ULTRASOUND EVALUATION OF NORMAL AND ABNORMAL POSTERIOR CRUCIATE LIGAMENT - A PROSPECTIVE STUDY

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PJR July - September 2010; 20(3): 125-129

ABSTRACT

OBJECTIVES: To evaluate the role of Ultrasound in the assessment of Posterior cruciate ligament and to calculate the sensitivity and specificity of Ultrasound in diagnosing Posterior cruciate ligament (PCL) pathology. **MATERIALS AND METHODS:** This prospective study was conducted over a period of 8 months and included 110 patients. An ultrasound of the knee was performed before the Magnetic Resonance Imaging (MRI) and a diagnosis regarding PCL appearance was made on the ultrasound. After the ultrasound an MRI using standard protocol was performed and the ultrasound and MRI findings were compared. **RESULTS:** Sensitivity of ultrasound in recognizing PCL pathology was 90.90%. Specificity was 100%.Positive predictive value was 100%.Negative predictive value was 99%. Significant correlation was found between the ultrasound and MRI appearance of PCL pathology. **CONCLUSION:** Ultrasound is sensitive in the detection of PCL injury, with an excellent positive predictive value and high sensitivity.

Keywords: Ultrasound; Posterior cruciate ligament; Magnetic resonance imaging.

Introduction

Magnetic Resonance Imaging (MRI) of the knee is very popular and is requested more frequently than ultrasound of knee. This is probably due to the fact that in MRI we get a global view of all structures of the knee joint, which is not the case with ultrasound. We have studied the utility of ultrasound in evaluation of Posterior Cruciate Ligament (PCL) and have found it to be definitely useful in evaluation of PCL.

Materials and methods

All the patients referred to our center for Magnetic Resonance Imaging (MRI) of the knee were included in the study. This prospective study was conducted over a period of 8 months and included 110 patients. Informed consent was obtained from all the patients. An ultrasound of the knee was performed before the MRI and a diagnosis regarding PCL appearance was made on the ultrasound. Ultrasound scan was performed by a single radiologist who was blinded to the clinical findings and any available imaging data of the patient. Ultrasound was performed on a Siemens Antares machine with a 3-5 MHz probe. The patient was made to lie prone on the examining table with the limb in a comfortable neutral position. PCL was evaluated by placing the probe in the center of the popliteal fossa and angulated slightly medially in order to orient it parallel to the PCL. We used a convex probe for all the patients in order to maintain uniformity. PCL can also be seen using a high frequency linear transducer in thin patients, however we found it difficult to see PCL with a linear probe in well built and obese patients. On ultrasound the PCL thickness, echogenicity and pathology were recorded. A well defined uniformly hypoechoic PCL of thickness less than 4.5 mm was considered normal.(Fig. 1)

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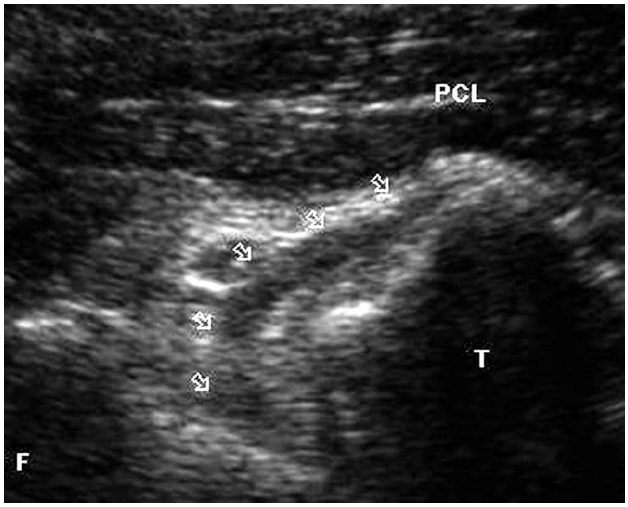

Figure 1: Ultrasound image of normal hypoechoic PCL (arrows) with the probe placed longitudinally in the popliteal fossa. F-Femoral condyle, T-Tibial plateau.

After the ultrasound, MRI of the knee was performed and PCL was evaluated. MRI was performed on a 1.5-T MRI machine (Siemens Avanto). MRI of the knee was performed with the patient in supine position with the leg in 15-20 degrees external rotation. An extremity coil was used. Field of View was 14-16cm with a slice thickness of 3mm. The sequences performed at our center were T2 axial, T2 coronal (TE-92ms, TR-4000ms), STIR coronal (TE-76ms, TR-6500ms, TI-150ms),T1 Sagittal (TE-15ms, TR-425ms), PD Fat Sat Sagittal (TE-13ms, TR-3620ms).
After the MRI was performed and read, a comparison of ultrasound and MRI appearance of PCL was made. Doubtful cases were confirmed on arthroscopy, which was considered the gold standard. Sensitivity and Specificity of Ultrasound in the recognition of Posterior cruciate ligament tears was calculated.

Results

The total of hundred and ten patients included 98 males and 12 females. The mean age was 34 years. There were 67 right knees and 43 left knees. There were a total of 3 cases of partial tears (Fig. 2A,2B), 4 cases of PCL avulsion injuries (Figure 3A,3B), and 4 cases of PCL contusions (Fig. 4A,4B and 5A,5B), while all the rest of cases had a normal PCL. On ultrasound we were able to detect 3 out of 4 cases of contusions, all cases of partial tears and avulsion injuries. The case of PCL contusion which was missed on ultrasound was at the femoral attachment and was confirmed on MRI and arthroscopy. Based on these results we found that the sensitivity of ultrasound in recognizing PCL pathology was 90.90%. Specificity was 100%. Positive predictive value was 100%. Negative predictive value was 99%. Significant correlation was found between the ultrasound and MRI appearance of PCL injury. Using Fishers exact test the p value was calculated which was significant, ($p<0.001$).

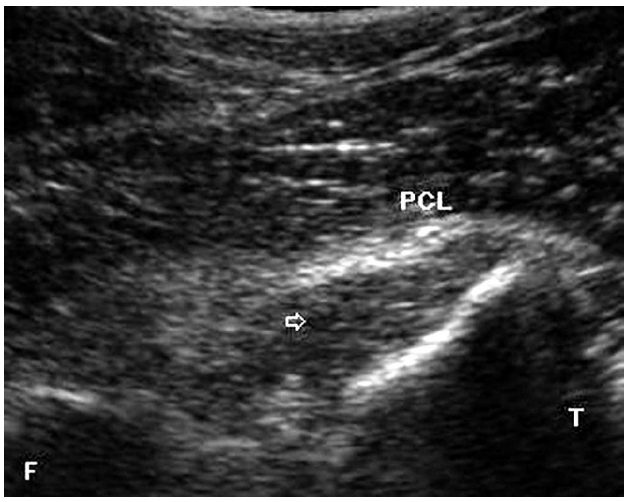

Figure 2A: Ultrasound image showing a thickened PCL with intrasubstance tear (arrow). F-Femoral condyle, T–Tibial plateau.

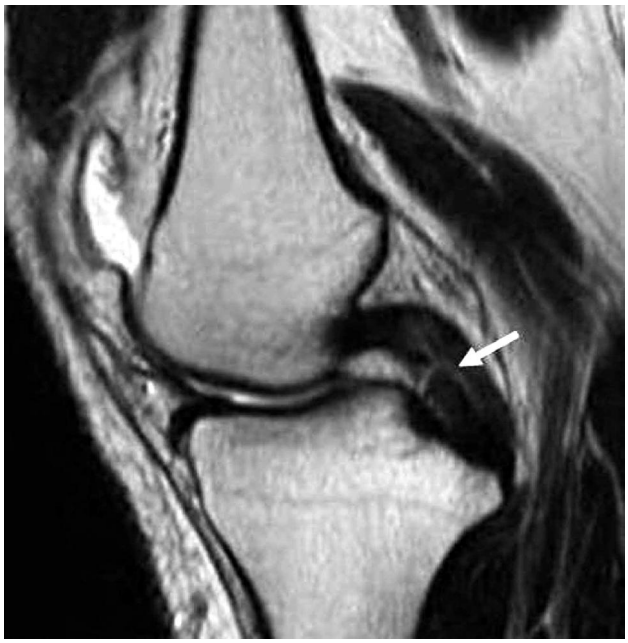

Figure 2B: Sagittal T1W MRI image of the same patient in figure 2A,reveals thickened PCL with intrasubstance tear (arrow).

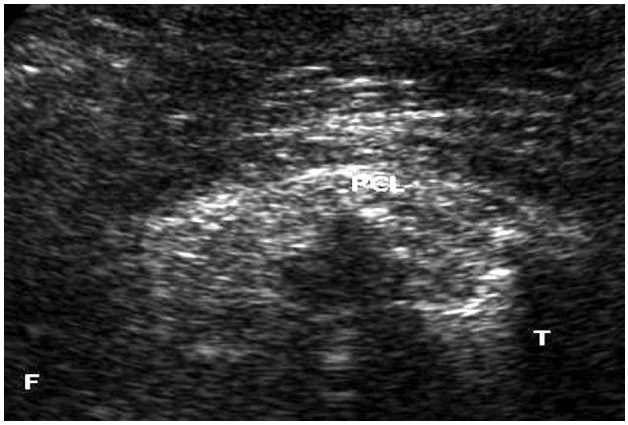

Figure 3A: Ultrasound image showing contused thickened PCL with avulsion injury. The avulsed bone fragment is causing posterior acoustic shadowing.

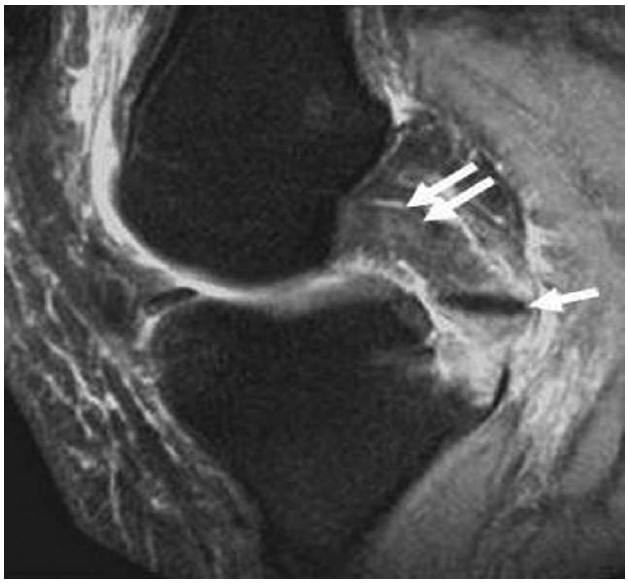

Figure 3B: Sagittal STIR MRI image of the same patient in figure 3A, reveals contused PCL (double arrow) with avulsion of tibial bone fragment (single arrow).

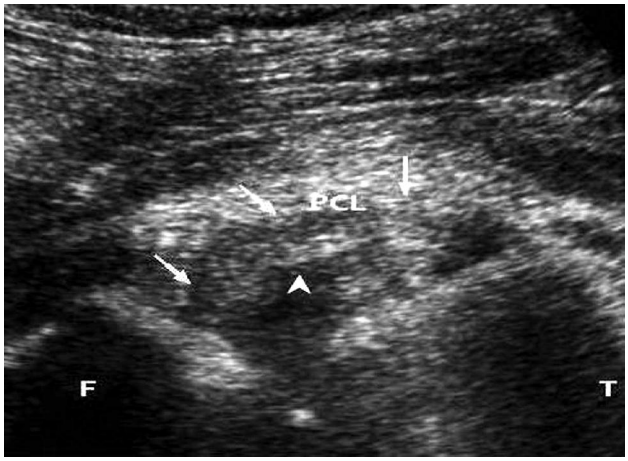

Figure 4A: Ultrasound image showing contused thickened PCL (arrows) with tear (arrowhead).

Figure 4B: Coronal T1W MRI image of the same patient in figure 4A, reveals tear with contusion of PCL.

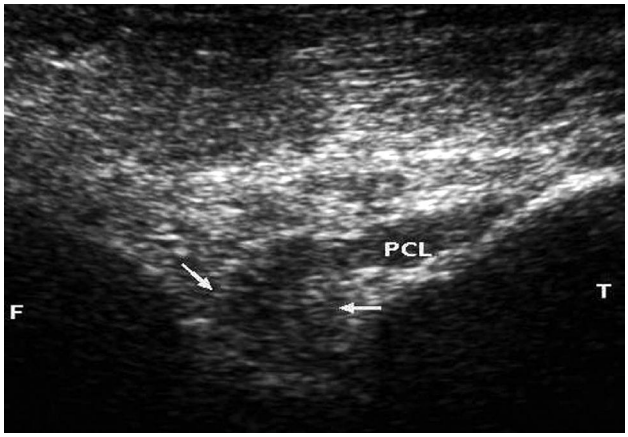

Figure 5A: Ultrasound image showing contused thickened PCL at femoral attachment (arrows).

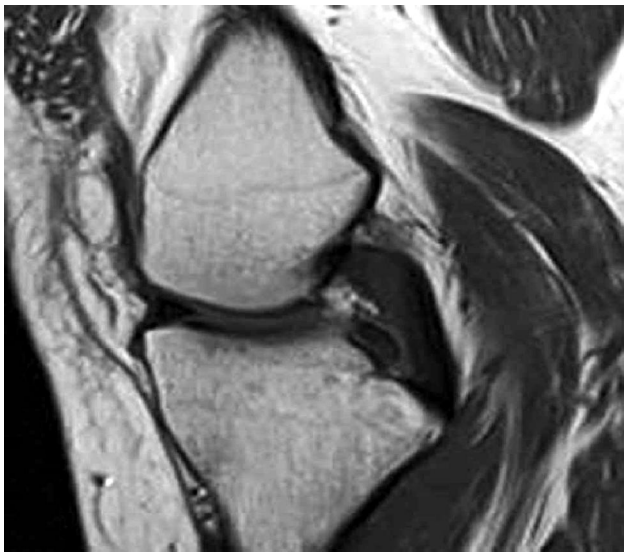

Figure 5B: Sagittal T1W MRI image of the same patient in figure 5A, reveals contusion of PCL at femoral attachment.

Discussion

The PCL is a strong supportive ligament of knee and consists of two functional bundles, the anterolateral bundle and the posteromedial bundle, in relation to the femoral attachments.[1] It originates from the lateral surface of the medial femoral condyle and inserts onto the intercondylar region of the tibia approximately 1cm below the articular surface. The PCL courses in an oblique-sagittal plane and is angled forward by 30°–45° in the sagittal plane. Rest of the distal half of the PCL is parallel to the posterior half of the proximal tibia and can be very well seen on the ultrasound. PCL injuries are less common as compared to ACL injuries and are seen in around 20-40% of knee injury cases.[2] Most of cases of PCL injuries are secondary to motor vehicle accidents or sports injuries. In the acute setting because of pain, muscle spam or hemarthrosis, it might not be possible to a thorough clinical examination or perform the posterior drawer, reverse pivot-shift or quadriceps active drawer tests in order to diagnose PCL injury. Arthroscopy is considered to be the gold standard in diagnosing internal knee derangement, however it is an invasive and expensive technique. The most reliable non-invasive imaging modality is the MRI, which is expensive and also time consuming. In situations where MRI imaging of knee is not available or cannot be done or isolated PCL injury is suspected, we have found that ultrasound is a very useful imaging technique for the visualization of the PCL. The PCL appears as a well defined hypoechoic band in intercondylar region coursing between the tibial and femoral attachments.[3] In the study by Suzuki et al the PCL has been described as a hyperechoic structure,[4] which was probably due to anisotropy. Zaka Khan et al in their study have stated that the PCL is very well demonstrated on the ultrasound, even better than the MRI.[5] The posterior cruciate ligament was found to be a uniformly hypoechoic structure with a mean thickness of 4.5mm at the level of tibial spine, in the study conducted by Kil-Ho Cho et al in a study population of 15 asymptomatic volunteers and 35 patients.[6] The ultrasound findings of PCL injury in by Kil-Ho Cho et al study were: increased thickness of the ligament, heterogenous hypoechoic texture, loss of sharpness or indistinctness of the posterior margin. Similar findings were also observed in our study, the most common and consistent finding being that of thickening of the ligament (greater than 6.5mm) We found that the femoral attachment was slightly more difficult to visualize as compared to the tibial attachment, especially in obese patients.

PCL can be injured at various levels along it's course. In the study performed by Patten et al in 59 patients of acute PCL injury, the PCL tear sites were: 42% at tibial, 36% at femoral and 22% at midsubstance levels.[7] Most of the tears of PCL were in the distal two thirds in the Patten et al study. Ultrasound however does have it's limitations in patients with open injuries and obese patients. In cases of complex knee injury where extensive internal derangement is suspected, in those cases MRI definitely scores over ultrasound. PCL injuries may be associated with injury to the anterior cruciate ligament (65%), medial meniscus (30%) and medial collateral ligament (50%).[6]

Conclusion

PCL is visualized as a homogenously hypoechoic structure on the ultrasound. Ultrasound is sensitive in the detection of PCL injury, with an excellent positive predictive value and high sensitivity.

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