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Comparison of the Diagnostic Values of Ultrasonography and Magnetic Resonance Imaging in the Soft Tissue Pathologies of the Knee Joint

Diz Yumuşak Doku Patolojilerinde US ve MRG' nin Tanısal Değerlerinin Karşılaştırılması

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ABSTRACT

Objectives: The aim of this study was to compare the diagnostic value of ultrasonography (US), that has not been widely accepted, easy accesible, cheap and non-invasive method and routinely used magnetic resonance imaging (MRI) in the diagnosis of the soft tissue pathologies of the knee.

Methods: Eighty patients who were admitted to the Orthopaedics and Traumatology Clinics with knee pain were examined with US. Seventy two (%90) of these patients also had MRI scans of the knee joint. The results were compared.

Results: Of these 80 patients, 45 were female (%56,25) and 35 were male (%43,75). The mean age was 43,4 (11-72). US examination results were in normal limits in 13 cases (%16,2), however MRI revealed only 4 (% 5) patiens as normal. The most common pathology that was detected both by US and MRI was, joint effusion. Meniscal degeneration and tears were the second most common accompanying lesions to joint effusions detected by MRI. Except determination of meniscal and ACL lesions and small amount of fluid in the tibiofemoral joint space, the diagnostic value of US was nearly same with MRI. By US, internal architecture of Baker cysts, synovial thickening and patellar tendon pathologies could be recognized better.

Conclusions: In conclusion, US is a cheap, easy accessible device. It has the advantages of real time imaging, comperative examination with the contralateral extremity, the capability of dynamic imaging of children for the possibility of performing the examination without sedation. Because of these, it is so useful in the evaluation of the patients for whom MRI couldn't be performed and would be supportive for the diagnosis in experienced hands.

Key words: *ultrasound, knee, ligaments,*

tendons, injuries

ÖZET

Amaç: Bu çalışmanın amacı diz eklemindeki yumuşak doku patolojilerinin tanısında rutin kullanıma girmemiş, kolay ulaşılabilir, non invazif ve ucuz bir yöntem olan ultrasonografinin (US) etkinliğinin araştırılması için, rutin olarak kullanılan manyetik rezonans görüntüleme (MRG) ile karşılaştırılmasıydı.

Gereç ve Yöntem: Ortopedi polikliniğine diz ağrısı nedeniyle başvuran 80 olguya diz US uygulandı. Bu hastaların 72'sine ayrıca diz MRG (%90) çekildi ve sonuçlar karşılaştırıldı.

Bulgular: Çalışma kapsamında bulunan 80 olgunun 45'i kadın (%56,25), 35'i erkekti (% 43,75). Yaş ortalaması 44,2 (yaş aralığı 11-72) bulundu. US inceleme 13 olguda (% 16,2) normalken, MRG incelemede sadece 4 olgu (% 5) normal olarak değerlendirilmiştir. Hem MRG, hem de US incelemede en sık rastlanan patoloji, eklem içi sıvı varlığıydı. MRG incelemede ise eklem sıvısı ile birlikte meniskal dejenerasyon ve yırtıklar en sık rastlanan patolojiydi. Meniskal ve ACL yırtıklarının saptanması ve tibiofemoral eklemdeki minimal sıvıların tespiti haricinde US'nin diagnostik değeri MRG ile benzerdi.US ile Baker kistlerinin iç yapısı, sinovyal kalınlaşmalar ve patellar tendon patolojileri daha iyi tespit edildi.

Sonuç: Sonuç olarak US, çok daha ucuz, kolay ulaşılabilir, real time görüntüleme avantajı, dinamik görüntülemenin mümkün olması, çocuklarda sedasyon gerektirmemesi, kolaylıkla karşı ekstremiteyle kıyaslama olasılığının bulunması nedeniyle çocuklarda, MRG çekilemeyecek olgularda ve MRG bulunmayan merkezlerde, tecrübeli ellerde tanıya belirgin katkılar sağlayacaktır.

Anahtar Kelimeler: *Ultrasonografi, Diz, Ligamentler, Tendonlar,Yaralanmalar*

INTRODUCTION

Ultrasound (US) is emerging as a viable imaging modality in the diagnosis and assessment of the musculoskeletal system. Advantages of ultrasound include; its easy availability and multiplanar capability, as well as low cost. Unlike magnetic resonance imaging (MRI), US demonstrates the fibrillar microanatomy of tendons, ligaments and muscles, enhancing its diagnostic capability (1-4). Usually, we use US for the superficial musculoskeletal tissues and it can also be used to evaluate the shoulder and hip joint diseases.

MRI is the current imaging procedure of choice for assessment of internal derangement of the knee joint, particularly for evaluation of the menisci, cruciate ligaments, bone marrow and cartilage. It is important to recognize the limitations of US for assessing the status of menisci, cartilage and bone. US, however, is increasingly being advocated as a valuable additional diagnostic modality for the evaluation of the knee joint, with recognition of its strengths and weaknesses. There are many advantages of this imaging tool, including cost, portability, dynamic real-time assessment, and easy side-to-side comparison. The specific structures best suited for US assessment include tendons, muscles and ligaments, as well as periarticular soft tissue masses (1-6). Joint effusions, synovial thickening, bursal fluid collections, intra-articular loose bodies, ganglion cysts, ligament and tendons tears, tendonitis and occult fractures can be diagnosed. With experience, US is a time-efficient, economical imaging tool for assessment of the knee. The major disadvantage of US is its operator dependence, as well as a long learning curve. It requires trained experienced hands, with appropriate high-resolution equipment, for US to succeed as an effective diagnostic tool. The aim of this study is to compare the diagnostic value of US, that has not been widely accepted,

easy accessible, cheap and non-invasive method and routinely used MRI in the diagnosis of the soft tissue pathologies of the knee joint (4-7).

MATERIALS AND METHODS

Among a period of six months, patients who were admitted to Orthopaedics and Traumatology Clinic of Istanbul Education Hospital with knee pain were examined with US by one radiologist. The choice of the transducer used depended on the size and location of the musculoskeletal structure to be imaged. Generally, linear transducers were used with high-frequency transducers (7.5-12 Mhz) that have higher-resolution imaging but poorer tissue penetrance, making them ideal for small, superficial structures. Low-frequency transducers (< 7.5 Mhz) have poorer resolution but excellent tissue penetrance; these were preferable for larger, deeper structers. Images in this study were attained by the Toshiba Power Vision SSA 370A US devices.

The anterior aspect of the knee was examined with the patient supine. Fluid was best seen in the medial or lateral suprapatellar and parapatellar bursae in a longitidunal plane. Examining the patellar tendon from its cranial origin down to its distal insertion; the lower pole of the patella has a V-shaped appearance, one should be aware that the tendon inserts not only on the apex but also along the inferolateral and inferomedial edges of the bone. Deep to the patellar tendon, intracapsular Hoffa's fat pad and infrapatellar bursa can be visualized. A knee flexion of approximately 20-30 degrees obtained by placing a small pillow beneath the popliteal space streches the extensor mechanism and avoids possible anisotropy related to the concave profile that the quadriceps and patellar tendons assume in full extension. For examination of the posterior knee, the patients were asked to lie prone with the knee extended. Scanning the posteromedial knee on the transverse plane demonstrates, from medial to lateral, the sartorius, the gracilis tendon and the semitendinosis tendon that is located behind the semimembranosus tendon. If a ligament or tendon tear was suspected, dynamic scanning during stress could improve the assessment of its integrity.

Seventy two (%90) of these patients also had MRI scans of the knee joint. MRI of the musculoskeletal system was obtained with a 1.5 T system, and sagittal SE T1, sagittal fat saturated T2, sagittal fat saturated PD, axial GRE T2, coronal GRE T1, and FSE STIR sequences were obtained. The results were compared.

RESULTS

Of these 80 patients, 45 were female (%56.25) and 35 were male (%43.75). The mean age was 43.4 (11-72). Knee pain was the most common complaint of the patients. 15 patients presented with swollen knee. US examination results were normal in 13 cases (%16.2), however MRI revealed only 4 (%5) patients as normal. Most common pathology detected both by US and MRI was joint effusion. Meniscal degeneration and tears were the second common accompanying lesions to joint effusions detected by MRI.

In 53 (%66.25) out of 80 patients joint effusion was found with US examination. In this group the effusion was found the suprapatellar bursae (SPB) in 44 (%55) knees. In some of the cases there wasn't enough fluid to be seen in US examination, so we put the transducer on the SPB and tried to see the patellofemoral joint space. In this group in 7 (%8.75) patients, fluid could be seen in the patellofemoral joint space. But in 5 patients fluid could be seen only in the pre-patellar bursae (%6.2). MRI revealed joint effusion in 55 (%76.3) of 72 cases. In 12 patients, US examination of this joint showed increase in both synovial thickness and effusion. We observed a correlation between synovial membrane

thickness and power Doppler US signal in 2 patients. The inflammed synovial membrane could be identified with magnetic resonance imaging after the intravenous administration of gadolinium. 12 patients were diagnosed with a Baker's cyst (%15). A Baker's 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. Two Baker's cysts were collapsed, so we could not see fluid in the cyst.

Suprapatellar plicae had been identified in 2 (%2.5) patients with US and is usually asymptomatic. It is best visualized on sagittal MRI sections. In our study we identified this in 6 (%8.3) patients with MRI. Prepatellar bursitis was diagnosed in 6 (%7.5) patients with US and in 10 (%13.8) patients with MRI. Pes anserine bursitis was found both with US and MRI in 2 patients (%2.5). In 4 patients (%5), medial collateral ligament (MCL) tear was diagnosed and also with MRI it was correlated as grade1-2 tear. In 2 patients (%2.5) lateral collateral ligament (LCL) tear was diagnosed with US, but MRI could not be performed in these patients because of the metal screws from a past knee surgery. In 12 patients with US (%15), 8 patients with MRI; anterior cruciate ligament (ACL) tear was diagnosed. 4 patients had false positive diagnoses as ACL rupture probably as a result of fluid collection around the ligament.

In the beginning of this study, we have also tried to show meniscal degeneration and meniscal tears but we concluded that ultrasound was neither sensitive nor specific for diagnosing meniscal tears and excluded this part from the study, because of the very high false negative results.

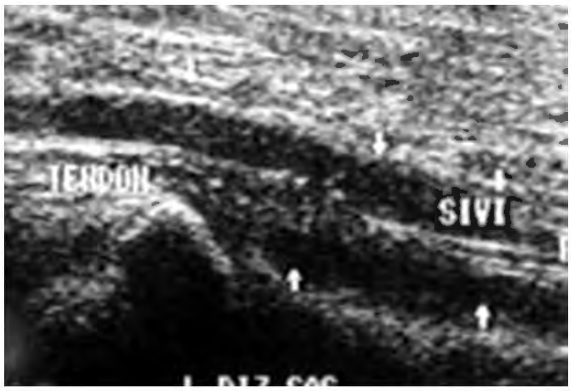

Figure 1a: *Longitudinal US image of the popliteal fossa, fluid around the popliteal muscle tendon*

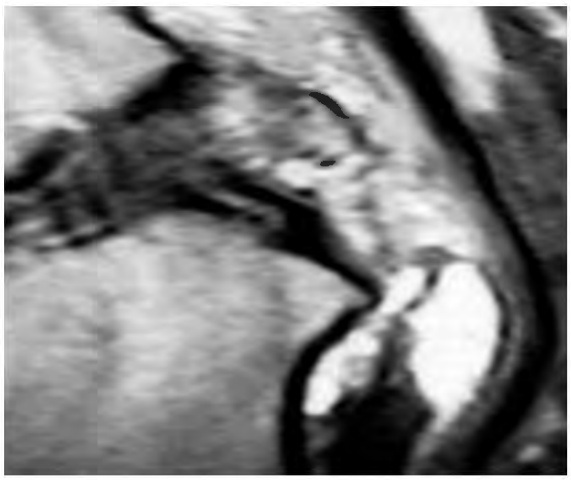

Figure 1b: *T2-weighted sagittal MRI image, hyperintense fluid collection around the popliteal tendon*

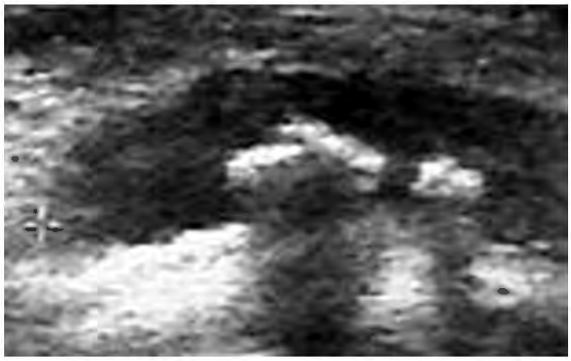

Figure 2: *Transverse and longitudinal US images of the popliteal fossa. A Baker's cyst is seen with loose body.*

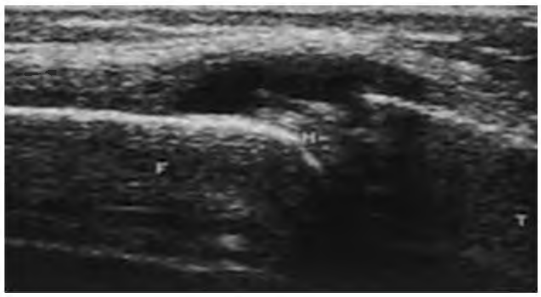

Figure 3a: *In the medial compartment of the knee, longitidunal US image. A cystic mass near the medial meniscus.*

Figure 3b: *T2-weighted MRI, the meniscal cyst*

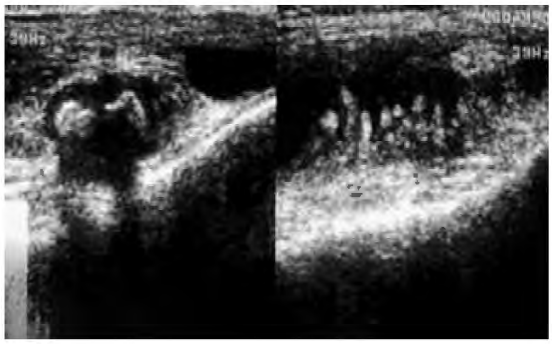

Figure 4a: *Suprapatellar and infrapatellar region in US image, synovial membrane thickness and a loose body may be seen.*

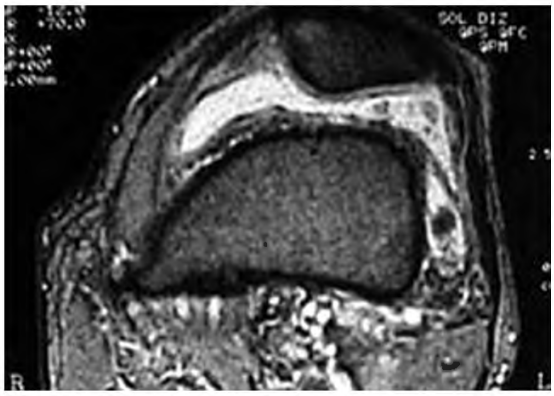

Figure 4b: *Axial, T2- weighted GRE MRI of the same patient*

Figure 5a: *Longitudinal US image from the prepatellar region, demonstrating hypoechoic hematoma*

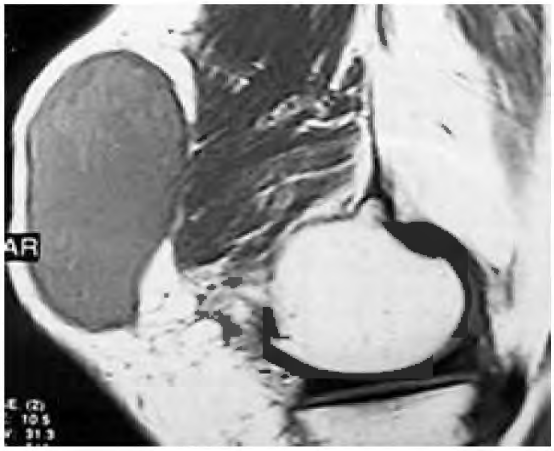

Figure 5b: *Sagittal T1-weighted MRI shows the hematoma*

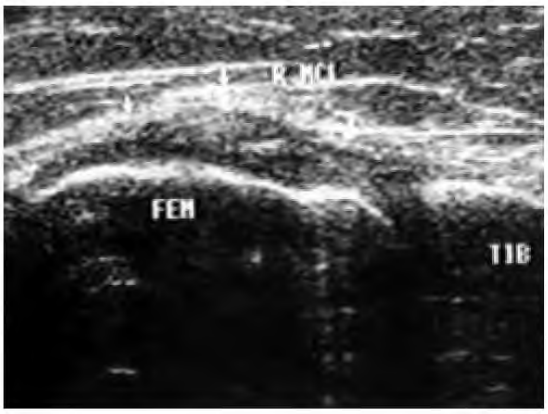

Figure 6a: *Longitudinal US image from the medial aspect of the knee; increased medial collateral ligament thichness and hypoechoic fluid collection (Grade 2 MCL rupture)*

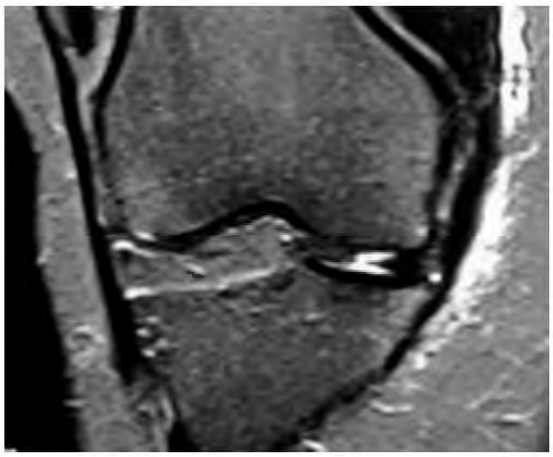

Figure 6b: *Coronal T2- weighted MRI of the same patient*

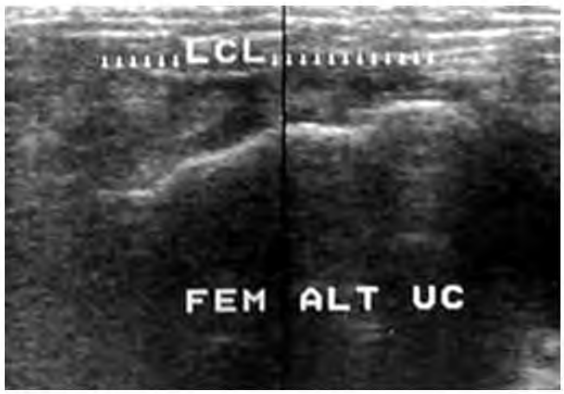

Figure 7: *Longitudinal US image from the lateral aspect of the knee, increased LCL thickness and tear (Grade 3 LCL rupture).*

Figure 8: *Longitudinal US image from the lateral aspect of patellar ligament; fluid collection surrounding ACL (ACL rupture).*

DISCUSSION

The most common finding in our patients was intraarticular fluid. We could get information about the amout of fluid in the SPB by US and in some cases we could find the pathology causing intraarticular fluid and also we could see if there is synovial hypertrophy accompanying the fluid (3,4).

Intraarticular fluid itself is a nonspecific sign of articular pathology and can be related to inflamatory processes, osteonecrosis, osteoarthritis and trauma. The absence of inraarticular fluid shows us that there is no pathology. With US, we can also see milimetric fluid in SBP. Normally fluid in SBP should not be more than 2 mm thickness (7). Intraarticular fluid also behaves like an acoustic window and helps us to see more easily the synovium, cartilage and meniscus. There can be clot, debris, fat lobules and osteochondral fragments in the intraarticular fluid.

The intaarticular fluid is mostly hypoechoic . Wang S.C et al. (1) showed that the fluid can be hyperechoic if there is an associated infecion or hemarthrosis. Harcke et al. (2) have concluded that if there is a small amount of fluid it can diffuse in intraarticular space while compressing with the probe and we can

do manipulation to collect the fluid together.

In our studies, US gave more accurate information in detecting synovial pathologies (US %9.3, MR %1.9), but the cause of this finding was because we did not do MR examination for detecting synovial pathologies. Sureda et al. (8) studied 36 patients with JRA and they found significant difference, in measurements of mean synovial thickness for control (2.7mm), inactive JRA (4.5mm), and in active JRA groups (5.2mm).

In US examination of patients with Backer's cysts, the most obvious finding was the accompanying fluid in the ipsilateral SPB. And this fluid was more than the controlateral side. The collapsed Backer's cysts in two cases were in concordance with this finding because we did not detect intraarticular fluid at this side and so the treatment of Backer's cysts was for the primary pathologies rather than the surgery of the cyst. In a study of Gordon et al. (10) they have compared Baker's cyst contents with US findings in 42 patients. They have found that the US findings of Backer's cysts was %100 corralated with surgical findings and the internal echogenities in these cysts were consistent with necrotic debris material or organized hematoma (9,10).

We found that in 2 patients in our study there were osteochondral fragments seen with US, but not seen with MRI. Also the internal features of cysts were demonstrated more detailed with US, than MRI.In our study we saw prepatellar bursitis only in advanced cases. In US of patients with bursitis there was prepatellar bursa thickening, heterogenity, and hypoechoic fluid collections. In MRI, T1WI studies were more accurate and we could see small amount of fluids also.

Pes anserine bursae is found between the attachment of tibial collateral ligament, distal sartorius, gracilis, and semitendinous tendons. US helps us to differantiate pes anserine bursitis and tendinitis. In bursitis, bursa is found as volumetric and filled with fluid, in tendinitis tendon is found as thickened (11).

MCL is composed of 2 hyperechoic, thick, parallel bands in US that are separated with hypoechoic areolar tissue in the middle of them and extends from the medial femoral condyle to medial tibial metaphysis. The band that is deeper is attached to inner meniscus. Pathologic MCL is seen as thickened, heterogenous, and hypoechoic. This finding is caused by edema and hemorrhage (4). In our study the rupture was both seen in US and MRI. In the literature the sensitivity of US was found as %94. Without the defect of ligament hypoechoic, thickened band means partial rupture. The thickened ligament never returns to normal. For detecting the pathologic ligaments Platsznik et al. (4) reommended that we should compare it to other side to be sure.

MCL rupture is seen mostly together with ACL and inner meniscus ruptures. In chronic MCL ruptures, we can see myositis ossificans in the ligament (Pellegrini Stieda calsification). We can see echogenic focus at the attachment point of the ligament and there can be pain at this side (4). All of our patients were belonging to acute phase.

LCL is a distal thinner structure than MCL and extends from the fibular head to the lateral femoral condyle. Ligament rupture is seen as focal, aching, hypoechoic and thickened segment at the side of the fibular head. Full thickness rupture is seen as a disruption of ligament integrity and partial rupture is seen as only hypoechoic thickening(4).

In ACL rupture, there is fluid around ACL, oblique extension and discontinuity can also be seen in US. If there is discontinuity of the ligament with accompanying fluid collection in Hoffa's fat

pad, it is called as ACL rupture. It is %91 sensitive and % 100 spesific according to Platsznik et al. (4). If there is hypoechoic collection in acute hemarthrosis along the lateral side of femoral intercondylar groove, it is thought that hypoechoic collection is the hematoma at the attachment side of the ACL to femur. The dettachment of ACL to the tibia in the acute or chronic ruptures of the ligament may not be seen with this technique. The sensitiviy of the technique is highest in 5 weeks after trauma and decreases with the resolution of the hematoma. Ikeda et al.(6) have told that US has %98 sensitivity and %97.6 true diagnostic capacity. Our results were correlated mostly with Platsznik (4).

With US, distal patellar tendinopathy is diagnosed easily (12,13). With US, as seen in other tendinopathies, normal fibrillary pattern and parallel extension of fibers may be disturbed. The most common affected side in tendinopathy is the deep side at the attachment of tendon to the patella.

In a study by King et al. (12) about computed tomography and US appearences of patellar ligament in 17 patients, they found that US has more sensitivity and spesivity in the diagnosis.

Synovial chondromatosis in which cartilagenous and osteocartilagenous nodules occur is a benign self-limiting synovial metaplastic change. If there is loose body more than synovial nodules, bilateral knee radiography is a more apropriate method to choise. MRI is a good method to see these masses (4,7,14). Since the masses were small in our patient, we had diffuculty to see them.
It is also important to see muscles around the knee with US. After trauma; we can see hematomas, partial or full thickness ruptures of tendons with US. In one of our patients with gun shot lesions we saw disorganized tendons and disruption of gastrocnemius muscle, increased echogenity in muscle and pain.

In a study of Ikeda et al. (6) about menisci ruptures in 67 patients (71 knee, 142 meniscus), meniscal posterior horn was thinner than normal and have compared US with arthroscopy. The sensitivity, specifity and true diagnostic features of US was found as %91, %69 and %79 respectively. With US there was no additional findings for anterior horn (15). MRI is more sensitive for meniscal pathology than US. We found the sensitivity of US less than the literature and we excluded from our study. Only in two patients, the meniscal cysts were seen both with US and MRI. In US, we detected localized fluid colllections with sharp boundaries near the menisci. Hence the meniscal ruptures along these collections could not be seen with US, they were easily detected with MRI (16-18).

In conclusion, MRI is a gold standart radiological method that can show all structures of the knee in detail. US can not show especially the deeper structures in the joint, as accurately as MRI. Since US is cheaper, easily obtained, providing dynamic observation, giving the advantage of comparison with the opposite side with no need for sedation in children; in the situations that MRI cannot be performed or if unavailable, US may be used to have opinion about the knee joint, especially the superficial structures.

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