Use of Ultrasonography as a Diagnostic and Therapeutic Tool in Sports Medicine

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Abstract: Ultrasonography has many important advantages over other imaging modalities and many important applications in sports medicine. This article presents an evidence-based discussion of the use of ultrasound technology to diagnose and treat common musculoskeletal disorders, with emphasis on the shoulder, elbow, hip, knee, and foot and ankle. Topics include basic principles, scan artifacts, the appearance of musculoskeletal structure characteristics and pathologies, and various diagnostic and therapeutic applications in sports medicine.

The first report of musculoskeletal ultrasonography (US) was published in 1958 by Dussik et al.,1 who measured the acoustic attenuation of articular and periarticular tissues. In 1972 McDonald and Leopold2 described the use of US imaging in differentiating Baker cysts from thrombophlebitis, an application still used in current clinical practice.

Interest in US in sports medicine has grown exponentially as image quality has improved in recent years.3 Furthermore, the ability to perform a dynamic examination offers advantages over the static assessments of magnetic resonance imaging (MRI) and computed tomography (CT). Other strengths include cost, portability, decreased artifact from metal hardware, and fast scan time.4 The most notable drawback of musculoskeletal sonography is that physicians are unaware of its usefulness in diagnosis and treatment and are untrained in scanning and image interpretation (Table 1).

Shoulder

Diagnostic US of the shoulder can identify abnormalities in the rotator cuff, biceps tendon, glenohumeral joint, and acromioclavicular joint, as well as other periarticular soft-tissue structures.

Static and dynamic evaluation of the rotator cuff has been shown to be highly accurate in diagnosing pathology. In a meta-analysis, de Jesus et al.5 showed that the sensitivity and specificity relative to diagnosis of a full-thickness rotator cuff tear were 92% and 94%, respectively. There was no significant difference in the diagnostic capability of US and MRI for either full-thickness or partial-thickness tears.5 Rutten et al.6 showed increased sensitivity (89% v 67%) but decreased specificity (80% v 86%) with US versus MRI in the diagnosis of partial-thickness tears and showed decreased sensitivity (95% v 100%) and increased specificity (93% v 91%) with US versus MRI in the diagnosis of full-thickness tears in 5,216 patients. Middleton et al.7 had 2 radiologists independently scan patients with shoulder pain, categorizing the rotator cuff as normal, partially torn, or fully torn, and they found low interobserver variability. The radiologists were in agreement in 92% of the patients. In 4 of the 5 discrepant cases, the disagreement was between a full-thickness and partial-thickness tear. They were in agreement concerning which tendons were involved in 80% of the patients in whom a tear was detected by both observers. In all discrepant cases, the disagreement was about whether a tear involved both tendons or was isolated to 1 tendon. Wall et al.8 examined the accuracy of US compared with MRI in identifying fatty degeneration and found that US accuracy was 93% for the supraspinatus and infraspinatus muscles and 88% for the teres minor.
The ability to diagnose rotator cuff pathology by use of US has been shown to be user dependent. Goldberg et al.9 showed that only 38% of cuff tears were diagnosed by community radiologists. They concluded that US, for diagnosing rotator cuff tears, may be limited to academic centers with well-trained radiologists.

US can also be used to assess rotator cuff repairs postoperatively (Fig 1). A recent study investigated serial US examinations in patients with large rotator cuff tears who underwent arthroscopic repair.10 Of the repaired rotator cuff tears, 9 (41%) showed recurrent tears. This study elegantly showed the appearance of a failing rotator cuff repair on serial US scans.

Sonographic evaluation of subscapularis repairs after total shoulder arthroplasty is a unique application and is considered more accurate than clinical examination findings. CT and MRI are difficult in this setting because of metal artifact. One study showed that 87% of patients had an intact repair at follow-up whereas abdominal compression tests had a sensitivity and specificity of 25% and 73%, respectively.11

US can also identify abnormalities affecting the biceps tendon. Such pathology includes effusion within the tendon sheath, tendon subluxation, or dislocation.12 The capacity for dynamic assessment with US has been shown to improve the accuracy of identifying biceps tendon instability to 86%.13

MRI with intra-articular gadolinium is the gold standard for diagnosing labral abnormalities. However, studies have shown that the sensitivity of US in the diagnosis of labral tears ranges from 67% to 95%.14,15 Paralabral cysts may also be identified. Evaluation of the periaricular structures should include imaging of the spinoglenoid notch and suprascapular notch because cysts in these regions may cause a suprascapular neuropathy.

US of the shoulder is increasingly being used for facilitation of minimally invasive procedures. A randomized, prospective study has shown no statistical difference in accuracy between blind subacromial injections and US-guided injections.16 However, other studies have shown 100% accuracy for image-guided subacromial injections versus 72% accuracy for non—image-guided injections of the subacromial bursa.17 Glenohumeral injections have been shown to be statistically more accurate with image guidance (92.5% to 95%) compared with a freehand technique (72.5% to 79%).17,18 Injections into the acromioclavicular joint have also shown significantly increased accuracy with image guidance (100%) versus blind injection (44%).17 Less commonly performed biceps tendon sheath injections have also been shown to be significantly more accurate with the use of US (87%) compared with blind injection (27%) (Fig 2).19

Calcific tendinosis of the rotator cuff is a common disorder. Both US-guided needle aspiration and extracorporeal shockwave therapy have been shown to improve clinical outcomes (Fig 3). Aspiration combined with shockwave therapy has been compared with shockwave therapy alone, and the combined treatment resulted in significantly improved Constant scores and a decreased progression to surgical debridement.20 A recent randomized, comparative investigation studied US-guided lavage of the calcific lesion and injection versus subacromial injection alone.21 Although both groups showed significant improvement compared with before the procedure, the lavage group had better clinical and radiographic results than the group that underwent injection alone. Symptomatic cysts in the spinoglenoid or suprascapular notch can be aspirated by use of US (Fig 4).22,23

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Table 1. Recommended Transducers Organized by Body Part According to Authors’ Preferences

<table>
<thead>
<tr>
<th>Scan</th>
<th>Probe</th>
<th>Frequency</th>
<th>Plane of View</th>
<th>Body Position</th>
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<td>Transverse</td>
<td>Lateral recumbent</td>
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<td>Transverse and axial</td>
<td>Supine</td>
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<td>15 MHz, small footprint</td>
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<td>Ankle</td>
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<td>Transverse and axial</td>
<td>Supine and prone</td>
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**Fig 1.** Recurrent supraspinatus tendon tear after prior repair. A longitudinal US image shows supraspinatus tendon retraction (white arrows) and discontinuity with the suture anchor (red arrow), reflecting recurrent tear.
In summary, US has shown equal or increased sensitivity and specificity versus MRI in the noninvasive diagnosis of common sports medicine shoulder pathologies, as well as increased accuracy for injections into the acromioclavicular and glenohumeral joints, subacromial bursa, and biceps tendon sheath. Increased accuracy of US-guided injections of all joints, particularly of the shoulder, is independent of the physician’s level of experience.24

Elbow
US is an effective imaging modality for the elbow. Abnormal signals in the soft tissues can identify pathology, including partial- and full-thickness tears of tendons, tendinosis, epicondylitis, ligament tears, ulnar nerve entrapment, olecranon bursitis, effusions, and loose bodies.25

Lateral and medial epicondylitis can be diagnosed with US because the involved tendon appears swollen and hypoechoic from degeneration with possible interstitial tears and an absence of inflammation. There is often tenderness with transducer pressure or cortical irregularity of the affected epicondyle.26 In lateral epicondylitis, US has been used to guide injections of corticosteroids or platelet-rich plasma (PRP) (Fig 5). US-guided injection of PRP compared with whole blood has been described in a recent study.27 Significantly improved visual analog scale (VAS) scores were seen in the PRP group. US-guided radiofrequency-based plasma microdebridement has been advocated recently as an effective method to treat recalcitrant lateral epicondylitis. Another treatment option, US-guided radiofrequency thermal lesioning, has shown statistically significant improvements at 6 months’ follow-up with regard to VAS score, grip strength, and Modified Mayo Clinic Performance Index.4

US can also lend insights into the presence and severity of collateral ligament pathology of the elbow (Fig 6). Ligament integrity and competency can be directly observed with dynamic maneuvers that stress the ligament to identify instability of the elbow, including pushing up from a chair or tabletop with a supinated forearm. The size of intrasubstance tears and the presence of a lateral ulnar collateral ligament (UCL) tear on US have been used to assess tendinopathy severity and predict response to treatment.28 Valgus instability of the elbow, including partial and complete tears of the UCL, can be identified on sonography statically by focal hypoechoic areas in the ligament. In addition, dynamic
US may be used to identify valgus instability. Medial joint widening to valgus stress should be no more than 0.5 to 1.0 mm when compared with the uninjured side. This is a helpful adjunct to MRI, which cannot provide the dynamic information and often shows chronic changes in the UCL that are of uncertain significance in the overhead athlete. Ciccotti et al.30 recently presented data based on dynamic elbow US scans that were performed bilaterally in 368 professional pitchers. The mean amount of stressed joint space, change in joint space, and presence of heterogeneity were significantly different in pitching arms when they compared initial and final US scans, but there were no significant differences in any parameters when they compared asymptomatic elbows with those that underwent subsequent UCL reconstruction.

Distal biceps ruptures can also be diagnosed with US. This imaging not only confirms the diagnosis but also can characterize the integrity of the lacertus fibrosis and quantify the degree of retraction superficial to the brachialis.31 Furthermore, US can identify musculotendinous junction injury, which may not benefit from surgical exploration (Fig 7).

Hip

In the past, US as a diagnostic modality for the hip was thought to be anecdotal.32 Recently, however, US has been used in both diagnostic and therapeutic protocols in and around the hip joint.

Coxa sulcans, or snapping hip, is a common cause of hip discomfort. The syndrome is classified into external, internal, and intra-articular causes. External snapping is typically attributed to the iliotibial band or the gluteus maximus tendons snapping over the greater trochanter. The internal type typically involves the iliopsoas snapping against the superior pubic ramus near the ilipectineal eminence.33 Intra-articular lesions may be due to a variety of causes, including loose bodies, labral tears, osteochondral fractures, or synovial chondromatosis. Recent radiologic advancements have shown great utility of US in sorting through these diagnoses (Fig 8). Pelsser et al.34 showed that a cause of snapping hip could be identified in 24 of 26 cases (92%). An evaluation of 26 ballet dancers with 50 snapping hips showed that US could identify a cause in 63%; intra-articular causes were suspected to account for the remaining one-third.35

Other muscles around the hip can also be evaluated with US, specifically the abductors. US can be used to evaluate partial- and full-thickness tears and tendinosis, all of which are commonly found in athletes.36 These pathologies can be viewed with both MRI and US, and a systematic review of gluteal tendon tear diagnostic accuracy by Westacott et al.37 found US to have a higher sensitivity and positive predictive value. This improved visualization may be combined with therapeutic interventions to offer accurately placed needle fenestration or injections for tendon pathology.

Few studies have investigated the role of US in the diagnosis of acetabular labral tears. Troelsen et al.38 reported a sensitivity of 44% and a positive predictive value of 88% and concluded that the use of US in diagnosing labral tears should be developed further. Subsequently, Troelsen et al.39 were able to diagnose labral tears with a sensitivity of 94% and a positive predictive value of 94%, as confirmed by magnetic resonance arthrography. This indicates that a significant learning curve may be associated with diagnosis of

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**Fig 3.** US-guided lavage for supraspinatus calcific tendinitis. (A) A transverse US image shows an echogenic mass within the supraspinatus tendon, reflecting a calcific tendinitis deposit (arrow). (B) A transverse image shows the needle entering the calcific deposit (arrow). (C) A transverse US image shows disbursement of calcification during lavage, now with internal areas of fluid (arrow).
intra-articular pathology using US. Most recently, a study evaluated the potential benefit of an intra-articular injection on the ability to diagnose an acetabular labral tear. Although the authors were able to show that the accuracy of US diagnosis of labral tears was improved with an intra-articular injection, they also found that the interobserver reliability was poor. Furthermore, they found that CT arthrograms were more accurate than US in this setting. We currently prefer MRI and, specifically, magnetic resonance arthrography to characterize pathology of the hip.

Sonographic guidance is commonly used in and around the hip. Injections and arthroscopic portal placement have been described using US. Trochanteric bursitis and associated gluteus medius tendinopathy have been treated with US-guided injections. One study found that 72% of patients with US-guided injections of the gluteus medius tendon showed clinically significant improvement as measured by VAS pain score. Smith et al. showed that sonographically guided intra-articular injections could be placed with 97% accuracy as verified by fluoroscopy. Sonography also allows for paralabral cyst aspirations in patients with hip pain who do not wish to undergo arthroscopic hip surgery. This has allowed for outpatient intra-articular hip injections to be an option without the risk of the radiation exposure that is associated with fluoroscopically or CT-guided injections.

US has also proven valuable in the setting of athletic pubalgia. Although this diagnosis is often based on clinical symptoms, a dynamic US evaluation of the abdominal wall musculature and fascia with a Valsalva maneuver has allowed for the identification of potentially reparable lesions. A recent prospective study also investigated the response of US-guided corticosteroid injections as a treatment modality for athletic pubalgia, in which 13 of 18 patients (72%) achieved an ideal outcome based on the Western Ontario and McMaster Universities Arthritis Index score.

**Knee**

There are many indications for US of the knee. Peripheral meniscus tears, patellar or quadriceps tendinopathy, and bursitis can be confirmed. This is particularly beneficial in claustrophobic patients or patients with implanted devices that preclude the use of MRI. In patients whose body habitus can make blind injections difficult because of loss of the normal anatomic landmarks, US provides a safe and accurate way to provide intra-articular injections.

Use of US in patellar tendinopathy (jumper’s knee) has shown benefit with regard to diagnosis and prognosis. In
a study investigating competitive athletes with clinical symptoms of jumper’s knee, 60% of the examined tendons displayed structural tendon changes with neovascularization and increased blood flow whereas 26% had structural changes alone and 14% were normal.45 This neovascularization may indicate that a patient could benefit from recently described therapies, such as US-guided sclerosis of neovessels using polidocanol.46

Cystic abnormalities about the knee can be identified and treated with US as well. Baker cysts represent distention of the semimembranosus—medial gastrocnemius bursa and are a significant source of pain and disability. Ward et al.47 showed that Baker cysts could be diagnosed with 100% accuracy as confirmed by MRI. US can also categorize cysts as either simple or complex. These categories were used to predict treatment outcomes in a prospective study of 32 patients.48 US has also been used in the treatment of Baker cysts by guiding both aspiration and localized corticosteroid injections. Bandinelli et al.49 showed that US-guided direct aspiration of a Baker cyst followed by US injection of steroid directly into the cyst resulted in a significantly smaller cyst compared with intra-articular injection. When one is aspirating a Baker cyst, it is critical to also aspirate any knee joint effusion, given potential communication between the Baker cyst and knee joint (Fig 9).

Ganglion cysts, though less common than Baker cysts, have also been described in and around the knee. They may be intra-articular or extra-articular and may not have a definable connection with the joint. They can occur in atypical locations, including the proximal tibiofibular joint, tendon sheaths, cruciates, or peripheral nerves.50 Jose et al. have reported success with aspirations of atypical symptomatic ganglion cysts, including an intraneural cyst of the tibial nerve51 and 1 associated with the popliteus tendon.52

Parameniscal cysts can be identified on US when a hypoechoic cyst is in contact with the meniscus.53 Macmahon et al.54 performed US-guided percutaneous drainage of parameniscal cysts in 18 patients. Ten patients reported complete resolution of symptoms and returned to high-level sports, and all had a pain-free interval of at least 1 week. A coexisting meniscal tear is present in approximately 85% of cases and may also be visualized with US.53 Shetty et al.55 performed a prospective study investigating the accuracy of diagnosing meniscal tears by US in comparison with MRI, as confirmed by arthroscopy. For US, there was a sensitivity of 86.4%, a specificity of 69.2%, a positive predictive value of 82.6%, and a negative predictive value of 75%. This compared with a sensitivity of 86.4%, a specificity of 100.0%, a positive predictive value of 100.0%, and a negative predictive value of 81.3% for MRI. The similar sensitivity between modalities implies that US can be applied to confirm the clinical diagnosis but MRI remains the standard of care because US is limited with regard to a comprehensive evaluation of the meniscus. However, in patients who cannot undergo MRI, US is a viable alternative.

Intra-articular knee injections are commonly performed in clinical practice. The placement of these injections can be significantly improved with US guidance compared with freehand.56,57 A systematic review by Berkoff et al.56...
found that sonography-guided intra-articular knee injections improved accuracy to 95.8% compared with accuracy of 77.8% for anatomic guidance. In addition, it has been found that accurate intra-articular injections have significantly improved clinical outcomes.

Foot and Ankle

Achilles tendon abnormalities that have been diagnosed by US include tendinosis, partial- and full-thickness tears, and Haglund syndrome. Surrounding structures that may also be identified during examination include the plantaris tendon, retrocalcaneal bursa, retro-Achilles bursa, and gastrocnemius musculature and aponeurosis.

Achilles tendinopathy can be both diagnosed and treated with the use of sonography. US of Achilles tendinopathy has resulted in the development of a grading scheme that has been shown to predict healing times. In a placebo-controlled study of US-guided peritendinous steroid injection in athletes with Achilles tendinopathy, Fredberg and Ostgaard found that the steroid group had reduced pain and tendon thickening compared with the placebo group. Koenig et al. investigated color Doppler-guided injections of glucocorticoids in 6 tendons. They concluded that color Doppler significantly contributes to Achilles tendonitis diagnosis, location, and follow-up. Early studies of sclerotherapy of neovessels using US-guided polidocanol injections have achieved encouraging results. One study of polidocanol injections at 3 months' follow-up showed significantly reduced tendon pain when compared with controls. Clinical follow-up at 2 years showed good results with a significant reduction in the mean tendon thickness, as well as a reduction in the number of neovessels in treated tendons. A recent technique has been described for US-guided injection of PRP into the tendon and paratenon in the presence of Achilles tendinopathy.

Other modalities using US guidance with some degree of success include high-volume saline solution injections, electrocoagulation of neovessels, intratendinous injection of hyperosmolar dextrose, and percutaneous tenotomy.

US is also valuable in the diagnosis and characterization of traumatic Achilles tendon injuries. US is reliably used to diagnose complete Achilles tendon tears, estimate the severity and location of the abnormality, and assist in preoperative planning by identifying the location of the tear. Recent studies have evaluated the use of dynamic US in acute complete Achilles tendon rupture as a method of evaluating the reduction of the tendon gap, as well as better determining whether to recommend operative versus nonoperative management. Qureshi et al. evaluated 125 patients with acute Achilles tendon ruptures with dynamic US. Patients with a gap of 5 mm or more in equinus on US underwent surgery, whereas those with a gap of less than 5 mm received nonoperative treatment. There were 2 reruptures in the nonoperative group and 1 in

**Fig 8.** Iliopsoas complex with snapping hip syndrome. (A) A short-axis US image of the iliopsoas tendon shows the medial fibers of the iliacus (MFI) with a segment of iliacus muscle (arrow) entrapped between the psoas major tendon (PMT) and superior pubic ramus (SPR) with the hip in abduction, flexion, and external rotation. (B) The entrapped muscle is then released with the hip in a full-extension position, causing an abrupt snapping movement of the psoas major tendon to contact the superior pubic ramus (right side of image is medial).

**Fig 9.** A transverse image shows the needle (arrow) within a Baker cyst, inserted from a posteromedial approach. The patient underwent US imaging in a prone position.
US is also well suited for the evaluation of other tendons and ligament injuries about the ankle. The resolution of modern US allows for detailed evaluation of tendon architecture (Table 2). Skilled radiologists are able to identify a spectrum of pathology based on findings, including tendinosis, tenosynovitis, and tears. Waitches et al. have shown 100% sensitivity and 88% specificity in the diagnosis of tears involving the peroneal, posterior tibial, and flexor digitorum longus tendons. More recently, Grant et al. found US to have a sensitivity of 100% and specificity of 85% in diagnosing peroneal tendon tears with surgical correlation. A cadaveric study comparing MRI and US in diagnosing surgically created posterior tibial tendon tears found the 2 imaging modalities to be equally sensitive and accurate, with US being more specific. This study suggests that US can be more appropriate than MRI in the evaluation of posterior tibial tendon tears. A preliminary study recently investigated the accuracy of dynamic US in the diagnosis of ankle syndesmotic injury in professional athletes and found a sensitivity and specificity of 100%, as confirmed by MRI. Identification of tendon subluxation is important not only to explain patient symptoms but also to allow prompt treatment. Neustadter et al. evaluated 13 consecutive patients in whom peroneal tendon subluxation was clinically suspected with dynamic US. Of the 13 patients, 12 had sonographic findings of peroneal tendon subluxation that was confirmed by subsequent surgery. Sonography showed peroneus brevis tendon tears in 5 patients and a peroneus longus tear in 1 patient; all findings were confirmed at surgery, with no false-positive sonograms. A study of 14 patients with 2 subtypes of intrasheath subluxation yielded results of 100% sonographic accuracy after intraoperative confirmation.

Plantar fasciitis is a diagnosis commonly encountered in orthopaedics. Studies have proven the diagnostic efficacy of sonography in the evaluation of plantar fasciitis. Findings included hypoechoic plantar fascia as well as significantly increased fascia thickness in patients with symptomatic heels when compared with patients with asymptomatic heels and a control group. With advances such as power Doppler US, additional information on neovascularity can aid in the diagnosis and treatment. Walthen et al. compared 20 patients with a diagnosis of unilateral plantar fasciitis and 20 healthy volunteers and found moderate hyperemia in 40% of the symptomatic heels compared with 5% of the asymptomatic heels. McMillan et al. randomized 82 patients with plantar fasciitis to US-guided injections of corticosteroid or normal saline solution. At 4 weeks, there was a significant reduction in pain scores in the steroid group. Corticosteroid injections are often used, but palpation-guided injections are not always accurate. With inaccurate injections of corticosteroid, the complications can include heel fat pad atrophy and fascia rupture, emphasizing the importance of accurate injection. In a study of 4 patients who were unresponsive to palpation-guided injection, Kane et al. used US-guided injections and found complete relief at 24 months in 4 of 5 heels. Tsai et al. confirmed these findings in a subsequent study of 14 patients with unilateral plantar fasciitis; after US-guided injections, the patients had significantly improved VAS scores, decreases in thickness, and improved echogenicity, as well as no change in the properties of the heel fat pad. A
subsequent study by Tsai et al. showed that although both US-guided and blind injections produced decreases in thickness, improved echogenicity, and improved VAS scores, the US-guided group had a significantly decreased recurrence rate (8%) compared with the palpation-guided group (46%). Other injections of the foot and ankle may also be facilitated by US guidance. Wisniewski et al. injected 40 cadaveric ankles, randomizing between US guidance and a blind anterior technique. The accuracy rate for guided tibiotalar joint injections was 100% versus 85% and a blind anterior technique. The accuracy rate for sinus tarsi injections was 90% for guided injections versus 35% for blind injections. This shows the accuracy of US-guided injections over conventional blind injection techniques using superficial anatomic landmarks alone.

Conclusions

Sonography is an excellent imaging modality for the diagnosis and treatment of common musculoskeletal injuries that avoids the risk of ionizing radiation or contrast material. It is useful in the presence of metallic hardware and offers equal or higher diagnostic sensitivity and specificity compared with MRI in a wide variety of musculoskeletal disorders. It is particularly useful in the identification of pain generators that are evident with dynamic, provocative maneuvers. US-guided injection of intra-articular and periarticular structures is reliable and improves accuracy compared with conventional blind techniques. Close communication between the orthopaedic surgeon and the sonographer is essential for a successful and meaningful evaluation, but the combination of clinical examination and dynamic imaging can offer great synergy for improved diagnostic accuracy and clinical outcomes after US-assisted procedures.

References

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55. Shetty AA, Tindall AJ, James KD, Relwani J, Fernando KW. Accuracy of hand-held ultrasound...


