or tenosynovitis from septic arthritis and help clinicians obviate unnecessary needle joint aspiration.

Li et al. [11] who studied 64 patients knee joints with hemophilia stated that main characteristics of ultrasonography in haemophilic arthropathy in knee joints were: Synovial hypertrophy, cartilage damage, bone erosion and haemosiderin deposition. The prevalence of synovial hypertrophy, haemosiderin deposition were 77.0% and 49.6%, respectively; and the prevalence of cartilage damage, bone erosion, were 63.7% and 48.1% respectively.

This matches with our results, we found US 100% sensitive, specific and accurate in detection of the joint effusion, synovial thickening and haemosiderin deposition in comparison with MRI in two cases with hemophilia.

Lakkaraju, et al. [12], did ultrasound evaluation for three hundred and fifty-eight consecutive patients referred from primary and secondary care with soft-tissue masses and stated that ultrasound is an effective diagnostic triage tool for the evaluation of soft-tissue masses referred from primary care.

In our results we found US 100% sensitive, specific and accurate in detection and anatomical evaluation of the mass lesions in comparison with MRI in two cases with synovial related mass lesions.

**Conclusion:**

We concluded that ultrasonography has an important alternative and complementary role to MRI examination in the evaluation of the knee joint synovial lesions.

**References**


الملخص العربي

الهدف من هذه الدراسة هو تقييم دور الموجات فوق الصوتية في المرضى المشتبه بصابيتهم باعتلالات النسيان الزائلي.

أجريت هذه الدراسة في مستشفى جامعة القاهرة في الفترة من 2011-2014 على مفصل الركبة في 39 من المرضى المشتبه باعتلالات النسيان الزائلي.

خضع كل مريض إلى تصوير كامل لمفصل الركبة باستخدام الموجات فوق الصوتية والرنين المغناطيسي.

تم التأكد من تطبيق جيد في النتائج بين الموجات فوق الصوتية والرنين المغناطيسي في الكشف عن اعتلالات النسيان الزائلي المتمثلة في ثخانة النسيان الزائلي. ارضاع الركبة وتكون الكتلة.

يمكن الاستخلاص أن الموجات فوق الصوتية وسيلة هامة وممكّنة لفحص الرنين المغناطيسي وذلك لقدرتها على إعطاء صورة واضحة عن ثخانة النسيان الزائلي. ارضاع الركبة وتكون الكتلة في المرضى المشتبه باعتلالات النسيان الزائلي.