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ORIGINAL RESEARCH

Evaluation of Role of Sonography in the Management of Painful Knee Disorders

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ABSTRACT

Background:In developing countries where MRI is still unaffordable and not readily available, ultrasound may serve as an efficient substitute in trained hands. Sonography is vastly underutilized and with additional advances in technology and scanning techniques, we expect further expansion of its role in the evaluation of knee joint. Thus, ultrasound can be used as an initial modality for painful knee joint and may be helpful in making decisions to perform more costly MR imaging or invasive arthroscopy.

Materials and Methods: A descriptive observational study was conducted amongst 33 patients who underwent ultrasound imaging of the knee when they presented with knee pain at a tertiary care hospital in Delhi, NCR from July 2017 to March 2020. Ultrasound was performed using the technique described by Von Holsbeeck. Bilateral scans were taken for each patient for comparison. Examination was done with the patient supine, left and right lateral and prone positions.

Results: All except six cases (82%) were diagnosed with arthritis on ultra-sonography – osteoarthritis (21, 63%); infective arthritis (3, 9%) and inflammatory arthritis (2, 6%). Six cases were diagnosed with idiopathic popliteal cyst. On ultrasonography of degenerative arthritis cases, cartilage lesions were identified in 10 cases in the form of cartilage thinning. Joint effusion was detected in 13 cases as fluid echogenicity in the suprapatellar recess. Meniscal lesions were detected in 12 cases.

Conclusion: High-resolution sonography is a novel technique for the assessment of the painful knee. We recommend that ultrasound should be used regularly as a second line after plain radiography in radiological evaluation of the knee joint. Ultrasound provides very useful information on the status of menisci, ligaments, tendons and muscles in low resourced country like India where MRI is expensive and accessible only to a few.

Keywords: Musculoskeletal Sonography.

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INTRODUCTION

The knee joint is one of the major weight bearing joints of the body and subsequently, is a significant source of morbidity in the adult population. The mainstay of radiological evaluation of knee joint has been conventional plain radiography that can demonstrate osseous abnormalities but has a limitation in the assessment of the surrounding soft tissue. Use of ultrasonography as clinical investigative tool in musculoskeletal imaging remains underutilised.[1,2]

Since 1977, technology has markedly improved ultrasound imaging. The spatial resolution of sonography exceeds that of MR imaging without the use of small surface coils and specific imaging parameters.[3] The resolution of ultrasound with standard high frequency transducers allow visualisation of individual neuronal fascicles.[4]

Ultrasound evaluation for peripheral nerve abnormalities, such as nerve entrapment disorders and nerve dislocation, is now a standard diagnostic protocol at many higher centres.[5] Many researchers have documented the ability of ultrasonography in detecting synovial hypertrophy in case of inflammatory arthritis[6,7] and to assess response to treatment in patients of arthritis by monitoring the decreasing extent of joint effusion and synovial thickening.[7,8-10] US can help in early diagnosis of acute osteomyelitis before any changes on plain radiographs are evident.[6,11-14]

In developing countries where MRI is still unaffordable and not readily available, ultrasound may serve as an efficient substitute in trained hands. Sonography is vastly underutilized and with additional advances in technology and scanning techniques, we expect further expansion of its role in the evaluation of knee joint. Thus, ultrasound can be used as an initial modality for painful knee joint and may be helpful in making decisions to perform more costly MR imaging or invasive arthroscopy.

This study was conducted to assess the role of sonography in evaluation of knee joint pain/ disorders that patients most commonly presented with to the out-patient department.

MATERIALS & METHODS

A descriptive observational study was conducted amongst 33 patients who underwent ultrasound imaging of the knee when they presented with knee pain at a tertiary care in Delhi-NCR from July 2017 to March 2020. A high frequency linear array transducer with frequency range of 5 -10 MHz of MedisonSonoace X8 and MedisonSonoace X6 ultrasound machines were used. Color Doppler and Power Doppler were used as and when required. Patients included in our study were those individuals who were advised a ultrasonography for knee pain, irrespective of the duration of their symptoms. Patients with prosthesis, or any knee surgery and paediatric patients were excluded from our study.

All study participants were administered a study proforma and briefed about the procedure. A written informed consent for inclusion in the study was obtained prior to their recruitment. Subsequently, all study participants underwent ultra-sonographic examination of their knee joint. All the images of the patients examined were stored in the USG machine and were later transferred into an external storage device and PACS. The findings were immediately recorded in the study proforma. Bilateral scans were taken for each patient for comparison with the normal structures and functional difference between two sides. Dual image mode and aligning the soft tissue on both sides to mirror each other were used for such precise comparison often with bony landmark and contour as guides. Examination was done with the patient supine, left and right lateral and prone positions.

Ultrasound was performed using the technique described by Von Holsbeeck.[15] The examination was initiated with the patient supine and the knee in full extension. Imaging in anterior aspect of knee allows identification of suprapatellar pouch and medial and lateral recess and quadriceps tendon .Then knee is placed in moderate flexion and patellar tendon and Hoffa's fat pad ,deep infrapatellar bursa are assessed. For examination of anterior cruciate ligament, flexion of 45-60° is required and transducer is placed anteriorly below patella and medial to midline followed by a 30° counter clockwise for right knee and clockwise for left knee; transducer should sweep from superolateral to inferomedial along the course of ligament.

Medial aspect of knee was examined with the patient turned to lateral decubitus position or supine with external rotation of leg centring the transducer to the medial joint line with a

longitudinal orientation visualizes the medial collateral ligament. To study the medial meniscus the gain setting should be increased and mild valgus strain will open up the joint space and allow better delineation of meniscus. Thickness of medial collateral ligament at femoral attachment is 4.0 mm & 2.0 mm at tibial attachment.

The lateral aspect of the knee was studied with the patient in one of the three positions - internally rotating the leg and maintaining full extension, a lateral decubitus position, and for the pateriolateral structures, examination was done in prone position.

When the transducer is oriented from anterosuperior to posteroinferior, lateral collateral is imaged, and it appears as thin band like hypoechoic structure. The lateral collateral ligament and biceps femoris muscle join to form a letter "V" complex with the apex of "V" inserting into proximal part of fibula. The posterior limb of "V" is biceps femoris and anterior limb of letter "V" is the LCL. Thickness of LCL is 2.00mm.The body of lateral meniscus and the lateral femorotibial joint space is imaged deep to it.

The posterior aspect of the knee, the popliteal fossa, is examined with the patient prone. Most anatomical structures in the popliteal fossa are initially imaged in the transverse plane. Following structures are visualized in the posterior aspect, popliteal artery, and vein medial and lateral heads of gastronemius and distal tendon of semimembranosus and posterior horns of the medial and lateral meniscus. For posterior cruciate ligament the transducer is placed in the midline in long axis posterior aspect of the distal femoral epiphysis and proximal tibial epiphysis, the transducer is then rotated 30° counter clockwise for the right leg and clockwise for the left leg and gently moved from medial to lateral to display the ligament . It appears as a hypoechoic hockey- stick shaped structure extending from posterior tibial plateau to femur.

All data was entered, cleaned and coded in MS Excel. Categorical data was expressed as percentages while continuous data was expressed in means and standard deviation.

RESULTS

A total of 33 patients were analysed for the purpose of our study. There was a slight preponderance (54.5%) of male patients in our study group, while fifteen patients recruited were female. The majority of male patients (61%) were aged less than 50 years. In contrast, most female cases (53%) were aged above 60 years.

Almost half of the study group (48%) presented with the complaint of a painful swollen knee. Seven patients presented with a painless restricted range of movement, while 38% of the cases presented with pain in knee joint alone. Seven cases in the study group were referred with a diagnosis of Baker' cyst.

After analysis of sonographic findings, all lesions were categorised in five broad groups, and later evaluated each group independently. All except six (82%) were diagnosed with arthritis on ultra-sonography – osteoarthritis (21, 63%); infective arthritis (3, 9%) and inflammatory arthritis (2, 6%). Six cases were diagnosed with idiopathic popliteal cyst.

It was found that osteoarthritis was commonest 21(81%), of cases. The above sonographic pathology was correlated with age, sex. Osteoarthritis was common above 40 years. Overall, more females were affected than males. Thirteen (61%) female had osteoarthritis compared to eight (39%) males.

On ultrasonography of degenerative arthritis cases, cartilage lesions were identified in 10 cases in the form of cartilage thinning, loss of clarity of the cartilage as well as loss of sharpness of cartilage soft tissue interface. Joint effusion was detected in 13 cases as fluid echogenicity in the suprapatellar recess. Meniscal lesions were detected in 12 cases, which includes; Intra-substance degeneration in three cases which appeared as punctuate hypoechoic foci, Meniscal tears in two cases which appeared as transverse hypoechoic line; Meniscal destruction in seven cases in which the hyperechoic pattern of the meniscus was lost. Meniscal extrusion (meniscal protrusion with associated collateral ligament

displacement) was identified by ultrasound in three cases as extension of the meniscal border beyond the bony margins. Marginal Osteophytes were detected in twelve cases; four of them were mild and eight were severe. They appeared as bony outgrowths at the articular margins. Loose bodies were detected in three cases as echogenic foci with acoustic shadowing within the joint space.

Baker's cysts were seen in six cases as anechoic or hypoechoic fluid seen between the semimembranosus and medial gastronemius tendons wrapping around the medial gastronemius tendon in the axial plane concave toward midline.

Ultrasonography of the two inflammatory arthritis cases revealed a suprapatellar effusion, detected as fluid echogenicity in the suprapatellar recess in both patients. Synovial thickening measured at the suprapatellar pouch was detected in one patient. Erosions were detected as breaks in the bone cortex, usually containing thickened synovium in both patients. Baker's cyst was seen in one patient.

Ultrasonography of three infective arthritis cases revealed joint effusion in all cases, presenting as fluid echogenicity in the suprapatellar recess. This fluid appeared turbid in one case. Synovial thickening was detected in two cases, while erosions were detected in one case. Extraarticular abscess was detected in one case as a well-circumscribed thick walled cystic lesion with internal echoes posterior to the joint space. Cellulitis was detected in 1 case as thickening of the subcutaneous tissue.

Seventeen patients of knee joint trauma were referred for sonographic examination to rule out soft tissue injury/haemarthrosis. The largest group of patients presented with post traumatic joint effusion which was seen in all patients referred for traumatic knee evaluation. Among these, fluid was echogenic in twelve patients. Three patients with collateral ligament injury were seen, all have partial tears, and two of them had medial collateral ligament injury. Meniscal injury is seen in seven patients, five of them had medial meniscal injury. Single case of quadriceps tendinosis seen secondary to repeated minor trauma seen as echogenic focus of calcification with acoustic shadowing. Two cases of fracture were diagnosed by the ultrasound.

Six cases of idiopathic Baker's cysts were seen in our study, beside six cases seen in Osteoarthritis and one case in inflammatory arthritis. All the cases had joint effusion. No case complicated by rupture of popliteal cyst was seen. In ultrasound, the reliable sign for diagnosis of Baker's cyst was detection of fluid between the medial head of gastronemius and the semimembranosus muscles which communicate with a posterior cystic lesion forming a crescent whose border is concave towards midline. In ultrasound, the cyst was anechoic in 6 cases, echogenic in 3 cases. Septations was seen in 1 case.

DISCUSSION

Ultrasonography has been available widely as a diagnostic imaging tool since 1970s, but it was not until the mid 1980s that sonography of musculoskeletal structures was popularized.[16]

The accuracy of sonography in evaluating various conditions of the musculoskeletal system has been demonstrated and its utility as a primary diagnostic imaging modality is increasing in frequency. Sonography is universally tolerated across a broad patient population, including paediatric and pregnant patients and those in whom traditional magnetic resonance imaging is not an option, due to either absolute or relative contraindications.

Sonographic examinations are relatively quick compared with an MR or computed tomography study, and delays in scheduling are therefore minimal, an advantage for those patients who have travelled a long distance or who are in a considerable amount of discomfort at the time of their visit to the orthopaedic surgeon. With portable US units,

examinations can be performed immediately at the time of the acute injury, for rapid diagnosis. Lastly, US can be used to guide for therapeutic procedures at the same time the diagnostic examination is performed. [17]

Establishing clear-cut diagnostic and therapeutic objectives is important. Trauma to the knee is the second most common occupational accident. Misdiagnosis or mismanagement of damage to supporting structures of the knee may lead to chronic knee instability with subsequent development of degenerative joint disease and loss of knee function, including an inability to bear weight or ambulate.[18]

In our series of 33 patients who had presented with knee pain and were administered ultrasound, there was a preponderance of males than females. Additionally, most male patients were aged less than 30 years old and had been referred after a traumatic injury to the knee. This may explained by the statistics of the Indian population in which males have higher sex ratio, more so males are more active in sports in Indian scenario. Concurrently, the number of women presenting with arthropathies was 69% of all the patients presenting with arthropathies. This may be explained by the fact that women have more chances of developing arthropathies due to pregnancy, obesity and post-menopausal osteoporosis.[19]

Painful swollen knee were found to be the commonest clinical presentations. This was similar to what was observed by Verena T. Valley et al.[20]

A spectrum of knee U/S findings were demonstrated. We found degenerative osteoarthrosis in patients of 50 years and above, this finding corresponds to Skimmer and Sherger who reported that it is usually uncommon in the age group 41-50.[21] In cases of patients less than 40 years who had knee osteoarthrosis, there was previous traumatic injury to the knees 5-10 years before the onset of knee symptoms. U/S was able to detect early degenerative processes where plain radiographs were reportedly normal.

Osteoarthritis is the most frequent disease of the musculoskeletal system. The knee is one of the most common joints involved in OA. Ultrasound assessment of osteoarthritis is based on measurement of cartilage thickness and osteophytes.[22] In the present study, ultrasound was able to detect cartilage lesions in 10 cases (47 %) out of 21 cases diagnosed as osteoarthritis. Marginal osteophytes were detected in 12 (57%) of cases. Although ultrasound readily shows marginal osteophytes, it fails to demonstrate central osteophytes.[23]

In the present study, joint effusions were detected in 61 %, Baker cysts were seen in 28 % and meniscal extrusion was detected in 14 % of cases. This disagrees with the results of Naredo et al, 2005.[22] In their study effusions were detected in 46.7 % of cases and Baker cysts in 22.2 % of cases and meniscal extrusion in 61.1 % of cases. This could be explained by that the group of patients in their study were early cases of osteoarthritis.

In degenerative osteoarthritis it's difficult to detect by ultrasound if meniscal lesions extend to the articular surface and thereby differentiate them from clinically significant meniscal tears.[24]

Loose bodies in cases of osteoarthritis may be detected within joint fluid located in the suprapatellar pouch deep to the quadriceps tendon or posteriorly within a Baker’s cyst. (Ptasznik, 1999).In the present study loose bodies could be detected within joint fluid in the suprapatellar pouch casting posterior acoustic shadow in three cases.

Rheumatoid arthritis is a chronic systemic disease characterised by an inflammatory erosive synovitis. Early changes in the synovium are represented by neovascularisation, inflammatory cell infiltration, and associated synovial hyperplasia, which produce a pannus of inflammatory vascular tissue. This "tumour-like" pannus destroys adjacent structures,

including the bone, cartilage, tendons, ligaments, and capsule. US imaging offers a simple, non-invasive, reproducible, non-radiating, and inexpensive method for examining joints in patients with rheumatoid arthritis. It has been used to evaluate bone, cartilage, effusion, and pannus of the joint.[25]

Cellerini et al 1999 used sonography to show an increase of intra-articular fluid and synovial thickening in active arthritis of the knee, which was significantly less in a group of patients during remission.[26]Eich et al 1994 confirmed that ultrasonography is sensitive to changes in effusion and synovial hyperplasia and may be useful for monitoring response to intra-articular treatment.[27] In the study conducted by Frosch et al, 2003 joint effusion was detected in 87 % of cases with active rheumatoid arthritis and 30 % of cases with inactive disease.[28] Synovial thickening was detected in 92 % with active disease and 81 % with inactive disease. This is in agreement with our study in which joint effusion was detected in 100 % of patients. In our study synovial thickening was seen in one (50%) case.

In patients with active inflammatory arthropathies, patients may have coexistent Baker's cyst. In our study, Baker's cysts were detected in 50% of cases.[24]

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. Joint fluid in septic arthritis may be hypoechoic and clearly demarcated from joint synovium and capsule or, hyperechoic and less clearly demarcated from joint synovium or capsule.[29]

In our study joint effusion was detected by ultrasound in 100 % of cases, in 33 % the joint effusion was turbid while it was clear in 67 %. Abscesses complicating septic arthritis appear as anechoic or diffusely hypoechoic mass with increased through transmission or maybe hyperechoic or isoechoic relative to surrounding tissues, the margins maybe well circumscribed or blend with the surrounding tissues, septa maybe present and internal echoes represent debris or gas.[30] In our study, extraarticular abscess was seen in 33 % of cases. It was located posterior to the joint, its walls were thickened, and internal echoes were detected inside. Ultrasound appearances of cellulitis range from diffuse swelling and increased echogenicity of the skin and subcutaneous tissues, to a variable cobblestone appearance depending on the amount of perifascial fluid, the degree of subcutaneous oedema and the orientation of the interlobular fat septa. These grey-scale appearances are not, in themselves, diagnostic of cellulitis as similar appearances occur in subcutaneous oedema resulting from non-infective conditions.[29] In our study 33 % of cases showed thickening of subcutaneous tissue which was assumed to be cellulitis based on the clinical findings of pain, redness and hotness. However, no US finding could confidently diagnose cellulitis.

In septic arthritis, the fluid frequently had a hypoechoic appearance with internal echoes (particulate appearance).[31] The effusions associated with chronic inflammatory arthritic conditions, such as rheumatoid arthritis (RA), were often difficult to differentiate from acute infective arthritis. One sonographic sign of infection versus a rheumatoid joint is a marked increase in intra-articular fluid without a concomitant increase in synovial thickness. The amount of joint effusion is proportionate to the amount of synovial thickening with flaring in rheumatoid arthritis.[31] However, septic arthritis cannot be ruled out based solely on the sonographic appearance.[32-33] Synovial hypertrophy or pannus, are most commonly seen in inflammatory arthritis, but can also be found in chronic infections (tuberculosis, brucellosis, Lyme disease, or fungal infection).

Popliteal or Baker's cyst represents fluid distension of a bursa between the gastronemius and semimembranosus tendons via a communication with the knee joint. In 1877, Dr William Morrant Baker described 8 cases of peri-articular cysts caused by synovial fluid that had escaped from the knee joint and formed a new sac outside the joint. The common underlying conditions were osteoarthritis and Charcot joint. Baker's cysts may commonly be associated with joint effusion, meniscal tear, osteoarthritis and degenerative joint disease.[34,35] A popliteal cyst may serve as a protective mechanism for the knee. Intrinsic intra-articular disorders cause joint effusion. The knee effusion is displaced into the Baker's cyst, thus reducing potentially destructive pressure in the joint space. Joint effusion and fibrin are pumped from the knee joint into the popliteal cyst but not in the reverse direction because of a valve-like communication. A popliteal mass is the most common presenting complaint or symptom.[34] Although called gastronemius semimembranosus bursa, it represents a composite of two bursae: a bursa anterior to the medial gastronemius tendon (the subgastrocnemius bursa) and a bursa between the tendons of gastronemius and semimembranosus muscles.

Baker's cysts may be seen with many joint abnormalities.[36] Debris, haemorrhage, loose bodies, and synovial proliferation can be present in a popliteal cyst. The cysts are usually asymptomatic. If large, they may be palpable. Rupture of a popliteal cyst is a potential complication.[37] US is a very helpful imaging technique in the evaluation of a popliteal mass. US determine whether the popliteal mass is a cyst or solid mass. A simple Baker's cyst appears as an anechoic mass with posterior acoustic enhancement that communicates with the knee joint. Findings on US relate to the criteria of a simple cyst, which include an anechoic mass, sharply defined posterior wall, and posterior acoustic enhancement. A complex popliteal cyst has internal echoes within the hypoechoic mass. Calcified loose bodies within a Baker's cyst appear as mobile intraluminal echogenic foci with distal acoustic shadowing, an appearance similar to that of cholelithiasis within a gallbladder. An additional advantage of US is that it can exclude a coexisting Deep Venous Thrombosis.[34]

In the present work, 13 cases with Baker's cyst were encountered. In 4 cases, the cyst was associated with marked joint effusion. In 3 cases the cyst was large, the patients presented with a palpable mass at the popliteal region and sonographic examination revealed the bilocular configuration of the cyst. Six of the Baker's cyst was idiopathic, while six were seen in patients of osteoarthritis and one was in patient of inflammatory arthritis.

CONCLUSION

High-resolution sonography is a novel technique for the assessment of the painful knee. It is cheap, widely available, and allows real time imaging, dynamic assessment and side-to-side comparison focusing on the site of complaint. It also overcomes the disadvantages of conventional radiography regarding the hazards of ionizing radiation and the lack of soft tissue assessment. Sonography of the painful knee joint can diagnose all tendinous, bursal and synovial lesions. Most of meniscal and ligamentous lesions can be accurately depicted it. Regarding osseous lesions, US can diagnose most fractures (even occult ones) and dislocations but cannot depict bone contusions because of the high reflectivity of the bony cortical outline. Knowledge of the spectrum of abnormalities is important to reach the correct diagnosis. In addition, the high cost of MRI and its contraindications make ultrasonography very valuable.

We recommend that ultrasound should be used regularly as a second line after plain radiography in radiological evaluation of the knee joint.

Ultrasound provides very useful information on the status of menisci, ligaments, tendons and muscles in low resourced country like India where MRI is expensive and accessible only to a few. Knee recesses are best evaluated by US due to its ability to characterize masses as either fluid or solid. Application of Doppler study is imperative in cases of suspected ruptured cysts to differentiate them from DVT. Though ultrasound has its technical limitations, it provides useful diagnostic information which is relevant to subsequent patient management.

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