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Original Research Article

Investigation of Utility of Sonography in Early Management of Knee Pain Due to Traumatic Events.

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Abstract

Background: Knee pain and related symptoms may come as a result of damage to one or more of the soft tissue structures that stabilize and cushion the knee joint. Trauma to the knee is the second most common occupational accident. Ultrasound has a significant role in patients presenting with knee joint trauma as sonography can detect haemarthrosis, tendon and muscle injuries.

Methods: A descriptive observational study was conducted amongst 17 patients who underwent ultrasound imaging of the knee when they presented with knee pain following a traumatic episode 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: A majority (65%) of the cases in our study were male, while six patients recruited were female. Sport-related knee injuries were the most common type, encountered in 12 patients (70.5%) while traffic and occupational-related knee injuries were encountered in the remaining 5 patients (29.5%). In the present study, the most frequent knee injuries were 8 ligamentous (47.0%), followed by 7 meniscal (41.1%), 2 osseous (11.7%), 1 tendinous (5.8%) and all patients had effusions. Among patients presenting with post-traumatic joint effusion, fluid was echogenic in twelve patients. Meniscal injury is seen in seven patients, while one 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.

Conclusion: 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.

Introduction

Soft tissue pathology of knee represents one of more common MSK disorders. Knee pain and related symptoms may come as a result of damage to one or more of the soft tissue structures that stabilize and cushion the knee joint. 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. [1]

Ultrasonography of knee joint can yield a lot more information on the bursal, tendons, muscles, ligaments menisci and joint space pathologies making it potentially attractive screening examination for knee pain. High frequency transducers allow visualization of superficial structures with resolution greater than routine MRI. [2] Because of technical advances, ultrasound can now be considered an important diagnostic tool alongside MRI for imaging the musculoskeletal system. Despite these factors MR imaging remains preeminent modality because of its ability to depict anatomic relationship and tissue structure acquisitively. However, there are advantages with sonographic examination. They 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 on the playing field, immediately at the time of the acute injury, for rapid diagnosis. Lastly, US can be used to guide therapeutic procedures at the same time the diagnostic examination is performed. [3]

Sonography can be used to define the extent of injury and can also play a role in evaluation of other musculoskeletal abnormalities such as soft tissue masses and localizing foreign bodies. Injury during sports is a constant threat, and, of all injuries, those of the knee fulfil the athlete's greatest fear of spending a long time out of action. Not only may a knee injury require surgery followed by months of rehabilitation, but also permanent disability from both sport and work may be the outcome. [4] Soft-tissue injuries of the knee represent one of the more common musculoskeletal disorders presenting to the emergency department. Establishing clear-cut diagnostic and therapeutic objectives is important.

High-resolution sonography has opened up a new dimension in the diagnosis of knee joint disorders. It can be used effectively in the evaluation of both articular and periarticular structures. [5] Being a very sensitive modality, sonography is capable of detecting joint effusion and even small amounts of intra-articular fluid [6-9] while the articular cartilage of knee joint can be evaluated for its thickness and regularity of surface [9-12]. Ultrasound has a significant role in patients presenting with knee joint trauma as sonography can detect haemarthrosis, tendon and muscle injuries, [13,14] injuries of medial and lateral collateral ligaments. [9,15] US can be used to detect popliteal cysts. [6,8,15] It can differentiate a ruptured popliteal cyst from DVT of leg which may have similar clinical presentation. [14,16] Sonography can be used in the diagnosis of popliteal artery aneurysms [17]

This study was conducted to investigate the sonographic assessment of periarticular traumatic lesions of knee joint e.g. Bursitis, tendonitis,etc.

Methods

A descriptive observational study was conducted amongst 17 patients who underwent ultrasound imaging of the knee when they presented with traumatic knee pain at a tertiary care hospital 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 an ultrasonography for knee pain following a traumatic incident, 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 [16]. 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 ligament 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

Seventeen patients presented to the outpatient department with complaint of knee pain following a traumatic incident. The mean age of the patients in the study group was 29.47 (± 13.45) years with the youngest patient being 17 years old, while the eldest study participant was 69 years old. A majority (65%) of the cases in our study were male, while six patients recruited were female. The majority of male patients were aged between 16 and 30 years old. In contrast, 50% of female cases were aged between 41 and 50 years old. Out of 17 patients with history of trauma, 12(70%) were in less than 40 years of age.

Sport-related knee injuries were the most common type, encountered in 12 patients (70.5%) while traffic and occupational-related knee injuries were encountered in the remaining 5 patients (29.5%). In the present study, the most frequent knee injuries were 8 ligamentous (47.0%), followed by 7 meniscal (41.1%), 2 osseous (11.7%), 1 tendinous (5.8%) and all patients had effusions.

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.

Discussion

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.

In our series of 17 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. Painful swollen knee were found to be the commonest clinical presentations. This was similar to what was observed by Verena T. Valley et al. [18]

In the study of done for classification of 1833 knee injuries, it was found that ligament damage to the knee is more common than any other type of knee injury pathology accounting for 40%, while meniscal injuries were 11% and miscellaneous injuries (including bone lesions and bursitis) took up 49% of the total. [19]

The high reflectivity of the soft tissue-bone interface makes it possible to assess

bone contour and cortical fracture. US evaluation of osseous structures is limited to the most superficial cortex because of the highly reflective nature of cortical bone and subsequent lack of sound wave penetration deep to cortex. US by its ability to visualize developing callus before radiographic changes are evident can be utilized to assess changes of bone healing. [20,21] Radiographically occult fractures can be detected on sonography, seen as a "step-off" cortical disruption. As the bone interrupts the propagation of the US beam; only the superficial surface of the bone can be consistently evaluated on sonography. [22,23] In this work, two fractures were detected with ultrasonography. The sonographic appearance was interruption and discontinuity of the echogenic cortex of the fractured bone in both patients, in addition to visualization of a separated bone fragment in the cases of avulsion.

Pitfall in diagnosis of fractures by sonography was found to be wrongly diagnosed loose bodies and bipartite patella. Loose bodies are consistently depicted with US. Ultrasonography is able to support plain films to confirm the intra-articular location of a calcification around a joint. During routine joint examination, US can recognize loose bodies as incidental findings. The ultrasonographic appearance of loose bodies accurately reflects their anatomic structures. The articular cartilage appears as a thin hypoechoic layer, with uniform thickness and regular smooth surface that overlies the thick hyperechoic line corresponding to the subchondral bone. Posterior acoustic shadowing to the bone cortex is readily evident. The size of the fragment and the thickness of the cartilage can easily be assessed with ultrasonography, and measurements appear to be consistent with both radiographic and macroscopic findings. Calcified fragments appear hyperechoic at sonography without a detectable rim of hypoechoic cartilage. [24]

Ligamentous disruptions are an important component of knee injuries and require accurate clinical assessment and imaging for optimal management. The anterior cruciate ligament (ACL) is the most commonly injured of the major knee ligaments. [25] Injuries of the PCL are relatively uncommon, apparently because this is the strongest major knee restraint. [26]

The incidence of PCL injuries is reported to range from 1% to 4% of acute knee injuries. [27] The incidence and mechanism of so-called isolated ligament disruption continue to be debated. All the supporting structures about the knee function in concert, and probably no single ligament can be disrupted without sustaining some degree of injury to other supporting structures. Injury to the other structures may be minimal and thus may heal with conservative measures, leaving what is apparently an isolated injury. This is most common with the anterior cruciate ligament. [28]

MCL tears rarely are isolated. More commonly, they are associated with other soft tissue injuries of the knee, such as the ACL tears and medial meniscal tears (the O'Donoghue unhappy triad). Similar to MCL tears; isolated injuries of the LCL are uncommon and typically occur in association with ACL or PCL tears .46% of PCL injuries are combined ACL-PCL tears whereas 41.2% are PCL-posterolateral corner tears. Only 3% of acute PCL injuries seen in the trauma centres are isolated. [27]

In the present study, eight ligamentous lesions were found. The frequency of ligamentous injuries was: ACL in 3 patients (37.5%), MCL in 2 patients (25%), LCL in 1 case (12.5%) and PCL in 2 cases (25%). The injury of the MCL was associated in cases with injuries of the ACL and the medial meniscus. Most ACL tears (about 70 %) occur in the middle

aspect of the ligament; 7-20% occurs proximally near its origin. Only 3-10 % occurs distally at the tibial attachment. [29,30]

In acute ACL tear, edema, haemorrhage, and synovial reaction surround the injury. [31] The predominant diagnostic parameter for an ACL rupture is the physical examination for instability. Haemarthrosis, swelling and pain raise difficulties and hamper assessment of joint stability and reduce the reliability of clinical examination. To enhance the clinical examination and diagnosis of ACL rupture, it is desirable to have a diagnostic tool that is fast, inexpensive and easily available. The clinical diagnosis of an ACL rupture can be enhanced by ultrasonography. [32,33]

Sonography is a useful and inexpensive method of detecting the presence of rupture of the anterior cruciate ligament in the clinical settings of a recent traumatic haemarthrosis (within 10 weeks). The presence of a hypoechoic collection along the lateral wall of the femoral intercondylar notch, detected through a posterior approach, is interpreted as a hematoma at the femoral attachment of the anterior cruciate ligament. There is no statistically significant correlation between the time since injury and the width of the hematoma and although that, it is reasonable to assume that the sensitivity of the technique is maximal within 5 weeks of the injury and decreases over time due to resorption of the hematoma. If the rupture is located at the tibial insertion or if it has occurred some time ago, this sign is absent. [34] In the present work, 2 cases of MCL injury were encountered. US examination revealed a focal hypoechoic segment near the femoral attachment in 1 cases and diffusely thickened hypoechoic ligament in another case. None of the cases had complete ligament disruption.

One case with LCL partial tear was encountered in this study. The tear was at the fibular attachment. No relation was found between the sonographic appearance and the site of tear of the collateral ligaments. There is a wide range of tendon pathologies including partial and full thickness tears, tendinosis and tenosynovitis. [35,36]

This study included one case of tendinosis in the quadriceps tendon. Tendons represent one of the best applications of musculoskeletal US due to high lesion detection rate and diagnostic accuracy combined with its low cost, wide availability and ease of use. High-frequency US can identify degenerative changes, differentiate partial from complete tears and determine whether the patient has to be treated surgically or conservatively. Early diagnosis of tendon abnormalities may allow correction of the abnormality by conservative measures before the stage of frank tear is reached. [37]

The use of dynamic sonographic evaluation is helpful in the diagnosis of partial-thickness tears of the quadriceps tendon and may aid in differentiation of such cases from complete quadriceps tendon tears, particularly in the acute setting.

In the present study, on sonograms, the tendon appeared diffusely thickened and hypoechoic. Sonographic findings of patellar tendinosis include focal thickening of the proximal tendon; a hypoechoic appearance of the affected portion of the tendon; and increased sound transmission.

The presence of joint fluid indicates that intra-articular pathology is the likely cause of the patient's symptoms, although the possibility of coexistent pathology or a sympathetic effusion always merits consideration. Debris within a joint effusion may represent pus, blood clots, fat lobules or osteochondral fragments. [38] A joint effusion is easily confirmed on sonography, which typically reveals anechoic to hypoechoic fluid in the

suprapatellar bursa deep in relation to the quadriceps insertion into the patella. Fluid can also be identified in the medial and lateral recesses. [39] Associated synovial thickening and loose bodies can be detected. [35]

In this work, intra-articular effusion was detected in thirty five patients. Marked effusion was noted in 11 cases. Effusion was detected with sonography in all cases in the suprapatellar, medial and lateral recesses and posteriorly. Internal echoes were seen within the anechoic fluid in 20 cases. [40]

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.

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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